QUALITY OF TRANS-AMADI CREEK IN THE VICINITY OF AN ABATTOIR.

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CERTIFICATION

This is to certify that this project work titled: "**Quality of Trans-Amadi Creek in the Vicinity of an Abattoir**" was carried out by **Adiele Godspower**, with Registration Number **20144913898**, in partial fulfillment for the award of the degree of Master of Science (M.Sc) in the Department of Environmental Management, Federal University of Technology, Owerri.

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DEDICATION

I Dedicate this work to my Foster Mother Mrs. Anthonia Chike who made me to forget the pain of Motherlessness and gave me all that I needed to be at this level. Sister I owe you Much.

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TABLE OF CONTENTS

Page	
Title page	i
Certification	ii
Dedication	iii
Acknowledgement	iv
Table of Contents	v
List of Tables	x
List of figures	xi
List of appendixes	xii
Abstract	xiii
CHAPTER ONE	
1.0 Introduction	1
1.1 Background of the study	1
1.2 Statement of problem	5
1.3 Research Aim and Objectives	6
1.4 Scope of the study	7
1.5 Justification of the Study	7
CHAPTER TWO	
2.0 Literature Review	9
2.1 Water as a Resource	9
2.2 Surface Water Quality and Anthropogenic Activities	12
2.3 Water and Health	14
2.3.1 Water as a direct Vehicle for Disease Transmission	14

2.3.2 Water as a Vector Habitat in Disease Transmission 15
2.3.3 Water as Vehicle for transmitting Toxic Chemicals 16
2.3.4 Beneficial Health Effects 17
2.4 Abattoirs 18
2.4.1 Characterization of Abattoir wastes 19
2.4.2 Effects of Abattoir Effluent 20
2.4.2.1 Effects of Abattoir Operation/Effluent on Air 21
2.4.2.2 Effects of Abattoir Effluent on Soil 23
2.4.2.3 Effects of Abattoir Effluent on Water 24
2.4.2.4 Effects of Abattoir Effluent on Aquatic Lives 25
2.4.2.5 Effects of Abattoir Effluent on Humans 27
2.4.3 The Nigerian Experience 29
2.5 Parameters frequently Examined in the determination of Water Quality 31
2.5.1 Physico-Chemical Parameters 31
2.5.2 Microbiological Parameters 37
2.6 Water Pollution and Control in Nigeria 40
2.7 Water Laws and Standards 42
2.7.1 Water Standards 42
2.7.2 Water use Rights/Laws 43
2.8 Water Quality Index 44

CHAPTER THREE

3.0 Research Methodology 48
3.1 Description of the Study Area 48
3.1.1 Geology 48

3.1.2 Climate 49
3.1.3 Vegetation 49
3.1.4 Socio-Economic Activities 50
3.2 Sampling 51
3.2.1 Description of Sampling Location 51
3.2.2 Sampling Methodology 52
3.2.3 Samples Labels 53
3.3 Analytical Techniques 53
3.3.1 Physico-Chemical Analysis 53
3.3.1.1 PH 53
3.3.1.2 Colour 54
3.3.1.3 Electrical Conductivity 54
3.3.1.4 Total Dissolved Solids(TDS) 54
3.3.1.5 Suspended Solids (SS) 55
3.3.1.6 Dissolved Oxygen (DO) 55
3.3.1.7 Alkalinity 56
3.3.1.8 Chloride 56
3.3.1.9 Total Hardness (TH) 57
3.3.1.10 Phosphate 58
3.3.1.11 Sulphate 60
3.3.1.12 Nitrate 62
3.3.1.13 Biological Oxygen Demand (BOD) 63
3.3.1.14 Chemical Oxygen Demand (COD) 64
3.3.1.15 Determination of Zinc 65
3.3.2 Bacteriological Analysis 65

3.3.2.1 Total Heterotrophic Count 65
3.3.2.2 Total Coliform Count 66
3.3.2.3 Total Faecal Coliform (E.Coli) Count 66
3.4 Data Analysis 66

CHAPTER FOUR

4.0 Results and Discussions 67
4.1 Statement of Results 67
4.1.1 Levels of Physico-Chemical Parameters of Trans-amadiCreeek 67
4.1.2 Levels of Bacteriological Parameters of Trans-amadi Creek 69
4.2 Data Analysis 70
4.2.1 Spatial Variation in Physico-Chemical Parameters in Water Sample of Trans-amadi Creek 70
4.2.2 Variance between the Qualities of the Upstream, Midstream, and Downstream River Samples of the Study Area 76
4.2.3 Water Quality Index Analysis 77
4.3 Discussion 78
4.3.1 Variation in the levels PH, Alkalinity, Odour and Zinc 78
4.3.2 Variation in the levels of Colour, TSS and TDS 79
4.3.3 Variation in the levels of EC, Total Hardness and Chloride 80
4.3.4 Variation in the levels of Phosphorus, Sulphate, Phosphate and Nitrogen-Nitrate 81
4.3.5 Variation in the levels of DO, COD and BOD 83
4.3.6 Variation in the levels of Total Heterotrophic Count, Total Coliform and Escherichia Coli 85

CHAPTER FIVE

5.0 Summary of Findings, Recommendations and Conclusion 88

5.1 Summary of Findings 88

5.2 Recommendations 89

5.2.1. Provisional Recommendation 90

5.3 Conclusion 94

5.4 Contribution to Knowledge 95

References 96

Appendixes 104

LIST OF TABLES

Table		Page
2.1	Nigerian States, key Industries and waste characterization	41
2.2	Water Quality Index Scale	45
4.1	Physico-Chemical Quality of Trans-amadi Creek at various sampling points	68
4.2	Bacteriological Quality of Trans-amadi Creek at Various sampling Points	69
4.3	Analysis of Variance(ANOVA) Result of the Physico-Chemical and Bacteriological analysis across the sampling points	76
4.4	Water Quality Index Value across the three sampled points of Trans-amadi Creek.	77

LIST OF FIGURES

Figure		Page
3.1	Map Showing the Study Area	50
4.1	Variation in the levels of PH, Alkalinity and Zinc of Trans-Amadi Creek at three sampling points	70
4.2	Variation the levels of Colour, TSS and TDS of Trans-amadi Creek at three sampling points	71
4.3	Variation in the levels of Electrical Conductivity, Total Hardness, and Chloride of Trans-amadi Creek at three sampling points	72
4.4	Variation in the levels of Phosphorus, Sulphate, Nitrate, Phosphate and Nitrate-Nitrogen of Trans-amadi Creek at three Samplingpoints	73
4.5	Variation in the levels of Dissolved Oxygen, COD and BOD of Trans-amadiCreek at three sampling points	74
4.6	Variation in the levels of Total Heterotrophic Count, Total Coliform and Escherichia Coli of Trans-amadi Creek at three sampling points.	75

LIST OF APPENDIXES

Appendix page

1, 2 and 3 Plates showing various discharge points of abattoir wastes into the Trans-amadi Creek 104

4 Comparism of the values of Physico-Chemical Parameters of Trans-amadi Creek at three sampling points to WHO (2011) and FEPA (1991) standards. 107

ABSTRACT

This study presents the effect of abattoir waste and waste water on the quality of the Trans-amadi Creek, Port Harcourt, Rivers State. Physico-chemical and bacteriological parameters were assessed to evaluate the effect of the abattoir discharge in the Creek. Water samples from the Trans-Amadi Creek were collected from three locations, the upstream, middle-stream (point of abattoir effluent discharge) and the downstream. *In-situ* measurements were made and water samples collected with sample bottles according to standard methods for laboratory analysis. Analysis of variance and Water Quality Index were used to analyze the data. Values of the parameters obtained at the upstream, middle-stream and downstream were: pH 4.46, 5.09 and 5.51, color 10, 10 and 5pt/co, TDS 32, 25 and 22mg/l, electrical conductivity 50, 38 and 34 us/cm, TSS 6.5, 10.5 and 6.0mg/l, alkalinity 1.04, 1.54 and 1.55mg/l, total hardness 1243, 1505 and 1690mg/l, chloride 1205, 1820 and 3620mg/l, NO_3 15.1, 16.60 and 18.10mg/l, Nitrate-nitrogen 3.40, 3.70 and 4.10mg/l, SO_4 36.1, 42.1 and 37.5mg/l, NH4 1.02. ND and ND, DO 4.40, 4.25 and 4.35mg/l, BOD 3.20, 3.60 and 3.40mg/l, COD 142.5, 140.6 and 135.1mg/l, Phosphate 1.50, 0.50 and 1.40mg/l, Phosphorus 0.50, 0.20 and 0.40mg/l, Zn 0.260, 0.108 and 0.230, THC 2600, 2150 and 2860cfu/100ml, Total Faecal Coliform 110, 150 and 320cfu/100ml, *E.Coli* 30, 40 and 100cfu/100ml respectively.High concentration of TSS, SO4 and BOD were recorded at the point of abattoir discharge. Also TSS, TH, chloride, COD, THC, Total coliform and *E.coli* were above the WHO 2011 and FEPA 1991 acceptable limit for drinking water. The results of the Water Quality Index shows the river is not of good quality. From the findings, it is recommended that there should be sensitization on the importance of proper waste disposal and the implication of improper waste disposal within the environment.

Keywords: Abattoir, Downstream, Upstream, Wastewater, In-situ, Concentration.

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND TO THE STUDY

The management practice of abattoir in developing countries like ours is very poor; these have increased the pollution of surface and ground waters from animal wastes which calls for environmental and health concern (Millard et al, 1994). High loading rate of sediment, nitrogen, phosphorus and even pathogens to soil and water can occur from animal operations such as grazing and abattoir business (Besser et al, 1993). Concentration of Nitrogen in excess of 10mg/l in the nitrate (No_3) form renders groundwater unsuitable for drinking. Phosphate could be transported with the sediments to lakes and streams where its most significant effect is eutrophication (Clark, 1998). Animal wastes have been shown to be a source of micro-organism pathogenic to humans (Howell et al, 1996). When surface runoff occurs due to rainfall, contamination of water resources by enteric bacteria may result. The same bodies of water are used for sources of drinking water or recreational activities.

The wastes from abattoir operations which are often separated into solid, liquid and fats could be highly organic. The solid part of the wastes consists of condensed meat, undigested ingest, bones, hairs and aborted foetuses. The liquid aspect on the other hand consists of dissolved solids blood, guts contents, urine and water, while the Fat waste consist of fats and oil. The pollution of water resources often results in the destruction of primary producers which in turn leads to an immediate diminishing impact on fish yield, with the resultant consequences of decrease in diet (Aina and Adedipe (1991).

Clean water resources used for drinking, sustaining aquatic and terrestrial ecology, industry and aesthetic values, along with breathable air, rank as the most fundamental and important need of all viable communities. These water resources should remain within specific quality limits, and therefore require stringent and conservative protection measures. Raymond (1977) reported that animal wastes can affect water, land or air qualities if proper practices of management are not adhered to. The same wastes however, can be valuable for crops but can also cause water quality impairment. It also contain organic solids, trace heavy metals, salts, bacteria, viruses, other micro-organisms and even sediments. Also, improper animal waste disposal can lead to animal diseases being transmitted to humans through contact with animal faeces. Sangodoyin*et al*, (1992) reported that the groundwater quality in vicinity of abattoir were adversely affected by seepage of abattoir effluent as well as water quality of receiving streams that was located away from the abattoir.

Port Harcourt – the capital of Rivers State has generally witnessed large scale infrastructural and population changes since the last two decades. The population dynamics have by far exceeded those infrastructure and other social amenities. The cumulative impact of this scenario has been an overstretching of most basic amenities. The Port Harcourt abattoir serves more than 80% of the town, and its location beside the stream has facilitated easy disposal of the wastes into the stream channels, even without any proper treatment. Port Harcourt abattoir on Thursdays, Fridays and Saturdays slaughter over 400 cows, 40 rams, and 1000 goats, and lesser number on Monday to Wednesday. The weekends serves as their peak days of business. Also, the Port Harcourt abattoir is divided into different units- there are areas for food stuff, slaughtering and di-section of animals, roasting and scrapping of the animal skin, and area where the animal intestines are cleaned. The unites of Roasting and scrapping, and intestine cleaning are more close to the stream although they do not make use of the stream water in their cleaning works as it has become obvious even to the lay persons that the water is heavily polluted. The management of the abattoir always provide steady light for the pumping of their borehole. The wastes that emanates from these various units varies; From the food stuff unit—wastes like waterproof, vegetable leaves, and some fall-off of crayfish and other cooking items exist. From the slaughtering and dissecting unit-the major wastes that emanate is blood and bones. Also, wastes like animal horn, dirty water and some tire and wood remnants used as fuel for the roasting of animal skin emanate from roasting and scrapping unit, while the intestine cleaning unit produce wastes like animal dung, and waste/dirty water. This very unit make more use of water than any other unit in the abattoir.

This research therefore attempts to examine the implication of the continuous discharge of these abattoir wastes into the stream water on the water quality. The research is to evaluate the water quality at some locations in the stream channel, with the aim of establishing the extent to which untreated abattoir wastes would have impacted on the stream water quality.

1.2 STATEMENT OF PROBLEM

As previously mentioned, Trans-Amadi creek flows at the back of Port Harcourt abattoir. The creek is deteriorated in terms of its quality and certain hydrological conditions.

Along its course the deteriorating hydrological status and water quality of the Trans-Amadi creek over the past two decades have become issues of concern to local authorities, residents and business people within the area as well as the downstream land users. Issues of concern include microbial pollution, urban littering and silting up of the creek. Additional to these, the creek has also become unfit for recreational use and are fed by water of poor quality for the well-being of the aquatic ecosystem.

This study aims to establish the present water quality and condition of the creek in terms of the hydrological status. Existing water quality data (physico-chemical and microbiological constituent concentrations) are compared to the water quality guidelines as set by WHO to determine the suitability of the creek for consumption.

1.3 RESEARCH AIM-AND OBJECTIVES

The aim of this research was to determine the effect of abattoir waste on the physico-chemical content of Trans-Amadi Creek in order to have a general knowledge of the composition, and changes in this water that renders it unfit for consumption and other domestic uses.

The research objectives are:

a. Measurement/Determination of the physico-chemical quality of Trans-Amadi Creek at three different points.
b. Measurement/Determination of the microbiological quality of Trans-Amadi creek at three different points.
c. To compare results obtained from the analysis with regulatory Standards
d. To make recommendations where necessary in order to protect human health and encourage healthy aquatic ecosystem if found adverse.

1.4 SCOPE OF THE STUDY

The study consisted of a field survey, sampling exercise, a laboratory analysis of samples obtained and an interpretation of laboratory data using statistical method and also comparing the data with the WHO 2011 and FEPA 1991 standard.

The quality sample of water obtained from the Creek will be analyzed for physico-chemical parameters of pH, Total dissolved solids, Electrical conductivity, phosphate, Nitrate, Nitrite, Total suspended solids, COD, BOD, Ammonia, Phosphorus, Total Hardness, Colour, Chloride, Odour, zinc, Alkalinity, and DO, and also for Bacteriological Parameters of Total Heterotrophic count (THC), Total Coliform(TC) and Escherishia Coli (EC) at three (3) different points being the upstream (sample point A), middle-stream (sample point B) and the downstream (sample point C) at different intervals.

1.5 JUSTIFICATION OF THE STUDY

The importance of water in the live of humans, plants and animals cannot be over-emphasized, be it ground or surface water. While some people draw water from the river for various uses, others dump their wastes intothe creek, thus using the creek as a waste disposal facility. This conflict arising from the diverse interests and uncoordinated activities of people (which include commercial ventures) has put a large proportion of the consumers of the products of the water from the creek at high risk. However, one cannot entirely sacrifice commercial activities (which translate to economic growth) because of their effluents discharge alone. This is where the need for regulations comes in. However, regulation cannot be formulated without the scientific study of the creek, the type and concentration of the pollutants discharged into the creek, the economic advantage of the activities of the commercial users and the future potential uses to which the creek can be put (Anyata et al, 2000). The study therefore is to look into the impact of the effluents being discharged at different points along the water course, taking abattoir effluents as the case study.

Among all the identifiable source of pollution of the Trans-Amadi Creek, the most potent pollution is the abattoir effluent discharge. This is because of its high organic content, its concentrated discharge and volume of waste generated daily. The abattoir was thus adopted as the case study.

CHAPTER TWO

LITERATURE REVIEW

2.1: WATER AS A RESOURCE

Water is a marvelous substance flowing, rippling, swirling around obstacles in its path, seeping, dripping, trickling, constantly moving from sea to land and back again. Water can be clear, crystalline, Icy green in a mountain stream or black and opaque in a cypress swap (Cunningham et al, 2005). Water bug skitter across the surface of the quiet lake; a stream cascades down a stair step ledge of rock; waves roll endlessly up a sand beach, crush in a welter of foam, and recede. Rainfalls in a gentle mist, refreshing plants and animals. A violent thunderstorm floods a meadow, washing away streak banks. Water is a most beautiful and precious resource (Cunningham et al, 2005).

Water the second most important necessity of man performs three roles of regulating the body temperature, transporting body nutrients to other vital organs, and carrying waste out of our internal body organs (Akaninyene et al; 2000). Water resources are used in various ways including direct consumption, agricultural irrigation, fisheries, hydropower, industrial production, recreation, navigation, environmental protection, the disposal and treatment of sewage and industry effluents. Water has sources and supplies, economic, social and political characteristics which makes it unique and challenging natural resources to manage (Medalye&Hubbert, 2008).

Water resources refer to the supply of ground water and surface water in a given area. Water resources may also reference the current or potential value of the resources to the community and the environments. The maximum rate that water is potentially available for human use and management is often considered the best measure of the total water resources of a given regions. Approximately 30% of the world's fresh water is in liquid form and therefore potentially accessible for human use and management at any given time; the rest is either locked up in a polar or glacial ice or water vapour. Of the 30% of fresh water in liquid form, almost all is held in ground water (Medalye and Hubbert, 2008).

Clean, fresh water is essential for nearly every human endeavor. Perhaps more than any other environmental factor, the availability of water determines the location and activities of humans on earth. Renewable water supplies are made up in general, or surface run-off plus infiltration into accessible fresh water aquifers. About two-third of the water carried into the rivers and streams every year occurs in seasonal floods that are too large or violent to be stored or trapped effectively for human use. Stable run-off is the dependable, renewable year-round supply of surface water. Much of this occurs however, in sparsely inhabited regions or where technology, finances, or other factors makes it difficult to use it productively. Still, the readily accessible, renewable water supplies are very large, amounting to some 1,500km^3 (about 400,000gal) per person per year worldwide (Cunningham, 2008).

The value of usable water to future generations is hard to qualify and define and requires consideration of quantity, quality, timing and accessibility. As well, the value of water to particular uses depends crucially on its location, quality and timing. Its location determines its accessibility and costs. Its quality affects whether it can be used, and what treatment cost it will require. The time when it is available governs its reliability and its relative value for power, irrigation, environment or portable uses (FAO, 1995).

The availability of water determines the location and activities of human in an area and our growing population is placing great demands upon natural fresh water resources. Technological growth has also put the ecosystem we depend on under stress and the availability of water at high risk (Chukwuka, 2013).

Rivers State like quite a number of states in Nigeria is faced with increasing pressure on water resources and the wide spread, long lasting water shortages in many areas as a result of rising demand, unequal distribution and increasing pollution of existing water supply. The bye-product of agricultural activities, urbanization, and industrialization results in pollution and degradation of the available water resources (Waziri et al, 2009).

It is therefore important to analyze water and determine its suitability for drink, domestic use, industrial use, agricultural use etc. it is also important in water quality studies to know the amount of organic matter present in the system and quantity of the oxygen required for the stabilization of the water.

2.2 SURFACE WATER QUALITY AND ANTHROPOGENIC ACTIVITIES

According to United State Geological Survey (2011), pure water doesn't really exist in nature. Water, known as the "Universal Solvent always contains traces of substances with which it has been in contact. This is because most gases and rocks, on contact, dissolve in water. In water quality monitoring, concern is centered on keeping impurities within safe limits. Anyata et al, (2000) defined water pollution as the befouling of aquatic environment in such a way that it interferes with the intended use of water. Thus, while water may contain certain pollutants, it may not be described as polluted provided it meets the intended use for which it was designated. The source of pollution could be concentrated at a point or randomly deposited in the water body. When the former is the case, it is described as point source. When the latter is the case, it is called non-point source.

Surface water can be described as any naturally occurring body of fresh water that is exposed to the atmosphere. This definition includes rivers, lakes, streams, brooks and swamps. Such water is available for use for all forms of human needs, which include domestic consumption, fish propagation, irrigation, recreation and aesthetic/landscaping purposes. However, as in all cases where man utilizes any of the provisions of nature, pollution is bound to happen. When this pollution continues without any form of control or mitigation, environmental degradation sets in. Therefore, in order to protect the sustainability of the environment and by extension future users of this freely occurring and highly essential element of nature, it becomes imperative to see to it that minimum water quality standards are adhered to. Surface water contamination or pollution is a major issue when it comes to water resources.

2.3 WATER AND HEALTH

According to Akhionbare (2015), there exist certain relationships between water and health. Such relationship is divided into four categories as follows:-

2.3.1 WATER AS A DIRECT VEHICLE FOR DISEASE TRANSMISSION

Research has confirm at least 36 infectious diseases that probably can be transmitted directly by water. They include 12 diseases caused by bacteria, 4 by viruses, 19 by protozoa and other parasites and 1 by several different infectious agents. Examples are amoebiasis, balantidiasis, giardiasis are caused by protozoas; angiostrongyliasis, anisakiasis, hepatic capillariasis and gnathostomiasis caused by nematodes; cholera, enteropathogenic diarrhea, leptospirosis salmonallosis and typhoid fever caused by bacteria; hepatitis A and poliomyelitis caused by viruses; fascioliasis, paragonimiasisandschistosomiasis caused by nematodes etc. These are termed "waterborne diseases.

2.3.2 WATER AS A VECTOR HABITAT IN DISEASE TRANSMISSION

Several diseases are transmitted by organisms that require water as a habitat for at least part of their life cycles. Of those "vectors", the mosquito is best known and is responsible for transmitting such deadly diseases as malaria, yellow fever, filariasis and encephalitis.

Malaria: The role of water is the mosquito life cycle requires water to receive the eggs and allow the growth of the larvae until adult mosquitoes emerge. Without a proper water environment, development of the mosquito would be impossible breaking the chain for transmitting the disease. Eradicating or preventing the development of mosquitoes is the basis for practical malaria control programs. That is equally true for other mosquito-borne diseases like yellow fever, filariasis and human encephalitis. A similar situation exists for onchocerchiasis a disease transmitted by flies.

2.3.3 WATER AS A VEHICLE FOR TRANSMITTING TOXIC CHEMICALS

The number, type and quantities of potentially toxic and suspicious chemicals added to our environment has increased over the years. Water is an important vehicle for transmitting those agents to potential victims.

Water is only one route by which persons may be exposed to toxic chemicals. Other major sources include the food chain and air pollution. Three different problems are encountered here namely;

1. **Acute Toxicity:** In which adverse effects of the agent are observed quickly, usually within minutes e.g. high dosage of CN, As, F. It is also common with methaemoglobinaemia-blue babies problem that results from the consumption of water containing excessive concentration of nitrates by infants. Acute toxicity represents the simplest toxicity problem to evaluate and easiest to control.
2. **Chronic Toxicity:** Effects may not be observed until exposure to the chemical has occurred for an extended period of time. e.g. heavy metals, persistent organics which accumulate in the victim for months/years before reaching a body burden high enough to cause observable symptoms and illness. Thereafter the problem is

irreversible as the body cannot release the accumulated concentrations. e.g. poisoning by Hg, Pb, Cd, As and PCB's.

3. **Genetic Toxicity:** Here, there may be no visible effect on the victim, but it may surface in his offspring e.g. radiation, birth defect from using various drugs. Little is known about them because of limited technology.

2.3.4BENEFICIAL HEALTH EFFECTS

Various benefits accrue from water and its constituents. Namely:

1. Satisfying our metabolic needs for water, without which life can only continue for a short time. It is crucial for survival.
2. Several chemicals in water are beneficial

- ❖ Floride – reduces dental caries among young people
- ❖ Iodine – prevent goiter
- ❖ Calcium and magnesium- offset the negative effect of sodium in hypertension and heart disease
- ❖ Trace minerals – Insure human nutritional requirements

3. Agents of improved cleanliness and general sanitation. Better water supply facilities usually lead to a reduction in many water-borne disease .e.g. UNICEF. Water programme in the third world countries.

2.4 ABATTOIRS

Slaughter houses also known as abattoir is a place where animals are butchered for food according to Environmental Dictionary. Abattoir Act 1998 cited by Chukwuka 2013 defined abattoir as any premises used in connections with the slaughter of animals whose meat is intended for human consumption and include a slaughter house but does not include a place situated on a farm. Animals include cattle, sheep, goats, pigs and other equine animals (Chukwuka, 2013).

One of the greatest threats to surface water quality and general environmental safety and health is the waste from abattoir. This is because they pollute all phases of the environment namely land, water and air. Wastes emanating from slaughtered animals are basically in solid and liquid states. However, the gases and the odor emitted from putrefying waste become very offensive to the nostrils.

2.4.1 CHARACTERIZATION OF ABATTOIR WASTES

Waster from slaughter houses include fat, grease, hair, feathers, flesh, manure, grit and undigested feed, blood, bones and the wastewater (Omole, 2006). A world bank report of 1998 informs that the total amount of waste produced per animal (cow) slaughtered is approximately 35% of the animal weight. The matured animal weighs 400kg (thin), 550kg (moderate) or 750kg (extremely fat) (Hammack et al, 2002). Scahill (2003) also informed that if a cow weighs 400kg, the carcass would be about 200kg after slaughter (50%). After passing through the butcher, it looses about one third in fat and bone, so a 400kg live weight animal should give 140kg (35%) of edible meat. Gannon et al (2006); also showed from studies that each cow slaughtered produces 13.6kg of blood (with brine blood density ranging between 0.01g/kc - 0.15gkc). Moreover, the amount of water that is required for the rendering (processing) of slaughtered animal ranges from 1.5-10m^3/tone of product for hogs, 2.5-40m^3/tone of product for cattle and 6-30m^3/tone of poultry. Scahill (2003) believes 2.5m^3 of water is used to process each cow slaughtered. This studies also reviewed that for every tone of carcass weight a slaughtered beef produces

5.5kg of manure (not including rumen content or manure) and 100kg of paunch manure (partially digested food).

2.4.2EFFECTS OF ABATTOIR EFFLUENT

Livestock production which is perceived by the public to be potential food for the world's needy people, is a major pollutant of the country side (where the animals are raised) and cities, if processors do not manage slaughter wastes properly with dung and slurry washed into water ways. Improper management of abattoir wastes and subsequent disposal either directly or indirectly into River bodies potends serious environmental and health hazard both to aquatic lives and humans (Chukwuka, 2013).

The pollution load on a water body from abattoir effluent can be quite high, for example, studies done in Canada (Mittal, 2004) and Nigeria (Adie and Osibanjo, 2007) Showed a very high contaminants levels which are known to be hazardous to human beings and aquatic lives.

2.4.2.1 EFFECTS OF ABATTOIR OPERATION/EFFLUENT ON AIR

Noise pollution was reported by Oyedemi (2004) to be associated with abattoir activities and location. In abattoirs, noise can be generated by several sources, including:

- Animals especially when in concentrated groups
- Processing activities within the slaughter house
- Plant machinery
- Plant and service vehicles.

Noise from the slaughter house and by-product area is generated by mechanical plants (such as conveyors), ventilation plants, air conditioning, stunning boxes, compressed air equipment, pumps and rendering plants. Some of these equipment may need to operate 24 hours a day. An abattoir is serviced by a variety of vehicles including trucks and forklifts (Chukwuka, 2013).

Moreover, an abattoir operation brings about odour in the environment which is another effect on air. Potential sources of odour in abattoir operations are:

- The cooking and rendering process

- ❖ Waste effluent treatment plants
- ❖ Slaughter houses
- ❖ Product storage and handling areas
- ❖ Material drying areas
- ❖ Animal holding pens
- ❖ Holding of carcass before disposal
- ❖ Odour from skin handling
- ❖ Odour from skin shed

Sources of odour in the rending plant include stale materials and fugitive emissions from cookers. Odours come from solid wastes such as paunch contents and blood residues.

Potential sources of dust emission at an abattoir are:

- ❖ Unsealed roads
- ❖ Paddocks, sale yards and holding pens
- ❖ Stock piled products and materials
- ❖ Construction activities

Operations in the abattoir also give rise to atmospheric emission. Materials burned at an abattoir include:

- ❖ Coal or gas fuel for boilers and steam production
- ❖ Diseased animals
- ❖ Packagings
- ❖ Sludge
- ❖ Unusable skin

The burning of the above emits green house gases into the atmosphere and this leads to air pollution. Wing wolf (2000) noted decrease in health and quality of life of residents around intensive livestock operation and hinted that respiratory and mucos membrane effects were common with neighbours of intensive swine operation.

2.4.2.2 EFFECTS OF ABATTOIR EFFLUENTS ON SOIL

Discharging abattoir effluent to surrounding soil has significant effect on the soil physico-chemical properties. The abattoir effluent causes significant changes in the natural value of soil pH, available phosphorus and micronutrients (Zn, Mn and F). A low pH value of contaminated soil indicates the presence and prevalence of micro-nutrients in the soil, some of which are hazardous to microbial community of the soil as well as plants (Abubaka, 2014). Higher exchangeable sodium value was observed in some land area within the vicinity of an abattoir. Excess level of sodium ions in the soil disperses fine particles into pores, thereby reducing water penetrating and blocking root access (Oyeleke, 2011). Low values of exchangeable calcium were also found from abattoir effluent discharging areas and this is said to make the soil of such area more prone to erosion risk. (Abubaka et al 2014, Oyeleka et al, 2011).

2.4.2.3 EFFECTS OF ABATTOIR EFFLUENT ON WATER

Waste water from an abattoir is particularly concentrated source of oxygen-consuming wastes (Girards, 2005). Abattoirs are usually located near water bodies in order to gain unhampered access to water for processing. Abattoirs generally use large quantity of water for washing meat and cleaning process areas (Kuyeli, 2007). The disposal of effluent into stream of Trans-Amadi is a common practice which poses health and environmental hazards to the people downstream (Ezeilo, 2012). Tekena (2014) in his research observed that water bodies are contaminated by a variety of sources, with the direct discharge on various streams of untreated abattoir waste being a major contributor to the poor health of water bodies. It has been explained that oxygen availability in an aquatic ecosystem is an indication of the systems health and general well-being (Tekena, 2014, Akhionbare, 2015).

Excess nutrients can cause a water body to become choked with organic substances and organisms. When organic matter exceeds the capacity of the micro organism in the water that breaks down and recycles it, this leads to eutrophication and encourages rapid growth or bloom of algae (Chukwuka, 2013, Akhionbare, 2015). Abattoir effluents can hence increase the level of nitrogen, phosphorus, total solids in receiving water body considerably. It was noted that water quality degradation interferes with the vital and legitimate water quality uses at any scale and pollution of water resources reduces the availability of clean and safe drinking water.

2.4.2.4 EFFECTS OF ABATTOIR EFFLUENTS ON AQUATIC LIVES

Newcombe and Macdonald (2011) found out that the effect of water pollution is more on aquatic lives, because their existence depends on water and when there is any disturbance in the ecosystem, the impact is maximum on them. In polluted water, due to abundant growth of algae which is also as a result of excess nutrient (N and P), the oxygen content becomes reduced causing the death of fishes and other organisms. They estimated that during the last two decades, there are a decrease of about 40% in aquatic life.

They further reported that there are so many causes of the destruction of marine life by polluted water. Mass killing of fish was among the earliest and most dramatic result of indiscriminate pollution of water.

Occasionally deaths of animals have also been reported by drinking polluted water. If water pollution is more severe, the process of photosynthesis is also obstructed which affects the growth of aquatic vegetation. All the chemicals that are drained into the water have harmful effects on every organism that survive there (Newcomber and Macdonald, 2011).

Pollution of water resources might lead to destruction of primary producers and in turn lead to diminishing consumer population in water. The direct repercussion of this diminishing fish yield with the resultant consequence that human diet suffers. Such conditions may arise through careless discharge of dangerous slowly biodegradable and non-biodegradable waste. Anaerobic conditions may rise and this will make it difficult for aquatic life to flourish. Incidentally, survival of aquatic life is one very important tool for water quality monitoring. In terms of biological indications of water quality, use is made of aquatic lives (e.gDiphniamagna) which are very sensitive to changes in pH, pressure, dissolved oxygen, toxicity and other chemical changes in water. These organisms may become disfigured or their reproductive lives impaired or are killed (Chukwuka, 2013).

Organic effluents also frequently contain large quantities of suspended solids which reduce the light available to photosynthetic organisms and on setting out, alter the characteristics of the river bed, rendering it an unsuitable habitat for many organisms. The waste from animals that are washed into the stream reduces oxygen in the water

thereby endanger aquatic lives. (Chukwuka 2013).

2.4.2.5 EFFECTS OF ABATTOIR EFFLUENT ON HUMANS

Abattoir activities if not properly controlled may pose dangers to the farmers, butchers, the environment as well as the consumers. These effluents that enter streams reduce; the physical and chemical qualities of the stream, so pathogens from cattle waste could be transmitted to humans recreating in such streams (Chukwuka, 2013).

Coker et al; (2001) identified seven pathogenic species of bacteria species in abattoir effluent in south western Nigeria. These species among others include staphylococcus Spp in harsh environmental conditions; affects animals and human health. Likewise improper disposal of effluent from abattoir operation could lead to transmission of disease, such as Coli Bacillus, Salmonella Infections, Brucellosis and helminthes disease and infections (Coker, 2001).

Medical experts have associated some disease with abattoir activities which include Pneumonia, diarrhea, typhoid fever, asthma, wool sorter diseases, respiratory and chest disease (Oyedemi 2004). E. coli infection source related to undercooked beef which has been contaminated in abattoir with faeces containing the bacterium (Encarta, 2005). These diseases can spread from the abattoir to the neighbourhood via vectors or animals.

However, growing population with increase in demand for meat has resulted in increased abattoir related pollution and has attracted interventions in many developed countries. There is high level of awareness on pollution from animal waste (including abattoir) whether in the farm or in the city and over the years several measures have been put in place to protect the public health and the environment. According to Robert (2005), in 1992 the European commission introduced a pan-European fresh meat directives designed to standardize structural and hygiene regulations for abattoirs in all EU countries. The requirement was said to have a pro-found impact on slaughter industry structures in the United Kingdom. Similar intervention was recorded in the United States of America with the introduction of Abattoir Act (1988). In the contrary, little intervention or response had been made in the developing nations like ours (Chukwuka, 2013).

2.4.3THE NIGERIAN EXPERIENCE

Improper management and supervision of the activities of abattoir operators in Nigeria is a source of great risk to public health. Most abattoirs are located near water bodies because of the high demand for water needed for the processing. Not only is most of the animals blood and wash water released untreated into the flowing stream, consumable parts of the slaughtered animals are washed with water drawn from the stream or the beef is washed directly into the flowing stream (Adelegan, 2002).

In the study conducted by Sangodoyin and Agbawe (1992) on five streams around abattoir in Ibadan, it was shown that although pH levels were within acceptable range, all other standards were found to be in excess of 2000mg/l, suspended solids were between 590 to 1050 times the acceptable limits and phosphate levels ranged from 115-175mg/l, nitrate levels were not as extreme but all sites were within six time the general discharge standard of 20mg/l. BOD and metals were not determined in the study for surface water. The down stream water quality parameter showed that river bodies were well able to assimilate the pollutants within significant modification of the aquatic ecosystem. At 500m down stream, COD levels were similar to those upstream. The groundwater near two slaughter houses was however adversely impacted through abattoir waste water leachates. The wastewater samples were characterized by high pH, Ca, Mg, Na and chlorides. It was found however that the soil matrix removed solids and nitrates well. Comparatively, in the study conducted on wastewater from some abattoir by Mittal in Quebee, Canada, the COD-TS was found to be between 2333-8620mg/l; SS was between 736-2099mg/l, nitrogen and phosphorus were 6.0 and 2.3g/l of COD. The COD of fresh blood that is universally put at 375,000mg/l was compared to the COD of manure put at 15000-30,000mg/l.

It has been established that abattoir effluents increase nitrogen, phosphorus, solids ad BOD levels of the receiving water body, potentially leading to entrophication. Pathogens from cattle waste can also be transmited to humans who are in contact with the water body (FEPA, 1995).

2.5 PARAMETERS FREQUENTLY EXAMINED IN THE DETERMINATION OF WATER QUALITY

Most of the parameters that are checked for in the assessment of water quality can be grouped into the following categories.

2.5.1PHYSICO-CHEMICAL PARAMETERS

This term is generally used to refer to the physical and chemical characteristics that define the pattern of each fresh water body (Chukwuka, 2013). The brief description of some of the important physico-chemical parameters are as given below:

1. **PH:** It is one of the factors which influences the biological activity of the water micro flora. The principal component regulating ion pH in natural waters is the carbonate which comprises $C0_2$, H_2C0_3, and HCO_3. Low values in pH are indicative of high acidity, which can be caused by the deposition of acid forming substances in precipitation. A high organic content will tend to decrease the pH because of the carbonate chemistry. (APHA, 1995).
2. **Chloride:** This is an important organic anion which contains varying concentrations in natural waters. Chlorides are troublesome in irrigation water and also harmful to aquatic life. High concentration of chloride is considered to be the indicator of pollution due to organic wastes of animals or industrial origin (Rajkumar et al, 2004).
3. **Electrical Conductivity:** This is the ability of any medium, water in this case, to carry an electric current. The presence of dissolved solids such as calcium, chloride and magnesium in water samples carries the electric current through water.
4. **Turbidity:** This is the cloudiness of water caused by a variety of particles and is another key parameter in drinking water analysis. It is

also related to the content of disease causing organisms in water, which may come from soil runoff.

5. **TDS:** These are the inorganic matters and small amounts of organic matter, which are present as solution in water ((Rahmanian et al, 2015).
6. **T.S.S:**Total suspended solids (TSS) is the material left in a vessel after filtration of water sample. T.S.S range in size from colloidal to coarse dispersions and range from pure organic substances to those that are highly inorganic in nature.
7. **Total Solids:** This is the term applied to the materials left in a vessel after evaporation of a water sample on its drying in the oven at a defined temperature.
8. **Total Harness:** Total hardness (calcium and magnesium) is an important parameter in the detection of water pollution. It exists mainly as bicarbonates of Ca^{++} and Mg^{++} and to a lesser degree in the form sulphates and chlorides. Calcium is an essential nutritional element for animal life and also aids in maintaining the structure of plant cells and soil. Magnesium possesses no major concern with

public health. Limits of concentration of hardness set for water are based mainly on palatability, corrosion and incrustation

9. **Nitrite ($N0_2$):** Nitrite is an intermediate stage in oxidation of nitrogen, both the oxidation of ammonia to nitrate as well as in the reduction of nitrate.

10. **Nitrate ($N0_3$):** Nitrate is the most highly oxidized form of nitrogen compound commonly present in natural waters. It is a product of aerobic decomposition of organic nitrogenous matter. Significant sources of nitrates are fertilizer, decaying vegetation and animal matter, domestic and industrial effluents and atmospheric fall out. Excessive concentration of nitrate in drinking water is considered hazardous for infants because in their intestinal tract nitrates are reduced to nitrite, which may cause blue baby syndrome. Hence nitrate level need to be maintained in a water body.

11. **Phosphate (PO_4^{-3}):** Phosphate plays a major role in biological metabolism. In comparison to other micro nutrients required by biota, phosphorus is the least abundant and commonly the first element to limit biological productivity. The deposition of phosphorus into lake sediments occurs by mechanisms such as: sedimentation of

phosphorus minerals imported from drainage basin, adsorption or precipitation of phosphorus with inorganic compounds, uptake from the water column by algal and other attached microbial communities (Saeedand Mahmound, 2014).

12. **Dissolved Oxygen:** Dissolved oxygen in water is a very important parameter in water analysis as its serves as an indicator of the physical, chemical and biological activities of the water body. The two main sources of DO are diffusion of oxygen from the air and photosynthetic activity. Diffusion of oxygen from the air into water depends on the solubility of oxygen, and is influenced by many other factors like temperature, salinity, water movement etc while photosynthesis, a biological phenomenon carried out by autotrophs, depends on the plankton population, light condition, gases etc

13. **BOD:** Biological oxygen demand is the amount of oxygen required by microorganisms for stabilizing biologically decomposable organic matter (carbonaceous) in water under aerobic conditions. The test is use to determine the pollution load of waste water, the degree of pollution and the efficiency of wastewater treatment method.

14. **COD:** Chemical Oxygen Demand (COD) is the measure of oxygen equivalent to the organic content of the sample that is susceptible to oxidation by strong chemical oxidant.

15. **Colour:** In natural water, colour is due to the presence of humic acids, fulvic acids, metallic ions, suspended matter, plankton, weeds and industrial effluents. Colour is removed to make water suitable for general and industrial applications, and is determined by visual comparison of the sample with distilled water (Limgis, 2001).

16. **Alkalinity:** The alkalinity of surface water is primarily a function of carbonate, hydroxide content and also includes the contributions from borates, phosphates, silicates and other bases. It is a measure of the capacity of water to neutralize a strong acid (Pawar and Pulle, 2005).

17. **Heavy Metals:** These are elements (properties of metals satisfied) of high atomic numbers. They have high utilities in industrial application from paper to automobiles, by their very characteristic properties. They are found in the deep bowels of the earth as ores (complexes of mixtures). The metals are segregated from these ores, leaving behind the tailings that find their wail into the environment as toxic pollutants. They get into the water bodies directly from point sources as sewage and non-point sources as run-off and insidiously as atmospheric deposition that are transported from long distances (Saeedand Mahmoud, 2014).

2.5.2 MICROBIOLOGICAL PARAMETERS

Microorganisms exist and are an important and integral part of the water ecological system. Microorganisms come from water polluted with human and animal excrement (Chapman 1992). Human beings and warm-blooded animals carry pathogens within their intestinal tracts. When humans dispose their faeces into water or when animals intestines are washed in the abattoir into water bodies, disease-causing organisms are spread to a wider population. Freshwater also contain indigenous bacteria, fungi, protozoa and algae (Kiely, 1998). Intestinal pathogens which are most commonly associated with water-borne diseases include *Salmonella, shigella*, enterotoxigenic*Escherichia coli*, campylobacter, *Vibrio* and *Yersinia* (Chapman, 1992). Bacteria usually requires surfaces to which they can attach themselves before they can perform their activities. This surfacecould be a suspended solid, or a semi-solid like faeces or other decaying substances like leaves and pieces of wood (Omole, 2006).

Pathogens present in animal carcasses or shed in animal wastes may include rotaviruses, hepatitis E virus, *Salmonella*Spp*E. Coli* 0157:H7, *Yersinia enterocolitica, campylobacter* spp. *Cryptosporidium parvum* and *Giardia lamblia* (Sobsey et al, 2002). The Zoonotic pathogens can exceed millions to billions per gram of faeces and may infect humans through various routes such as contaminated air, contact with livestock animals or their waste products, swimming in water impacted by animal faeces, exposure to potential vectors (such as rodents, flies etc), or consumption of food or water contaminated by animal wastes (Armand-Lefevre*et al,* 2005). The consequences of infection by pathogens originating from animal wastes can range from temporary morbidity to mortality, especially in high-risk individuals. Due to difficulties in quantifying pathogens, indicators of fecal pollution including coliform bacteria, fecal coliforms, *E-coli* and/or Enteracocci have been monitored in lien of overt pathogens for more than 100 years (Byamukama*et a*l, 2005). Epidemiological evidence supports the relationship between the fecal indicator bacteria *E.Coli*, Enterococci and theincidence of gastro-intestinal illness following creational water exposure and provides the basis for water quality regulations (Omole, 2006).

In Nigeria, abattoir wastes are sources of embarrassment that requires immediate remedy because wastes with large quantities of animal faeces are often channeled directly into water bodies, used for domestic purposes by human beings (Along, 2001). Nafarnda*et al*, (2012) observed that untreated abattoir effluent discharged into water bodies in Nigeria contains bacteria counts above recommended levels for discharge into water bodies and that receiving water bodies were contaminated with bacteria pathogens that could impact on public health, especially on rivers that serve as major sources of water supply for communities.

Bacteria from abattoir waste discharged into water columns can subsequently be absorbed to sediments and when the bottom stream is disturbed, the sediment releases the bacteria back into the water column presenting long-term health hazards. The primary reservoir for E. coli 0157; H7 has been reported to be healthy cattle in a study in Canada, although this bacterium is also endemic to swine and sheep (Omole 2006).

2.6 WATER POLLUTION AND CONTROL IN NIGERIA

Industries are the foremost surface water polluters in Nigeria because of the high volume of water needed to carry out their economic activities. However, studies carried out by FEPA in 1995 on 200 industries in Lagos revealed that only 18% of them performed any form of primary treatment on their wastewaters before discharging them into nearby surface waters, This means that four years after the publication of FEPA guidelines in 1991, industries were still flouting the standards. Though recent statistics are not available, not much change have taken place in terms of improvements from the scenario of 1995. Surface water in Lagos continue to be openly polluted while the law enforcement agencies appear helpless in the face of the menace. An inventory of key polluters of surface water in Nigeria shows that the largest amount of hazardous wastes come from steel, metal fabrication, textile, pharmaceuticals, tanneries, oil refineries and paint industries (Omole,2006). Locations within Nigeria where these waste generators are concentrated in order of volume of wastes are detailed in

Table 2.1

Table2.1: Nigerian states, key Industries and Waste Characterization (FEPA, 1995)

S/N	State	Key industries	Waste characterization and description
1.	Lagos (8000 tones/year	Food process, textile mills, pharmaceuticals metal fabrication and finishing, paints	Food processing (high BOD, dissolved oxygen depletion, high suspended solids)
2.	Rivers (7,500 tones/year)	Oil refineries, paint, petro-chemicals	Refines, petrochemicals (Aldehydes, ammonia, organic acids, oxides of sulphur and nitrogen, carbon monoxide and hydrocarbons.
3.	Kano (3400 tones/year)	Tanneries and textile	Tanneries (heavy metals, Cr, high TDS, high COD, acidity, sulphides, low pH; Textiles (bleaching agents, reducing agents, silicates and inorganic salts, oil, grease, wax, Cr, Pb, Zn, Cu, high COD, low DO.
4.	Kaduna 1,700 tones/year	Metallurgy, tanneries, textile, chemical manufacturing, pharmaceutical	Iron and Steel (suspended solids, phenols,ammonia, cyanide, heavy metals, oil and greases, dissolved iron).

Source: Osae –addo, (1991).

Studies conducted between 1998 and 1999 showed that among 14 sources of industrial and hazardous waste pollution, abattoir contribute 9th highest on the list in total wastes above breweries, cement, chemical, paint and fertilizer companies (FEPA, 1995). The abattoir contributed 16,764 tons per year in total waste, out of which 1,532 is solid waste, and 38 is oil and grease. Thus over 16,000 tons/year of liquid wastes end up mostly in surface water. However, its hazard was put at zero.

2.7 WATER LAWS AND STANDARDS

2.7.1WATER STANDARDS

Water quality standards are means by which regulatory bodies or agencies define their requirements for water courses. It normally identifies the concentrations of component properties shown by experience or scientific judgment to be safe from available water sources (Akhionbare, 2015).

Legislation cannot be made without first ascertaining the quality of water sources by identifying the common pollutants, causes, effects and mitigation measures. It is a data obtained from water quality assessments that lead to water quality standards and ultimately, legislations and regulations. There are no fixed standards with regards to water quality. It is the use to which the water is to be put that determines the quality standard that must be imposed (Anyata et al, 2000). Water meant for consumption, food and pharmaceutical industrial purposes have more stringent standards than water for fish production. To this end, different countries and regions of the world had adopted suitable standards for different water uses. There is the WHO standard, the European community (EC) limits, US limits, the USSR limits and of course, the Nigerian limits as specified in the FEPA guidelines and standards for environmental pollution in Nigeria (FEPA, 1991). However, standards are of little or no effect when they are not adequately backed up by functional legislations. The bane of the Nigerian society has been the lack of will to enforce legislations for the benefits of the general public. While potable water supply may not be possible in the nearest futures for majority of the ever increasing citizenry of Nigeria, certain actions can be taken to ensure that the available natural water resources are well managed and kept relatively safe through the instrument of scientific water quality assessment, design and specifications, regulations and public enlightenment.

2.7.2WATER USE RIGHTS/LAWS

Developed countries have certain water laws that give water use rights to deserving individual (Omole, 2006). Some of the conditions attached to the issuance of these water use rights include:

i. That the water should be put to beneficial use

ii. That the use to which the water is put upstream by the prior user does not adversely impact on the quality of the water that gets downstream to the next user.

Riparian law (of Colorado State Government) says that anyone owning a piece of land adjacent to a surface water source can make beneficial use of the water but has no right to divert it (Omole, 2006). Moreover, the riparian owner can only use the water on the site and has no right to pollute it beyond specified standards. Appropriation law subsequently came into effect when more beneficial uses for water came up but users could not secure land adjacent to surface water sources. They were thus enabled by law to remove and transport the water from the sources to the point of use. These two laws are common water laws and they confer property rights, not ownership rights (Longe, 2010).

2.8 WATER QUALITY INDEX

Water quality refers to the physical, chemical and biological characteristics of a water body. These characteristics determine how and for what water can be used and the species and ecosystem process it can support. It is designed to rate the general quality relative to expected quality.

The index is basically a mathematical means of calculating a single value from multiple test results. The index result represents the level of water quality in a given water basin such as river and lake. Water quality index uses a scale from 0 to 100 to rate the quality of the water, with 100 being highest possible score. Once the overall water quality index score is known, it can be compared against the following scale to determine how healthy the water is.

Table 2.2: Water Quality Index Scale

Scale	**Implication**
91-100	Excellent water quality
71-90	Good water quality
51-70	Average water quality
26-50	Fair water quality
0-25	Poor water quality

Source: national sanitation foundation, US (2005)

Water supplies with ratings falling in the excellent range would be able to support a high diversity of aquatic life and would also be good for drinking. In addition, the water would also be suitable for all forms of recreation including those involving direct contact with the water. Water supplies achieving only an average rating generally have less diversity of aquatic organisms and frequently have increased algae growth.

Water supplies falling into the fair rage are only able to support a low diversity of aquatic life and are probably experiencing problems with pollution. Water supplies that falls into the poor category may only be able to support a limited number of aquatic life forms and it is expected that these waters have abundant quality problems. A water with poor quality rating would not normally be considered acceptable for activities involving direct contact with the water, such as swimming.

To determine the water quality index, the following nine water quality parameters are measured; Biological Oxygen Demand, Fecal Coliform, Nitrate, pH, Dissolved Oxygen, Temperature, Turbidity, Total Dissolved Solids and Total Phosphate.

After the nine water quality test are completed and the results recorded, a "Q" value is calculated for each parameter. To calculate the Q-value for the parameters, the following procedures are used.

i. Locate and print the chart appropriate parameter
ii. Locate and mark your test on the horizontal axis of the chart

iii. Beginning on your mark, draw a vertical line up until it intersects the curve on the charts

iv. From the point of intersection with the curve draw a horizontal line to the left until you reach the vertical axis of the chart.

v. Record the value where the lines intersects on the water quality index worksheet. This would be the Q-value for the test.

vi. Repeat each of these steps to find the Q-value for each of the remaining tests result.

The Q-value obtained is the multiplied by the weighting factor for each test and the answer recorded in the "Total" column. The weighting factor indicates the importance of each test to the overall water quality.

Finally, add the numbers shown in the total column to determine the overall water quality index for the water source tested. The result is then compared to the scale shown in table 2.3 to determine the water quality rating for water supply tested.

If less than nine (9) test are performed, the overall water quality index can be estimated by adding the results and then adjusting the number of the tests. For example, if temperature and turbidity are not available, the seven remaining subtotal are added (to have a total) and the seven weighting factors are added. The former (Total) is the divided by the later (Total of the seven weighting factors) to obtain the water quality index (NSF, 2005)

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 DESCRIPTION OF THE STUDY AREA

Trans-amadi Creek is located in Port Harcourt metropolis of Rivers State on longitude 6.57^{0}E and latitude 4.57^{0}N. It flow from Okrika Town down to Mini-Ewa, Rumuobia-Kani through Woji, Oginigba, Okujagu Communities and then empties into the Bonny river, entronte to the Atlantic ocean (Onojake and Emereole, 2011).

The Port-Harcourt abattoir is located in Trans-Amadi beside the Trans-Amadi Creek. The abattoir is the largest in Rivers State at large and also one of the major activities that impact greatly on the Trans-Amadi Creek.

3.1.1GEOLOGY

Geological, Trans-Amadi is a typical Niger-Delta environment underlain by Benin formation classified as coastal plain sand (Reyments 1998). It consists of massive, highly porous and permeable fresh water bearing sand stones with minor clay intercalations. The formation is generally water bearing and hence it is the main source of potable ground water in the municipality. The aquifers are recharged mainly by surface precipitation and nearby drainage (Uwandu, 2014).

3.1.2 CLIMATE:

Trans-amadi features a typical wet climate with lengthy and heavy rainy seasons and very short dry seasons. Only the months of December and January truly qualify as dry season months in the city. The Harmattan, which climatically influences many cities in West Africa, is less pronounced in the area. The heaviest precipitation usually occurs during the months of June/July which is even termed the first maxima (Peak rainfall) of the year (Iwena, 2012). But current data on rainfall showed a different result. The month of June recorded 300.3mm of rainfall while July and August recorded a total of 280.1mm and 427.0mm respectively (NIMET, 2016).

Temperature throughout the year in the city are relatively constant, showing little variation throughout the course of the year. Average temperature is typically between 25^0C-28^0C in the city.

3.1.3VEGETATION

Trans-amadiwas originally occupied by mangrove swamp forest which has recently been drastically modified by human activities. But notwithstanding, certain localities in the area preserve their sacred trees. Some of the vegetations that are still found in Creeks are the raffia palm, oil palm, bamboos, mango trees, rubber trees etc.

3.1.4SOCIO-ECONOMIC ACTIVITIES

Trans-amadi is the main industrial layout in Port-Harcourt and as such, it is being occupied by so many industries and industrial workers. However, some other inhabitants are civil servants and fishermen. At present, Urban growth has ushered in several socio-economic activities into the town, such as trading, craftsmanship, tourism etc.

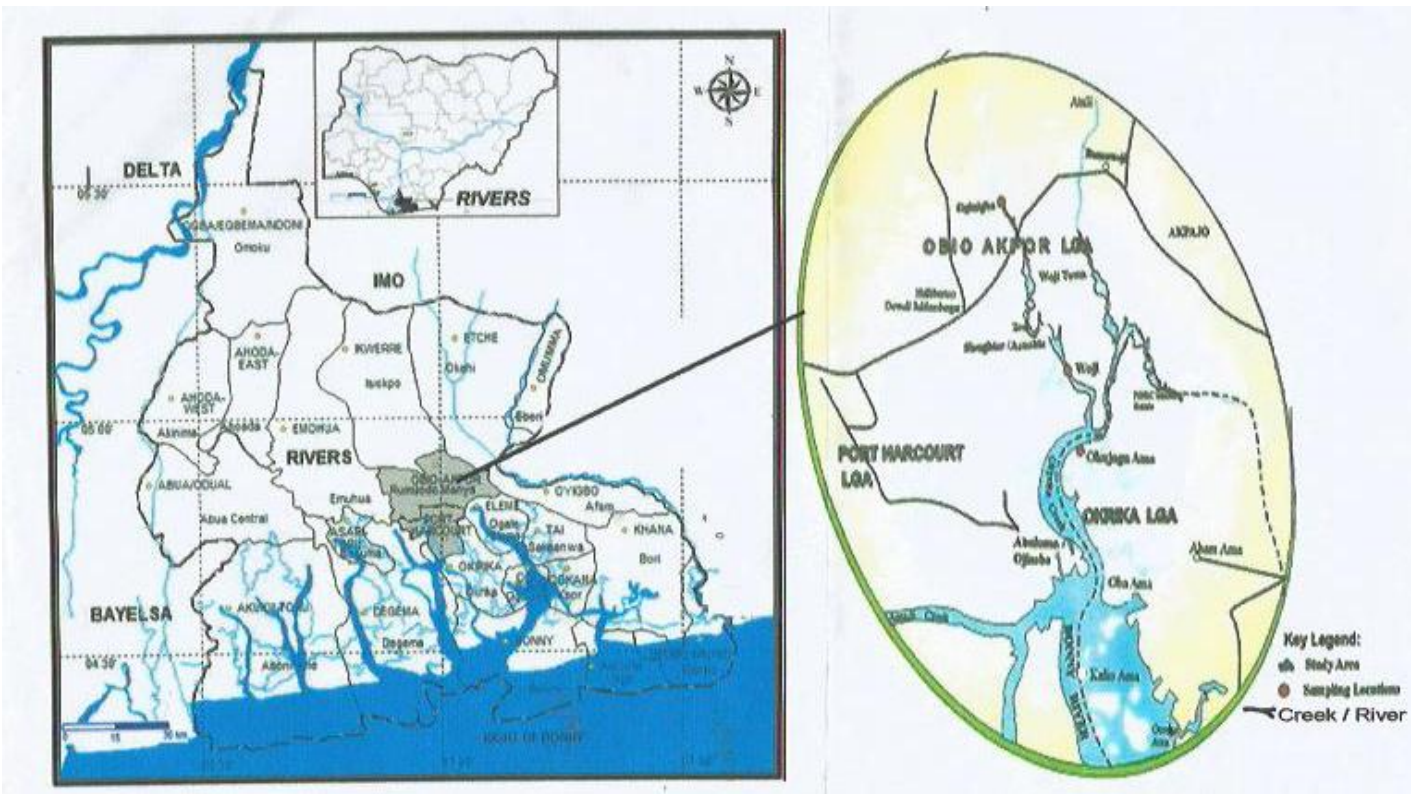


Fig 3.3: Map of study area showing host communities and sampling stations

3.2 SAMPLING

3.2.1DESCRIPTION OF SAMPLING LOCATION

Three sampling points were established to cover possible impacted and un-impacted area along the water course based on an earlierfieldreconnaissance survey. The location of different sampling points are as follows:

sampling Point: "A": This point is located in Oginigba Community-about 800m upstream of the abattoir effluent discharge area. The relevance of this sampling point was to reflect the un-impacted water quality and to serve as a control sample. It is pertinent to re-mention that Trans-Amadi is an industrial area in Port Harcourt and as such, some industries operate within this sampling area which could also impact on this ambient value of the water segment under study.

SAMPLING POINT "B": This is the actual point (or mixing zone) where the effluent flowing from the abattoir enters the Trans-Amadi creek. Although the sample was taken at about 50m down-stream from the discharge zone in order to avoid collection of the abattoir effluent, but to give room for dispersion and diffusion of the effluent within the water body. This point is located in Woji Community.

SAMPLING POINT "C": This point is located in Okujagu community-a distance of about 1000m down-stream from the discharge zone. This point was chosen to monitor the self-purification ability of the creek under study.

3.2.2SAMPLING METHODOLOGY

In order to ensure that the samples taken were true representations of the information that were to be obtained from the laboratory, some basic steps were taken.

A set of three plastic bottles of 2-liter capacity and another set of glass bottle of 250ml capacity were procured. Each bottle was thoroughly cleansed with detergent and detol, and was allowed to dry before usage. One set of the samples (250ml bottle) was for microbiological sample analysis while the set of 2-liter capacity bottles were used for water samples for all the other parameters. The sample bottles were first of all rinsed with the water from the creek and they were totally immersed into the creek, at a depth of 3-5cm and filled without agitation, and air contact with the sample was avoided. The samples were transported to the laboratory immediately in a cooler with an ice-block for preservation of sample integrity.

Sampling took place early in the morning before the effect of the sun on the creek (between 6:30am and 10am). This time was specially chosen in order to beat the EPA specified holding time of 8 hours from time of collection to laboratory.

3.2.3SAMPLES LABELS

In order to get accurate record of the various sampling points, the sample bottle were properly labeled with letters A, B, and C, date and time of sampling and also the name of the sampler.

The sample bottles with the label "A" was used in sampling the upstream, bottles with the label "B" was for mid-stream (Discharge Zone) sampling while the bottles with labels "C" was for downstream sampling.

3.3 ANALYTICAL TECHNIQUES

3.3.1PHYSICO-CHEMICAL ANALYSIS

3.3.1.1 PH

The pH of the samples were taken in the laboratory using an already standardized pH meter with glass electrode model PHS- 25.

3.3.1.2 COLOUR (APHA 2002)

The colour of the samples was determined using a Nessleriser and comparing them with standard disc NSA. Colour values were read directly in Hazen Units on the platinum cobalt scale.

3.3.1.3 ELECTRICAL CONDUCTIVITY (APHA, 2002)

The electrical conductivity of the samples were measured using the battery operated conductivity bridge model mc-/markv electronic switch gear at room temperature. The values were read out directly in micro Siemens where the cell with a cell constant = 1 was used.

3.3.1.4 TOTAL DISSOLVED SOLIDS (TDS) (APHA, 2002)

Filtered water samples were evaporate and dried in weighed dishes at 105^0c to constant weight. The increase in weight over the empty dish represented the dissolved solid content. One hundred mills of the samples were used and the importing dishes were left to cool in a desiccators before the weighing was done. The results were expressed in milligrams per litre of sample.

3.3.1.5 SUSPENDED SOLIDS (SS) (APHA, 2002)

The samples were evaporated to dryness in an oven, as in the case above and further dried at $105^0{}_C$for two hours in the oven. They were cooled in desiccators and weighed. The difference between the weights obtained and those from T.S from each sample gave the value of the total suspended solids content for that sample. The results were expressed as milligram suspended solid per litre of sample.

3.3.1.6 DISSOLVED OXYGEN (DO) (APHA, 2002)

Water samples for dissolved oxygen determination were` analyzed using the Winkler's iodometric method. The bottles were completely filled with the water sample immediately after collection, 1ml of Winkler's solution A (manganoussulphate in distilled water) was added, after which 1ml Winkler's solution B (Alkaline Potassium iodide solution) was added to fix the oxygen. The sample bottle was slurped and stoppered. The bottle was opened in the laboratory and 1ml of concentrated sulphuric acid was added to dissolve any precipitate formed during the fixing, One hundred ml of the sample solution were titrated against 0.025N sodium thiosulphate solution using starch as indicator and titrating to the disappearance of the colour of the indicator in the solution. The dissolved oxygen was recorded in milligram per litre (mg/L) of DO by multiplying the value by 2.

3.3.1.7 ALKALINITY (APHA, 2002)

1ooml of each sample were pipette into 250ml Erlanmeyer flask and 10 drops of phenolphthalein were added and swirled to mix. As the sample turned pink, it was then titrated with 0.02N sulphuric acid to a colourless endpoint. The number of millimeters of the standard sulphuric acid solution used was multiplied by 10 to obtain the mg/l phenolphthalein alkalinity. But if the sample did not turn pink, 10 drops of methyl orange indicator were added and swirled to mix and then titrated with 0.02N sulphuric acid to an orange colour. The number of milliliters of sulphuric acid used in both tests was multiplied by 10 to obtain the mg/l total alkalinity.

3.3.1.8 CHLORIDE (APHA, 2002)

The chloride content of each sample was determined by titration against silver nitrate solution using 10 percent potassium chromate as indicator. 100ml of the water sample were measured into each 250ml conical flask and 1ml potassium chromate solution was added. The solution was titrated against silver nitrate solution (containing 4.791g silver nitrate in 1 litre of solution) with constant stirring until the slightest perceptible reddish coloration persisted. A blank titration using distilled water was carried out to allow for the presence of chloride in any of the reagents. The titre values minus the titre values for blank gave the PPM or chloride ions in the sample after calculations from the following formular.

$$\text{Mg/l Cl} = \frac{(A-B) \times N \times 35450}{\text{ml of sample}}$$

Where A = Ml titration of sample

B = Ml titration for blank

N = Normality of silver nitrate

3.3.1.9 TOTAL HARDNESS(TH) (APHA, 2002)

50ml of sample were pipetted into a 250ml Erlenmeyer flask and a few drops of 1.0N hydrochloric acid solution were added to it to decompose any hydrogen carbonate which would interfere with the determination. The solution was boiled to expel carbon dioxide. It was then cooled to 50^0C and 2ml buffer solution pH 10 (containing 67.5 ammonium chloride and 750ml ammonium hydroxide in litre of solution in distilled water) were added. A small amount of Eriochrome Black T indicator (made by grinding 0.3g eriochrome Black T and 100g of potassium chloride together to form a dry powder) was added and the solution was titrated against EDTA standard titrant (containing 7.5g ethylene diamine tetra acetic acid disodium salt and 0.1g magnesium chloride $mgcl_2$ $6H_20$ in 500ml of distilled water, 0.77g sodium hydroxide, diluted to 1 litre and standardized against standard calcium carbonate solution) to a blue coloured end point. The total hardness was calculated from the relation: Hardness/EDTA/mg/l calcium carbonate

$$= \frac{x \text{ Ml EDTA } x F x 1000 x 0.1 x 17.8}{x \text{Ml of sample}}$$

$$\text{Where } F = \frac{\text{Mg calcium carbonate}}{\text{xml of EDTA}}$$

Obtained from the standardization of EDTA using standard calcium solution.

3.3.1.10 PHOSPHATE (APHA, 2002)

A colour developing reagent was prepared from two set of reagents, A and B. reagent A was made by mixing 12g of ammonium molybdate in 300ml of distilled water, 0.827g of antimony potassium tartarate in 100ml of distilled water, and 148ml of concentrated sulphuric acid in 50ml distilled water all in a 2 litre flask and make up to the mark with distilled water. Reagent B was made by mixing 200ml of reagent A with 1.056g of L-Ascorbic acid. Also, a primary phosphate standard was prepared by dissolving 0.2195g of potassium dihydrogen orthophosphate (previously dried at 105^0C for 1 hour) in about 250ml distilled water 5ml of concentrated sulphuric acid were added and the solution was diluted to 1litre to yield 50ppm phosphorus. A 5ppm secondary standard solution was prepared by pipetting 10ml of the primary stock solution into a 100ml flask and making up to the mark. From the secondary stock solution, 2,4,6, 8, 10ml were pipetted out into a series of 50 volume Nessler's glasses and made up to the mark with distilled water. These yielded 0.2,0.4, 0.6, 0.8, 1.0ppm available phosphorus. 8ml of reagent were added to each of the standard and the optical density (absorbance) read out from a spectrophotometer –SP500PYE UNICAM model- at 880nm after allowing to stand for 10 minutes for full colour development. A calibration graph of the various absorbance's against the corresponding concentrations of the standards was plotted. To 50ml of each of the samples, 8.0ml of the reagent was added and the absorbance were read out as above. From the calibration graph, the various values of phosphorus in ppm were read out directly. The phosphate contents of the sample were calculated from the reaction:

$$\text{Mg/l phosphate} = \frac{\text{mg phosphorus x 3.06}}{\text{ml of sample}}$$

3.3.1.11 SULPHATE (APHA, 2002)

A primary standard sulphate solution was prepared by dissolving 0.1479g anhydrous sodium sulphate in distilled water and making up to 1 litre. This primary standard is equivalent to 100ppm sulphate. A conditioning reagent was made by dissolving 75g sodium chloride in 300ml of distilled water, adding 30ml hydrochloric acid of specific gravity 1.18 and 100ml of 95% Iso-propyl alcohol and mixing the solutions well with 50ml of glycerol.

0.5, 10, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5 and 5.0ml of the primary standard sulphate solution were pipette into a series of 100ml flasks and each was make up to the mark with distilled water. These correspond to 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0ppm sulphate five ml of the conditioning reagent were added to each of the flasks. The contents were mixed using a magnetic stirrer maintained at a constant speed. While the solution was being stirred, about 0.5g barium chloride crystals were added and the stirring of constant speed was continued for one minute immediately after one minute, the optical densities (OD) of the solution were measured using a spectrophotometer at a wavelength of 420mm with a violet filter using 10mm cell, readings were taken at 30 seconds intervals over a period of two minutes.

A blank determination was carried out and the optical density was subtracted from those of the standards. To one hundred ml the sample, the same amount of conditioning reagent was added and treated as in the case of the standards. The optical densities were measured and the amount of sulphate equivalent to the optical densities were read out from the calibration curve in mg sulphate. The results were then expressed as mg sulphate per litre of sample using the relation;

$$\text{Mg/l sulphate} = \frac{\text{my sulphate x 1000}}{\text{ml of sample}}$$

3.3.1.12 NITRATE (APHA, 2002)

A primary stock solution of nitrate was prepared by dissolving 0.7218g of anhydrous potassium nitrate in 1 litre of solution in distilled water. This gave a 100ppm solution. A secondary stock solution was made by pipetting 50ml of the primary stock solution into a beaker and evaporating to dryness of a steam water bath. The residue was dissolved by rubbing with 2ml phenol-disulphoric acid reagent (25g of pure white phenol dissolved in 150ml concentrated sulphuric acid, 75ml fuming sulphuric acid – 15% free sulphur trioxide was added and the solution was heated for 2 hours in a hot water bath), and diluted to 500ml with distilled water. This solution gave a 10ppm (N) secondary standard, which is equivalent to 44.3mg nitrate. 0.5, 1.0, 2.9, 3.0, 4.0 and 5.0ml of the secondary stock solution were pipette into a series of Nessler's glasses and were diluted to the 50ml mark with distilled water, these gave 0.1, 0.2, 0.4, 0.6, 0.8, 1.0ppm nitrate solutions. The optical densities were measured using a spectrophotometer at a wavelength of 410nm and a calibration graph was plotted. 20ml of the filtered samples were evaporated to dryness over a hot water bath. A glass rod was used to rub the residue thoroughly with 2.0ml phenol-disulphoric acid reagent to ensure dissolution of the solids. The solution was diluted with 20ml distilled water and while stirring, 7ml of ammonia solution were added until the maximum colour developed. The solution was transferred to a Nessler's glass and mad up to the 50ml mark with distilled water. The optical densities were measured for each sample and the concentrations of nitrate in micrograms were read out directly from the calibration graph. The nitrate content of the samples in mg/l were obtained from the relation;

$$\text{Mg/l nitrate (N)} = \frac{\mu g \text{ nitrate}}{\text{ml of sample}}$$

Mg/l nitrate = mg/l nitrate N x 4.43

3.3.1.13 BIOLOGICAL OXYGEN DEMAND (BOD) (APHA, 2002)

A 250ml reagent bottle was filled up completely with the sample and the dissolved oxygen content was determined as described above (3.3.1.6) was washed properly and filled with the sample and tightly stopped. The bottle and the stopper were wrapped with aluminum foil in order to exclude light. It was then incubated at 20^0C for five days after which its dissolved oxygen content was determined. The difference between the initial DO and the final value gives the BODs of the sample in mg/l .

3.3.1.14 CHEMICAL OXYGEN DEMAND (COD) (APHA, 2002)

Sample was refluxed with a strong oxidizing solution. To 20ml of sample in a refluxing flask, 8.4g of mercuric sulphate was added and mixed. 10ml of 0.25N potassium dichromate solution (12.259g of potassium dichromate crystals in 1 litre of distilled water) were added to the mixture. Previously heated glass beads were then added to the mixture and the flask was connected to the condenser. 30ml of concentrated sulphuric acid containing silver sulphate 50% saturated solution) were slowly added through the opened o fhte condenser; and mixed thoroughly. The whole mixture was refluxed for two hours, cooled and the condenser washed down with distilled water. The mixture was the diluted to about 150ml with distilled water and the excess dichromate was titrated against 0.lN ferrous ammonium sulphate (39g of salt, first dissolved in concentratedsulphuric acid and diluted to 1 litre with distilled water) using ferroin indicator. A blank titration was carried out using 20ml of distilled water.

The normality (N) of the ferrous ammonium sulphate solution was determined by standardization against 10ml of the standard potassium dichromate solution. The COD of the sample was calculated from the following relation:

$$\text{Mg/l COD} = \frac{(a - b)\, N \times 8{,}000}{\text{Ml of sample}}$$

Where a = ml of ferrous ammonium sulphate used for blank titration

b = ml of ferrous ammonium sulphate used for sample

N = normality of ferrous ammonium sulphate

3.3.1.15 DETERMINATION OF ZINC (APHA, 2002)

Determination of Zn was carried out using Atomic absorption spectrophotometer (AAS) according to standard method described by APHA (2002) using Air-acetylene at a wave length of 213.8NM.

3.3.2BACTERIOLOGICAL ANALYSIS (APHA, 2002)

3.3.2.1 TOTAL HETEROTROPHIC COUNT (CFU/ML)

Water samples were plated on nutrient agar and incubated at 22^0C for 72 hours to isolate the bacteria. Another set was incubated at 37^0C for 24 hours to isolate parasitic bacteria. Plates containing between 30 and 300 colonies were used in assessing bacteria density. Results were expressed as number per ml of sample.

3.3.2.2 TOTAL COLIFORM COUNT (CFU/100ML) (APHA, 2002)

The multiple tube test was carried out using Mac Conkey Broth. Tubes were incubated at 37^0C for 48 hours and the most probable number of presumptive coliform bacilli per 100ml of sample was estimated from the "MPN table of McCrady.

3.3.2.3 TOTAL FAECAL COLIFORM (E.COLI) COUNT (CFU/100ML) (APHA, 2002)

Positive tubes from the presumptive tests were sub-cultured into brilliant Green lactase Bile Broth and incubated at 44^0C for 24 hours "MPN" of E. Coli per 100ml of sample was calculated by means of the "MPN" tables. The positive tests streaks were made on Endo Agar, Mac Conkey Agar and Eosin Methylene Blue Agar and incubated at 44^0C for 24 hours. Developing colonies were stained with Gram's stain and examined by a photomicroscope.

3.4 DATE ANALYSIS

Descriptive and multi-variate statistics were used to explore the data obtained from different sampling locations.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 STATEMENT OF RESULTS

The results of the analysis carried out on Trans-Amadi Creek are presented in Table 4.1 and 4.2.

4.1.1LEVELS OF PHYSICO-CHEMICAL PARAMETERS OF TRANS-AMADI CREEK

The levels of the physico-chemical parameters of water determined across the sampling locations within the Trans amadi Creek is shown in Table 4.1. The pH ranged from 4.46 to 5.51 across the sampling points. Color ranged from 5 to 10pt/co, EC 34 to 50, and TDS 22 to 32. Total suspended solid ranged from 6.0 to 10.5, Total Hardness as CaCO3 from 1243 to 1690 and Alkalinity from 1.04 to 1.55. Nitrate and Nitrate-Nitrogen recorded 15.1, 16.1, 18.1 and 3.4, 3.7 and 4.10 respectively from sample A to C. Chloride ranged from 1205 to 3620, sulphate 36.1 to 42.1, phosphate 0.50 to 1.50 while phosphorus ranged from 0.2 to 0.5. High values were recorded in the concentration of COD (135.1 to 142.5). Dissolved Oxygen ranged from 4.25 to 4.40 while Zinc ranged from 0.108 to 0.260 across the three sampling points.

Table 4.1: Physico-chemical quality of Trans-amadi Creek at various sampling points.

Parameters	Sample A	Sample B	Sample c	WHO 2011
Ph	4.46	5.09	5.51	6.5 _ 8.5
Colour (pt/co)	10	10	5	15 pt/co
Electrical conductivity	50	38	34	1000
TDS	32	25	22	250
TSS	6.5	10.5	6.0	5
Total Hardness CaCO3 (mg/l)	1243	1505	1690	250
Alkalinity (mg/l)	1.04	1.54	1.55	60
Chloride (mg/l)	1205	1820	3620	250
Sulphate (mg/l)	36.1	42.1	37.5	250
Nitrate (mg/l)	15.1	16.60	18.10	50
Nitrate-Nitrogen (mg/l)	3.40	3.70	4.10	ND
Ammonia (mg/l)	1.02	ND	ND	ND
Phosphate (mg/l)	1.50	0.50	1.40	5
Phosphorus (mg/l)	0.50	0.20	0.40	ND
COD(mg/l)	142.5	140.6	135.1	40
BOD (mg/l)	3.20	3.60	3.40	10
DO (mg/l)	4.40	4.25	4.35	10
Zinc (mg/l)	0.260	0.108	0.230	5
Odor	ND	Very faint fishy	ND	ND

ND=Not Detected

4.1.2 Levels of bacteriological parameters of Trans-amadi Creek

The levels of various bacteriological parameters analysed across the Trans amadi Creek are shown in table 4.2. Total Heterotrophic count (cfu/100ml) recorded 2600, 2150 and 2860 for samples A, B and C respectively. Total Faecal Coliform (cfu/100ml) and E.Coli count (cfu/100ml) ranged from 110 to 320 and 30 to 100 respectively across the sampling locations.

Table 4.2: Bacteriological Quality of Trans-amadi Creek at various sampling stations

Parameters (cfu/100ml)	Sample A	Sample B	Sample C
THC	2600	2150	2860
E. Coli	110	150	320
Total coliform	30	40	100

4.2 DATA ANALYSIS

4.2.1 SPATIAL VARIATION IN PHYSICO-CHEMICAL PARAMETERS IN WATER SAMPLE OF TRANS AMADI CREEK.

Spatial variations were observed in the levels of the physicochemical parameters across the sampling points.

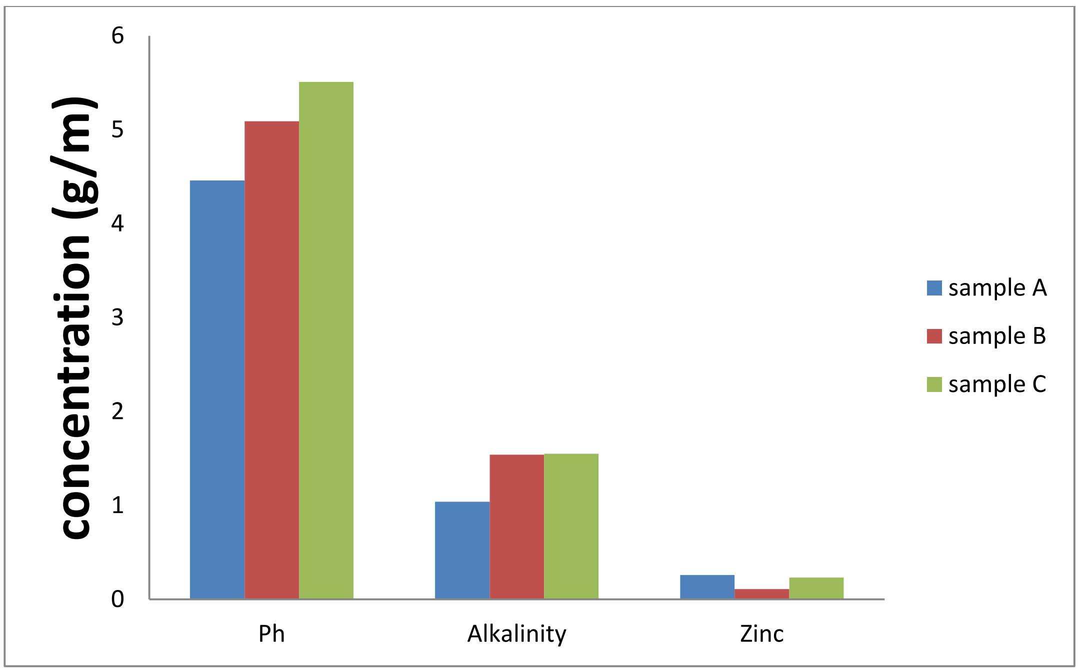


Fig 4.1: variation in the levels of pH, Alkalinity and Zinc of Trans-amadi Creek at three sampling points.

Maximum levels of ph 5.51 and Alkalinity 1.55mg/l were recorded at the downstream (C) while zinc had a lower value but recorded highest value at the Upstream (A). Lowest values of ph 4.46 and Alkalinity 1.04mg/l were recorded at the Upstream while the middlestream(B) had the lowest in zinc content with value of 0.108mg/l.

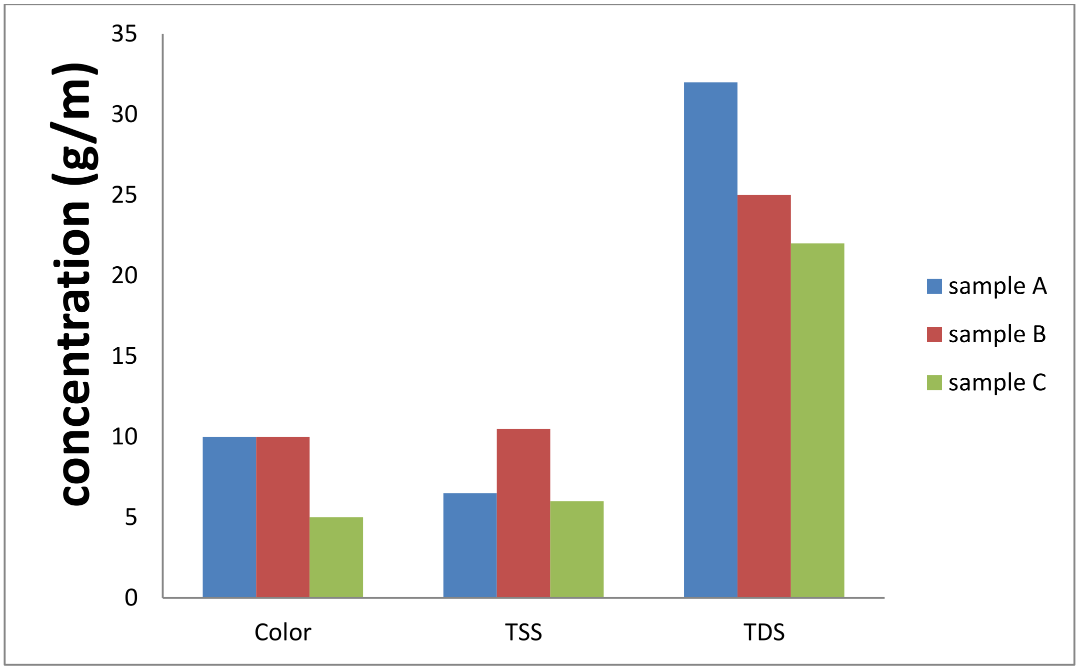


Fig 4.2: variation in the levels of Color, TSS and TDS of Trans-amadi Creek at three sampling points.

The Upstream recorded maximum values of TDS and Color while having lower values of TSS 6.5mg/l. The middlestream (B) has same value with the Upstream (A) in color parameter (10pt/co), highest value of TSS (10.5mg/l) and lower TDS value (25mg/l). The downstream (C) recorded lowest values in the above parameters.

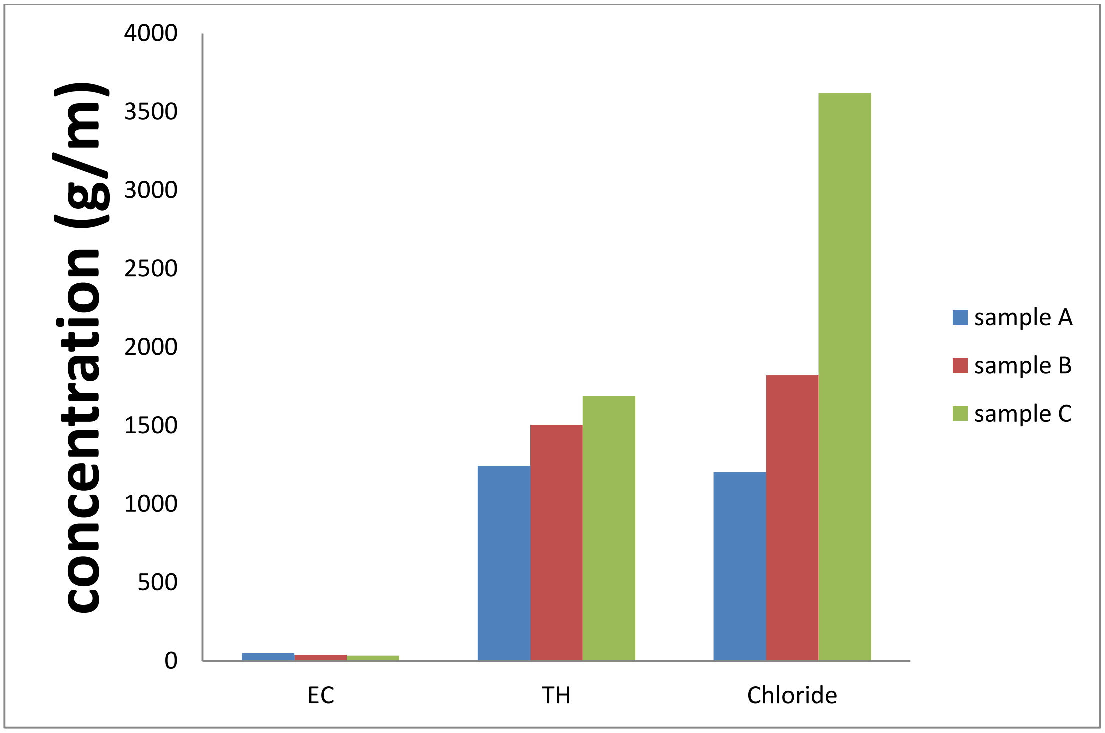


Fig 4.3: variation in the levels of Electrical Conductivity, Total Hardnessand Chloride of Trans-amadi Creek at three sampling points.

The Electrical Conductivity decreased from the upstream to the downstream while the Total Hardness and chloride content increased from the upstream to the downstream.

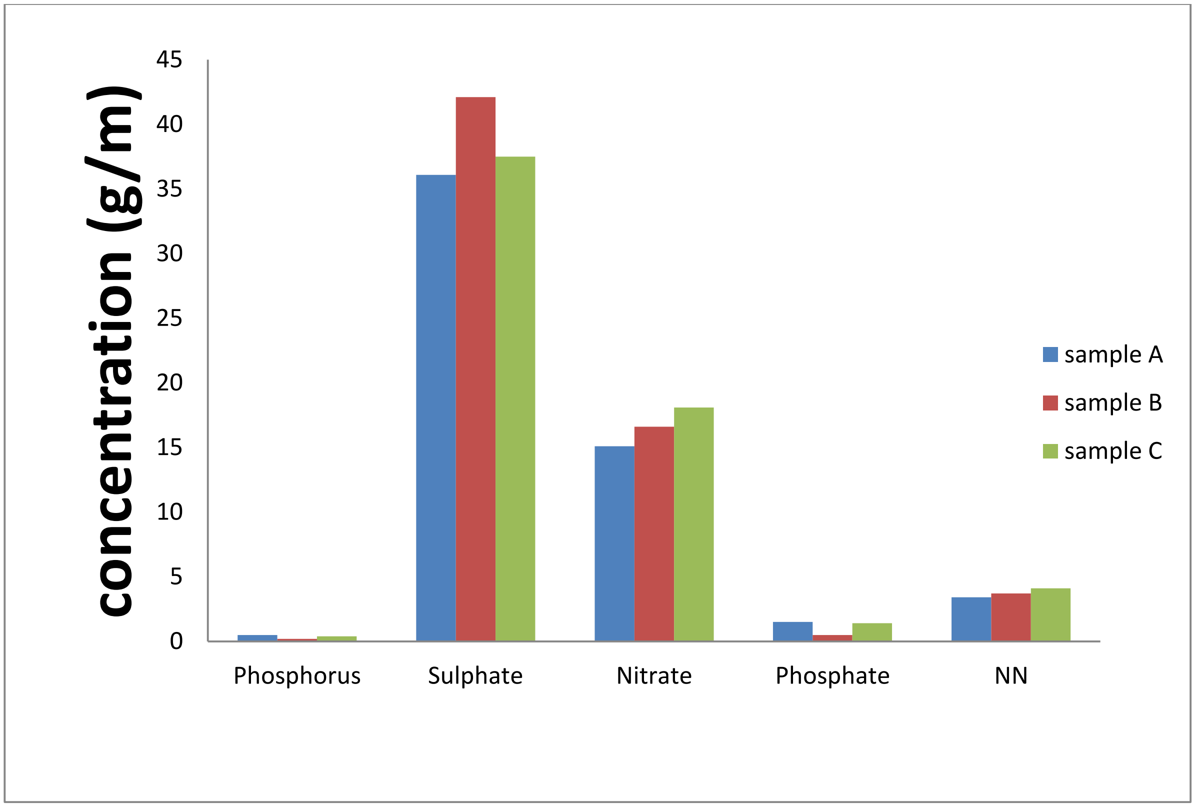


Fig 4.4: variation in the levels of Phosphorus,Sulphate,Nitrate, Phosphate and N-N of Trans-amadi Creek at three sampling points.

The upstream recorded lowest values of Sulphate, nitrate and nitrate-nitrogen while recording highest value in phosphorus and phosphate. The middle-stream had lowest values of phosphate and phosphorus. High value in sulphate was recorded and lower values in Nitrate 16.60mg/l and Nitrate-Nitrogen 3.70mg/l compared to the downstream high value of 18.10mg/l for Nitrate and 4.10mg/l value for Nitrate-Nitrogen.

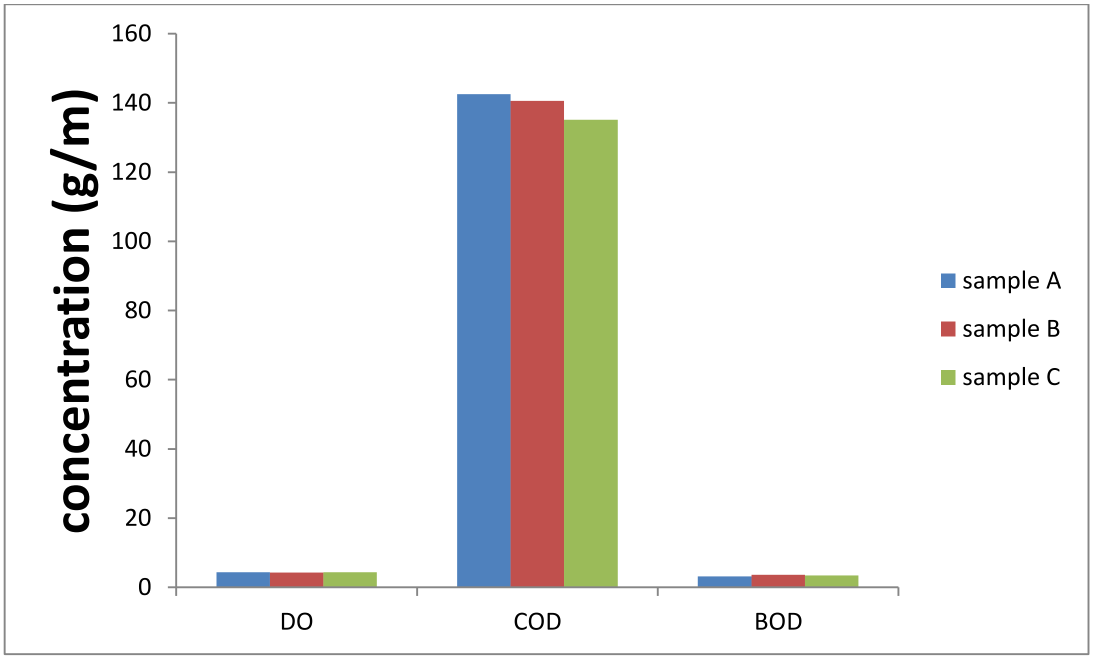


Fig 4.5: variation in the levels of Dissolved Oxygen, COD and BOD of Trans-amadi Creek at three sampling points.

The upstream recorded highest value of dissolved oxygen and COD while recording lowest value in BOD. The middle-stream had highest values of BOD and lowest values of DO. The downstream recorded lowest value of Chemical Oxygen Demand of 135.1mg/l.

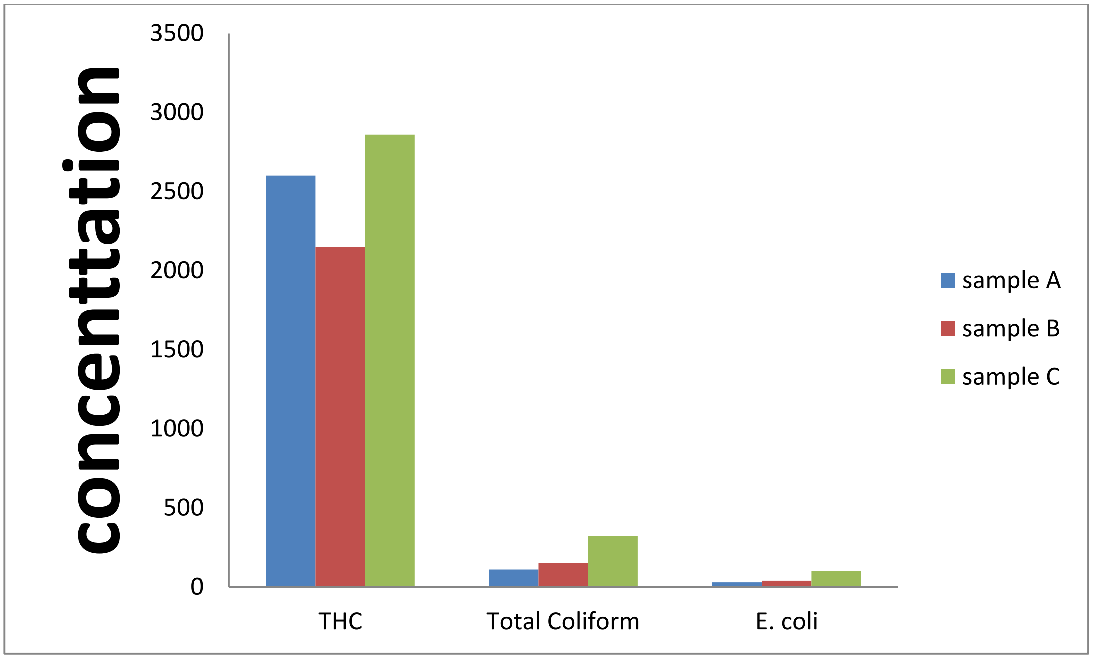


Fig 4.6: variation in the levels of Total Heterotrophic Count, Total Coliform and Escherichia Coli of Trans-amadi Creek at three sampling points.

The upstream recorded lowest values of Total coliform and E. Coli while it had lower value of Total Heterotrophic count. The middle-stream was lower in Total Coliform and andE.coli while recording lowest in total heterotrophic count while the downstream had the highest value of the three samples.

4.2.2 Variance between the Qualities of the Upstream, middle-stream and downstream River Samples in the Study Area.

The analytical data obtained were analyzed using one-way analysis of variance (ANOVA).

Table 4.3: ANOVA results of the physico-chemical and bacteriological analysis across the group showing summary of variance.

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Upstream	21	5499.98	261.9	417759
Middle-stream	21	5943.878	283.04	428231
Downstream	21	8868.64	422.32	1026445

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	319034.1	2	159517	0.25558	0.7753	3.1504
Within Groups	37448688	60	624145			
Total	37767722	62				

The analysis of variance result is as presented in Table 4.3. From the Table, the F-crit (critical value) is 3.1504 and is greater than the F (Fisher's ratio) of 0.25558 for degree of freedom of 2. The ANOVA result shows that there is no significant difference in the quality of water samples across the 3 sample locations in the study area.

4.2.3 WATER QUALITY INDEX ANALYSIS

The result of the water quality index was computed using a standard method as formulated by the United States National Sanitation Foundation (NSF 2005) and is presented in Table 4.4

Table 4.4: water Quality Index values across the three sampled stations of Trans-Amadi Creek.

Upstream	Middle Stream	Downstream
39.25	43.27	39.04

From the table, the results from the three sampled point of Trans-Amadi River falls within the fair range of 26-50 according to the NSF (2005). It can be deduced that the River is facing serious pollution problem and as such can only support a low diversity of aquatic life. Also, such polluted water is not good for consumption as it is associated with some diseases like diarrhea, typhoid fever, respiratory chest diseases etc as enunciated by Oyedemi (2004).

4.3 DISCUSSION

4.3.1: Variation in the levels of PH,Alkalinity, Odour and Zinc.

The pH values of the samples is found to bebelow the WHO 2011 acceptable limit. The river water is therefore acidic. This result are less than that of Osibanjo and Adie (2007), which ranged from 6.92-8.18 in their study of Impact of effluent from Bodija abattoir on the physicochemical parameters of Oshunkaye stream. The low pH values of the creek may be an indication of low CO2 content of the water (Edema *et al*., 2010).

The alkalinity value obtained in this study was highest at the downstream and lowest at the upstream (A). The various ionic species that contribute to water alkalinity are biocarbonate, hydroxide, phosphate, borate and organic acid. The observed value for the three points was far lower than the WHO 2011 acceptable limit.

The result also indicates that water resources in Trans-amadi Creek recorded odorless at the upstream and downstream while a faint odor was noticed at the Middle-stream which may be as a result of the abattoir effluent discharge.

Zinc values from this study are lower than the WHO 2011 standard of 5mg/l and FEPA 1991 of 3mg/l. The middle stream which is the point of abattoir discharge was the lowest of other sample areas with 0.108mg/l. This is in line with Masse and Masse 2000 who described abattoir wastewater as having significantly low amount of zinc content.

4.3.2: Variation in the levels of Color, TSS and TDS

The color range across the sampling locations were below the WHO acceptable limit. The high value of the color was noticed at the upstream and middle stream which could be as a result of certain types of dissolved and colloidal organic matter and the contributions of decaying plant detritus as described by Defew et al 2004.

The result obtained in the TDS showed low values which were quite below WHO 2011 standard for drinking water (250mg/l). The highest value of 32mg/l was recorded at the upstream while the middle-stream recorded 25mg/l.

The figures of the different sample points however show that effluent have dilution effect on TDS as there is progressive decrease from the upstream section through the point the effluents enters the stream to the downstream as described by Magaji, J.Y. and Chup, C.D (2012), in the study of the effects of abattoir waste on water quality in Gwagwalada, Abuja.

Total suspended solid (TSS) values were considered to be above the WHO 2011 acceptable limit. Maximum value was recorded at the middle-stream. Tekenah*et al* 2014, argued that abattoir waste capable of increasing TS and TSS at point source include condemned meat, undigested ingest, animal waste, carcasses etc.

4.3.3: Variation in the levelsof Electrical Conductivity, Total Hardness and Chloride

Electrical conductivity values from this study ranged were minimal with a mean value of 40.67us. Though these figures are lower than WHO 2011 for portable water, they are nevertheless higher than FAO recommended limit for agricultural purposes such as irrigation (Adelegan, 2002).

According to Canadian drinking water quality, water with hardness value of less than 60 mg/l is classified as soft, moderately soft when the hardness value is between 60-120mg/l, hard between 120-180mg/l and very hard above 180mg/l. The values obtained from the TH analysis showed that the water could be categorized as very hard with minimum and maximum values as 1243mg/l and 1690mg/l. The observed values were higher than WHO (2011) standard.

Chloride is a water quality problem which could be an indication of pollution from industrial or domestic activities. Chloride in water above permissible level of 250mg/l can bring about laxative effect in humans, change in taste of water and toxicity to aquatic life (Kumar 2004, Akhionbare 2015). The values of chloride observed across the three sampling points of trans-amadi creek showed high values especially at the downstream where value was maximum and above the WHO 2011 standard.

4.3.4: Variation in the levels of Phosphorus, Sulphate, Nitrate, Phosphate and Nitrogen-Nitrate

Sulphatelevel in this study were observed to be very low with the highest value recorded at the middle-stream which is the point of discharge of the abattoir effluent. These values are below the WHO 2011 standard for drinking water (250mg/l) and 100mg/l standard for FEPA 1991. There are several sources of Sulphate in Creek water; decaying plants and animal matter may release Sulphate into a water body. The consumption of water containing sulphate may result in intestinal discomfort, diarrhea, salty taste and consequently dehydration (Akhionbare, 2015).

Nitrate values from this study falls below the WHO 2011 acceptable limit of 50mg/l. Excessive enrichment of nutrients contained nitrate can result in deoxygenation of the water and consequently decline in the productivity of periphyton as well as reduction in population of bottom dwelling invertebrates (Meena*et al,* 2010). Chikere, 1996 also maintained that increase in nitrate supply in rivers could be as a result of organic detritus which consists of large amounts of protein and nucleic acids from dead organisms and nitrogenous animal wastes such as urea and uric acid as can be seen from the abattoir.

The Nitrogen-Nitrate level from this study ranged from 3.4-4.0mg/l with mean value of 3.73mg/l. The presence of Nitrate-Nitrogen in a water body can be seen as a threat or potential problem hence it can pose certain danger to human health and the health of the water. Some of the potential problems include toxicity to babies, acceleration of eutrophication in water (Akhionbare, 2015).

Phosphate in water is an indicator of agro-chemical usage on land surrounding the river. The low level of content show that it may have entered the river via runoff during rainfall. The determined value of phosphate in this study is below the WHO 2011 standard as the point of discharge of abattoir effluent had the lowest amount of phosphate released compared to the upstream and downstream.

4.3.5: Variation in the levels of DO, COD and BOD

COD test determines the amount of oxygen needed to chemically oxidize the organics in a water or waste water. Chemical Oxygen Demand (COD) of the present study shows values which were above the FEPA standard acceptable limit of 80mg/l. This could probably be due to the rate of dilution of the pollutants that led to the decrease as the water flows downstream. The result showed that at the point of entry of the abattoir effluent into the stream, COD was 140.1mg/l, but much higher at the upstream. High level of COD indicates the presence of chemical oxidants in the effluent while low COD indicates otherwise. High COD could likely cause nutrient fixation in the soil resulting to reduced rate of nutrient availability to plants. Chemical oxidants affects water treatment plants by causing rapid development of rust (Makwe*,* 2005).

Biochemical Oxygen Demand (BOD) exhibited significant variation across the sampling stations with highest value recorded at the point of discharge of the abattoir effluent (middle-stream) than at the upstream which recorded a minimum value of 3.2mg/l. The high BOD load observed at the middlestream could be attributed to increase degradable organic waste load from the abattoir effluent discharged into the river. Based on the observed result in this study, it could be stated that the BOD of the creek water was affected by the discharge of the abattoir effluent and the water quality termed unclean. This assertion follows the classification of Moore and Moore (1976), who opined that water bodies with BOD concentration between 1.0 and 2.0mg/l were considered clean, 3.0mg/l fairly clean, 5.0mg/l doubtful and 10.0mg/l definitely bad and polluted. The values were below the WHO 2011 permissible limit. BOD concentrations in a creek may therefore serve as a pointer to the level of organic pollution. This agreed with the observation by Braid *et al.* (2004) in their study on water Quality of Miniweja stream in Eastern Niger Delta.

Dissolved oxygen

isanimportantfactorthatdeterminesthequalityofwaterinlakesandrivershence,thehigheritsconcentration, thebetterthewater quality. Dissolved Oxygen values from this study fall below the WHO 2011 standard of 10mg/l. The result show a decrease in value at the middle-stream from 4.40mg/l at the upstream to 4.25mg/l which signifies reduction in dissolve oxygen. The dropinDOleveldefinestheputridconditionoftheriveratthepoint of abattoir effluent discharge. Factors that promote DO level in water includes, atmospheric diffusion, input from photosynthetic plants etc. (Akhionbare, 2009).

4.3.6: Variation in the levels of Total Heterotrophic Count, Total Coliform and Escherishia Coli

The detection of bacteriological parameters in large quantity signifies that the river contains bacteria which show that the river water is unsafe for human consumption. Total faecal coliform which indicates the level of contamination of human and animal waste was above the WHO 2011 permissible limit of 10mg/l. At the point of abattoir discharge the level of faecal coliform count increased as the dilution process had no effect downstream. The presence of E. Coli in water is considered a specific indicator of Fecal contamination and the presence of enteric pathogens. The high level of total coliform and E. coli in the creek are therefore indication of the contamination of water source with fecal material and possibly pathogenic organisms from abattoir waste water discharged untreated. Similar findings has early been made by Cadmus *et al* (1999) in their study on the prevalence and Zoonotic importance of bovine tuberculosis in Ibadan. The discharge of untreated abattoir waste water could result in outbreak of E.coli infection as observed by Cieslak*et al* (1993). The microbial concentrations observed upstream in this study could be as a result of indiscriminate disposal of domestic wastes into the water bodies by human beings in this area. Other bacteriological parameters indicated pollution at the point of discharge.

Hence at this point, it can be deduced that the pollution of this very creek also affect the aquatic macro invertebrate and the entire diversity of aquatic community, hence the species composition changes from natural species to tolerable species. This assertion is confirmed by Xu, M *et al*(2014) who stated in his research that "The species of aquatic animals may reflect water pollution level" . This is also inline with the research carried out by Ojesanmi and Ibe (2012) on the " Effects of pollution on

Vibrios in Woji creek". Their research shows that organic Nutrients (Sulphates, nitrates & Phosphates) from abattoir wastes have been responsible for a significantly microbial type both in the effluent and receiving water body, as the highest Vibrio counts was observed at sampling stations with close proximity to the discharge point of abattoir effluents.

CHAPTER FIVE

SUMMARY OF FINDINGS, RECOMMENDATIONSAND CONCLUSION

5.1 SUMMARY OF FINDINGS:

The levels of ph, Electrical conductivity, Alkalinity, Sulphate, Nitrate, Phosphate, Biochemical Oxygen Demand, Dissolved Oxygen and Zinc in Trans-Amadi creek across the 3 sample locations were recorded to be below the WHO (2011) and FEPA (1991) acceptable limit for drinking water. Other parameters like Total Suspended Solid, Total Hardness, Chloride and Chemical Oxygen Demand were all recorded to be above the WHO (2011) and FEPA (1991) acceptable limit. High concentrations of sulphate, BOD and TSS were noticed at middle-stream which is the point of abattoir discharge than the upstream and downstream. The value of the Parameters color, TSS, TDS and COD shows a significant effect in the self purification factor of the creek downstream. Physical parameters of Odor and color fell within the acceptable limits except for the downstream where the color was below the acceptable limit and Odor noticed at the point of effluent discharge into the creek.

Microbial parameters were all recorded to be very high at the downstream of the Trans-amadi Creek under study. The high counts recorded for the microbial parameters indicate abundance and considerable level of decomposition and biodegradation activities in the Creek.

Abattoir effluent discharge and other anthropogenic activities were some of the factors that contributed to the elevated levels of these variables in the water under study. The water Quality index indicates the deterioration of the water quality.

5.2 RECOMMENDATIONS

Based on the findings above, the following are recommended

1. The increasing population and industrialization of Trans-amadi should be sensitized on the importance of proper waste disposal and the implication of improper waste disposal within the environment.
2. There should be a proper disposal of abattoir waste instituted in the area in other to reduce the amount of abattoir waste and waste water discharged in the creek.
3. As can be seen from the analysis and result, other human activities like industrial effluent discharge, open defecation and agricultural activities also contribute to the deterioration of the creek. Stringent actions should be taken by the environmental ministry to protect the water bodies.

4. Environmental audit which involves regulation should be encouraged with the local communities within the Trans-amadi area as part of an overall environmental management policy. The advantage of this is that self regulation is frequently more effective than reliance on an official rules which may not cover every contingency.
5. Lastly, it is recommended that the Trans-amadi Creek is unfit for consumption but if it must be used, proper water treatment technique should be used to sterilize the water before consumption.

5.2.1 PROVISIONAL RECOMMENDATION

Most Nigerian abattoirs are sited near water bodies such that their waste water flows directly into the stream without passing any treatment process. Same is also the case of Port Harcourt abattoir.

The most widely used route for disposal of abattoir waste is Municipal sewers. Discharge cost due to high organic strength of untreated abattoir waste is relatively high. Abattoirs normally also have difficulty in meeting Municipal by-laws for fats, oils, greases and suspended solids. A degree of on-site pretreatment is therefore preferable, however, to minimize waste volume, water conservation and optimum house-keeping are essential.

In addition to good abattoir house-keeping, abattoir waste management should be progressively implemented commencing with low cost, low technology practices and thereafter, progressing to more sophisticated technologies.

Abattoir which is known as a diffused source of pollution can be made a point source by building a solid concrete wall that will separate the abattoir from the stream and also, creating a sewer system for the passage of the waste water into adeep pond/lagoon where the secondary treatment can take place, subsequently, tertiary, if need be, before it can be discharged into the stream.

Best management practices which broadly apply in terms of pre-treatment include:

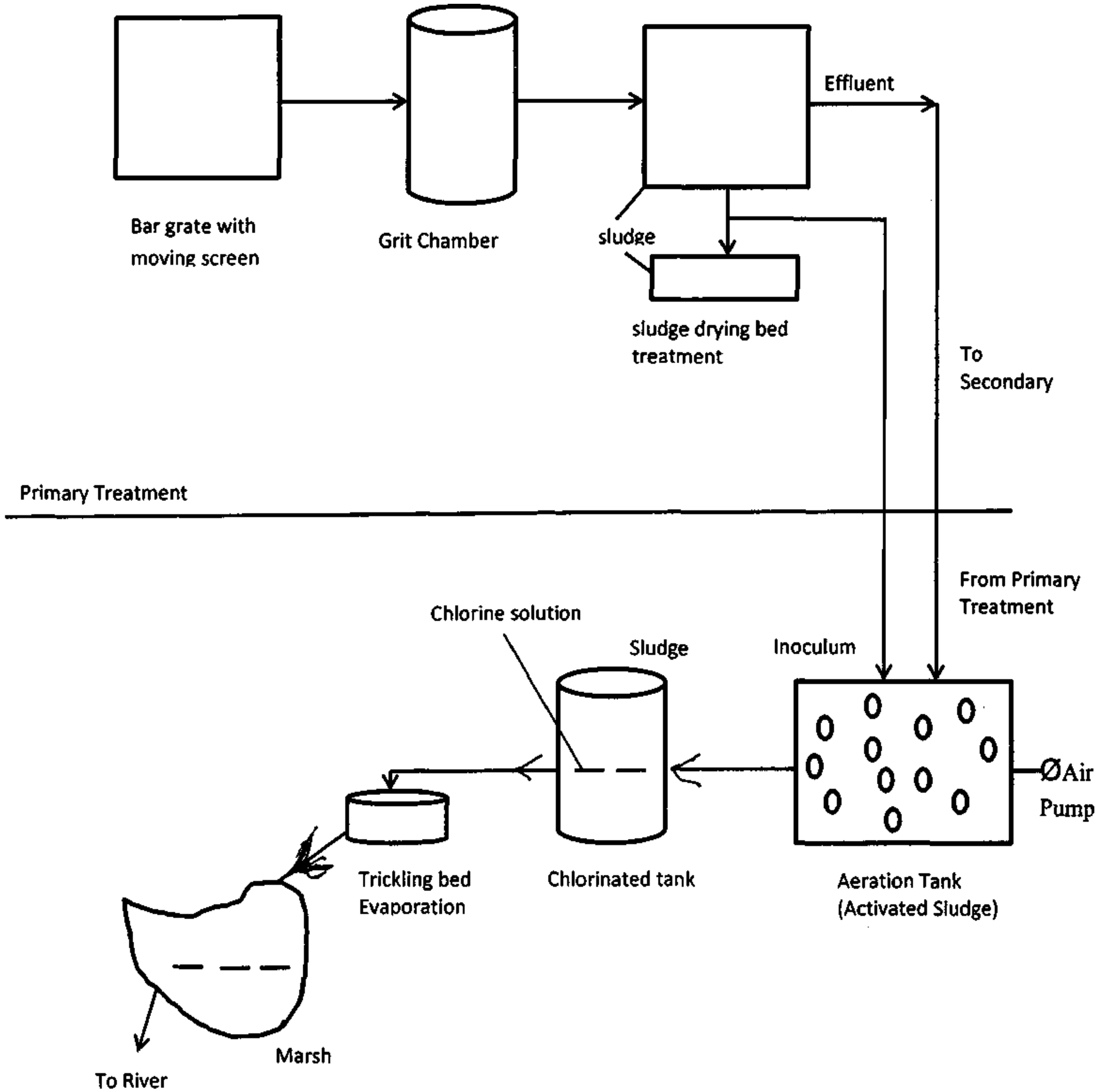
• Solid Separation by Screening: it is a process that removes particle size of about 1cm and above. This is important to prevent accumulation of these particles which may disrupt equipments. Primary screening can remove 5- 20% of BOD and 5-30% of TSS. Fixed bar screens are the most common types of screens used in domestic waste water treatment facilities. The screening process produces objectionable screenings which must be disposed of in a satisfactory manner. Methods of disposal include burial, incinerator, grinding and digestion.

• Fats/Oil removal by Skimming/Floatation: Skimming process are able to remove floating objects e.g. 20-30% BOD, 40-50% TSS and 50-60% grease. This process is more efficient than screening though more capital intensive. Floatation may also be used for treating effluents containing finely divided suspended solids and oil matter.

Particles of density close to that of water are very difficult to settle in normal sedimentation tank and take a longtime for separation (Rao C.S, 2009) In such cases the separation can be speeded up by aerating the effluent where by the air bubbles are attached to the suspended matter. This has the effect of increasing the buoyancy of the particles, as a result, the particles float to surface where they can be readily removed. To aid the floatation process, Chemical coagulant such as aluminum and feric salt are used. Two methods of floatation are currently available: The dispersed-air floatation and dissolved air floatation. But dissolved floatation is currently used because of the intimate contact between air and waste water while the diffused type generate bubbles which cause turbulence that break up fragile floe particle usually before anaerobic treatment, the waste water stream is diverted to the dissolved air floatation unit so that blood, fat, oil and grease constituents are reduced.

With the above treatment processes, the secondary and tertiary treatment can then be preceded before disposal into a stream.

Below is a practical design process as enunciated by Akhionbare (2009)



(b) Secondary Treatment

Akhionbare (2009)

5.3 CONCLUSION

The abattoir waste and wastewater which is discharged in the creek at the middle-stream of this study impacted negatively on some parameters. As a diffused source close to the creek, it is the major source of pollution of Trans- amadi creek during the rainy season during which this study was carried out. While rainfall may dilute and weaken the effects of point source pollution, it also increases the contribution of non-point source or diffuse pollution through land runoff from riparian communities and agricultural farmland.

However, the result of the analysis generally showed that Trans-amadi Creek is polluted and poses severe health risk to several riparian communities who rely on the Creek as their primary source of domestic water.

Nevertheless, Abattoir waste, like every other waste is a resource and could be utilized in several operations within and outside the activities of abattoir ,such as provision of bio-energy for self sustaining cycle (Budiyono *et al*, 2014), composting in agriculture (Sadik*et al,2010) etc.*

Findings from this current study indicate that the meat processing industry in Nigeria has a potential to worsen scarcity of clean water availability, thereby adversely affecting the range of uses of such water bodies. This is in line with the research carried out by Tekenah (2014). It is however recommended that in line with national and international effort being made to safe guard the water environment, provide clean water as well as protect human health, the sanitation of our local meat processing industries should be closely monitored. The enforcement of the existing health and hygiene regulations as well as the provision of standard equipments and functional units within the Abattoir should be encouraged.

5.4. CONTRIBUTION TO KNOWLEDGE

The study will provide basic information for researchers, government enforcement agencies and the general public on the water use and conflict. It will also evaluate the current water quality and level of pollution of the creek. The data obtained from the analysis will furnish information that will be useful to predict likely changes over time in the concentration levels of different pollutions. Possible solutions to the existing problems will be suggested and may form basis of adoption of engineering measures to arrest water pollution by commercial and industrial activities.

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APPENDIXES

APPENDIX 1: Plates showing various discharge points of abattoir wastes into the Trans-Amadi Creek.

Plate 1

Plate 2

Plate 3

Plate 4

Plate 5

Plate 6

Appendix 2: Comparism of the values of Physico-Chemical Parameters of Trans-amadi Creek at three sampling points to WHO (2011) and FEPA (1991) standards.

PARAMETERS	SAMPLE A	SAMPLE B	SAMPLE C	MEAN VALUE	WHO (2011)	FEPA (1991)
pH	4.46	5.09	5.51	5.02	6.5-8.5	6.5-8.5
TDS (mg/l)	32	25	22	26.33	250	500
TSS (mg/l)	6.5	10.5	6.0	7.67	5	
EC (µs/cm)	50	38	34	40.67	1000	1000
Turbidity (NTU)	-	-	-	-	-	-
Alkalinity (mg/l)	1.04	1.54	1.55	1.38	60	-
Total Hardness (mg/l)	1243	1505	1690	1,479.33	250	
Chloride (mg/l)	1205	1820	3620	2,215.0	250	250
PO4	1.50	0.50	1.40	1.13	5	
NO3 (mg/l)	15.10	16.60	18.10	16.60	50	50
SO4 (mg/l)	36.1	42.1	37.5	38.57	250	100
DO (mg/l)	4.40	4.25	4.35	4.33	10	5
BOD (mg/l)	3.20	3.60	3.40	3.40	10	-

COD (mg/l)	142.5	140.6	135.1	139.4	40	80
Zinc (mg/l)	0.620	0.108	0.230	0.199	5	3
Total coliform (cfu/100ml)	30	40	100		10	