WATER POLLUTION AND ITS IMPLICATIONS FOR AQUATIC RESOURCE CONSERVATION
(A CASE STUDY OF RIVER CHANCHAGA)

BY

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DECLARATION

I OBI IJEOMA MAUREEN of the Department of Geography, School of Science and Science Education, Federal University of Technology, Minna do solemnly declare that the research work presented for the award of Post Graduate Diploma in Environmental Management has been carried out by me, under the Supervision of DR. HALILU AHMED SHABA of the Department of Geography, School of Science and Science Education, Federal University of Technology, Minna, Niger State.

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OBI IJEOMA MAUREEN DATE

CERTIFICATION

This is to certify that OBI IJEOMA MAUREEN of the Department of Geography, Federal University of Technology, Minna, did conduct a Research on Water Pollution and its Implications for Aquatic Resource Conservation . In Chanchaga River Minna, Niger State. And is approved for its contribution to knowledge and literary presentation. In partial fulfillment of the award of Post Graduate Diploma, in Environmental Management.

DR. HALILU AHMED SHABA SUPERVISOR	25/03/02 DATE
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EXTERNAL EXAMINER	DATE
PROFESSOR J. ABALAKA DEAN POST-GRADUATE SCHOOL	DATE

DEDICATION

This THESIS is dedicated to ALL WHO SEEK KNOWLEDGE.

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ABSTRACT

Population stress and human activities in chanchaga river have impacted on the physico-chemical properties of the river thereby affecting aquatic resources. Four stations were located at chanchaga river as sampling station. Physico-chemical parameters were observed and analysed in the laboratory. The low dissolved oxygen, high biological oxygen demand and high ammonia content observed in some of the stations indicates that the river is under pollutional stress. The sampled stations located in the active part of the town (Station 3) shows marked signs of pollution and less presence of aquatic resources indicating that pollution has a negative implication for aquatic resource Conservation. Levels of heavy metals in the river were comparatively low. An indications of low industrial activity in chanchaga.

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CHAPTER ONE

1.0 INTRODUCTION

Water is essential for life on earth. All organisms contain it. Some Organisms live in it and get their food and other nutrients from it. In addition to this, water is useful in aquaculture production, It is used Industrially for the production of goods and services for man's enjoyment, It is also put into numerous uses domestically. Water can also serve as a source of recreation and other sporting activities as well as in generation of revenue when used, as a tourist's attraction e.g. is the Gurara falls in Niger state. It can also be used for transportation and hydro-electricity generation.

About 80% of the planet is covered by water. Water and the resources there in are abound ant and renewable, yet their continuous usefulness is dependent on the responsible usage of this resilient but fragile ecosystem. Being mindful of our activities that are deleterious to water quality.

In different parts of the world at large and Nigeria in particular, flowing water is seen as a limitless dumping ground for wastes. These wastes are generated from sewage domestically, industrially and agriculturally and when channeled into water bodies introduced noxious substances into them resulting in water pollution. Furthermore these wastes affect the physico-chemical properties of the water adversely and this in turn exerts its toll on aquatic resources.

Water pollution may be defined as the introduction of substances or energy into water bodies by people either directly or indirectly resulting in such undesirous effect as harm to living aquatic resources, hazards to human health, hindrance to aquatic activities including fishing, impairment of quality and use of water and reduction of amenities. Water pollution is the result of the release of too much unwanted material by human activities in the wrong place (water body) in amounts too large to be controlled by natural means either for neutralization or dispersion into harmless levels.

As a result of this indiscriminate dumping of wastes into water bodies, it has been estimated that nearly 1.5 billion people lack safe drinking water and about 5 million deaths per year are attributed to water borne illness and diseases. (Microsoft Encarta Encyclopedia 2000)

Beaches around the world are closed regularly often because of high amount of bacteria from sewage disposal, and marine wildlife are beginning to feel the impact. Reverine and marine ecosystems in the lagoon and the River Niger Delta are already affected by industrial and domestic pollution especially Oil spill in the Delta area.

In years gone by, when industrial activities and extensive agriculture were at low level, especially in Nigeria, many aquatic ecosystems remained largely unpolluted because pollution stress was low and easily accommodated by the natural self purification process of the aquatic ecosystems. But the situation is no longer the same as a result of increased demand for aquatic resources, high level of industrial activities and population pressure.

According to Sikoki et al (1992) of all pollution problems being experienced in Nigeria, water pollution occupies the pride of place. In view of the fact that pollution affects both man and the aquatic ecosystems directly and indirectly, ways and means need to be adapted to combat pollution to conserve aquatic ecosystem.

Water pollution could either be of two forms by point source or by non point source. When pollution and effluents are discharged at specific locations or at spots we can easily identify it is known as point source form of pollution such as from factories, sewage treatment plants or oil tanks. This form of pollution is easier to monitor and control.

Non-point source of pollution on the other hand occurs from run–off water containing pesticides and fertilizers. It does not have a specific location and can find it self in any water body. This form of pollution is difficult to control. They may appear a little at a time from large areas, carried along by rainfall or snowmelt for instance, the small oil leaks from automobiles that produce discolored spots on the asphalt of parking lots become non point sources of water pollution when rain carries the oil into local water. Most agricultural pollution is non point since it typically originates from many fields.

As opined by Ofojekwu (1990) water pollutants are of three principal types: physical, this includes silt and other abrasive agents, chemicals including toxic materials from industries and agricultural products like insecticides and weed killers, and organic including domestic sewage industrial wastes like canaries and fertilizers.

Wootton (1992) is of the opinion that poisonous substances may enter a river either by deliberate design or inadvertently. The relatively small water volumes in rivers compared to large lakes or marine ecosystems means that the adverse effects of such discharges are often seen quickly and more dramatically. He went further to explain that there are two forms of pollution. The first form of pollution are caused by pollution that have direct adverse effect on the fish and aquatic organisms by virtue of their toxicity these include heavy metal such as cadmium, lead and zinc, other inorganic compounds including chlorine, cyanide and ammonia as well as organic compounds such as phenol, insecticides and herbicides.

The second form of pollution is that created by organic wastes including farm –yard wastes and domestic sewage. The decomposition of these wastes by bacterial action uses up oxygen in the water, as a result the fishes are killed not by the pollutants themselves but by de-oxygenation.

According to Brown and Gratzek (1984), toxic materials that have caused the most problems in aquatic environments are those that are not easily broken down in the environment. Because of their resistance to bacterial breakdown those materials tend to accumulate in the environment and can bioaccumulate to very high concentration in fish and other aquatic organisms. This is especially true of polychlorinated biphenyls (PCBs).

According to Imevbore (1980) water pollution exist in both rural and urban areas of Nigeria. It is as common in the village as it is in cities albeit as a result of different set of factors. In the village, chinking water from natural sources such as rivers and streams get polluted by organic substances from upstream users who use the water for bathing, washing of cloths or agricultural production and other purposes. Such pollution from organic substance are usually death with naturally and rests normally with self purification within the river or stream system.

On the other hand, modern developments cause serious pollution problems and the main categories of development held responsible for water pollution are agriculture, urbansation and industrialization.

1:1 BACKGROUND TO THE PROBLEM

Advances in Agriculture in the eighteenth century improved productivity, making it possible for some men to leave the land for other occupations. This brought about inventions and discoveries, which enhanced the setting up of early factories and industries especially in the growing seasons. All over the country one finds these factories located on riverbanks, which discharge their effluents into the rivers. The citing of industries and factories attracted a lot of people to such places. As a results wastes forms homes, effluents from industries and factories all find their way into the river. The major industries which pollution water include the petroleum industry, mining industry (for local tin and gold) wood and pulp industry, pharmaceutical, textile plastic, iron and steel, brewing, distillery, fermentation and food industries. It was only in the 19^{th} century that man began to use his biological knowledge to solve the grave problem of water pollution.

1:2 STATEMENT OF THE PROBLEM.

Water dominates this planet and its unique physical and chemical properties (physico – chemical) make all the myriades of life possible it not only controls our climates but also controls the very structure of our genes by hydrogen bond formation.

Fishes already depleted by over fishing is being threatened by aquatic pollution. Streams, rivers and surface waters are the sources of water supply to all urban and semi urban centres of Niger state. There are incidents of surface water pollution in chanchaga through agricultural activities, minning and domestic activities, storm drains and pesticides all over the town. This trends of event given more weight by population pressure is alarming and if left unchecked will result in the complete destruction of aquatic ecosystem which forms a significant part of the national resource.

1: 3 AIMS AND OBJECTIVES OF THE STUDY

The study aims at assessing the implication of water pollution to aquatic resource conservation.

The objectives include

(i) Assessing the physico – chemical parameters of the river chanchaga and establishing whether the river is polluted or not.

(ii) If the river is polluted, establishing whether the pollution is from point or non point sources.

(iii) Assessing the effect of pollution, if any on the population of aquatic resources

(iv) Assessing the impact of pollution on the conservation of aquatic resources.

1:4 SIGNIFICANCE OF THE STUDY

There is a growing concern among the fishing industry and those who make their living from aquatic ecosystem as to the rate at which industrialization and urbanization are turning our waters unusable. This project paper will help to provide useful information on the nature of water pollution, proffer possible solutions as well as measures of control to make for sustainable use of aquatic resources so that the next generation will not crafty us for being thoughtless.

1:5 SCOPE AND LIMITATION

Due to time as well as financial constraints and available technology this research work will be limited to the Chanchaga River

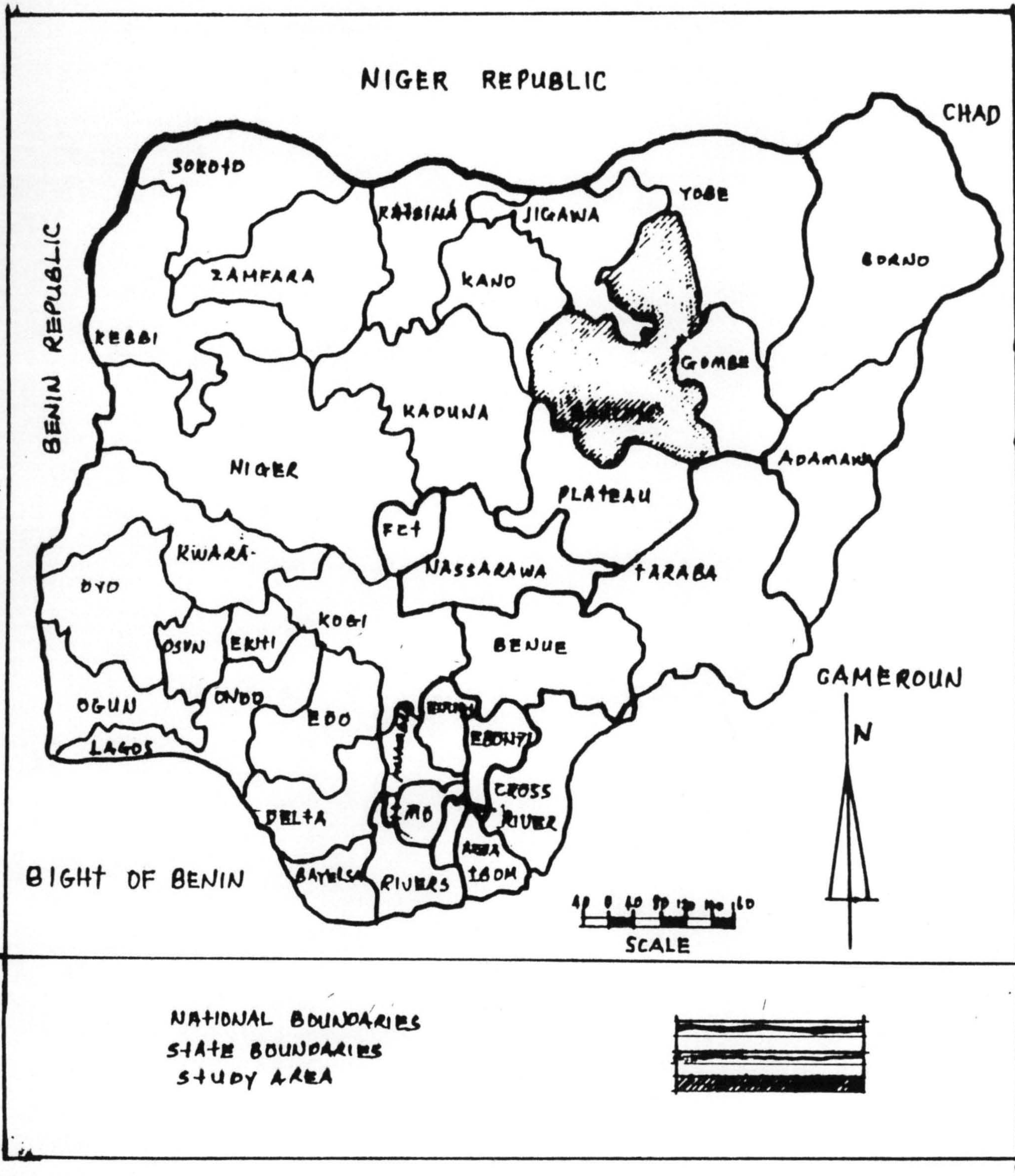
The study will only assess the effect of water pollution on the population or aboundance of aquatic resources like fishes and planktons. It will not go into laboratory dissection of such fishes to ascertain the level of pollutants they contain.

1:6 DESCRIPTION OF THE STUDY AREA

The study area is river chanchaga in Bosso Local Government Area of Minna Niger state. It lies between latitude 9^0 36' 32" and longitude 6^0 32' 13". The mean annual rainfall is 1337.8 with an annual mean temperature of 27. 2^0 c. Most parts of Niger state lie within the Guinea savana.

The river chanchaga flows through kasobo, Numu kpan, Tungawaya and Isafi wambai Gurusu residential areas. there is also a village know as chanchaga named from the river. An army barracks's situated a few yards from the bridge and schools lie within the vicinity of the river flowing through the town (collage of education and fed Govt college Minna). The people of the area are predominantly farmers and a lot of farming go in and around the flood plain. Domestic wastes are dumped in the river and domestic activities such as bathing, washing and defecation are done on the banks of the river and in the water itself. Digging for gold go on around the river banks.

Fig 1.1 Map of Nigeria showing Niger state



Source: Geography Department, F.U.T. Minna.

1.7 DEFINITION OF TERMS

ECOSYSTEM: This is any natural site or area in which living things occupy and interact with each other and the natural environment in that area.eg is water

AQUATIC ECOSYSTEM : This is the community of living organisms that live in water.

AQUATIC RESOURCES: These are all forms of matter or energy, or material, which is considered essential by human standard and lives in water. Water itself is an aquatic resource.

RENEWABLE RESOURCES: These are resources which by virtue of their nature are capable of reproducing themselves or those resources that are incapable of 'finishing' when managed properly.

PLANKTONS: These are aquatic living organisms, which stay at the surface or top of water bodies. They could be plants (phytoplanktons) or animals (zooplanktons)

BENTHICS: These are aquatic living organisms, which inhabit the bottom of a water body.

CHAPTER TWO

LITERATURE REVIEW

2.0 INTRODUCTION

Pollution is the contamination of the earth's environment with materials that interfere with human health, the quality of life, or the natural functioning of ecosystems. The environment is made up of four spheres, the lithosphere, the atmosphere, the hydrosphere and the biosphere. Any alteration in any of these spheres to the extent that it deteriorates or fails to give out its maximum service or function is termed pollution.

Water pollution is any impairment of water, which lessens its usefulness for beneficial purposes, or anything, the public does not like or that which is getting worse. Water is polluted if it is not of sufficiently high quality to be suitable for the highest uses people wish to make of it at present or in the future.(Halilu2001).

According to WHO (1974) the aquatic environment is considered polluted when it is altered in composition or condition directly or indirectly as a result of the activities of man so that it becomes less suitable for some or all of the uses for which it would be suitable in its natural state.

Water pollution is thus the downgrading of water quality to the point where it affects unreasonably water use for domestic, industrial, agricultural or other uses. Pollution exists only when the impurity concentration is high enough to harm water usage adversely and unreasonably. Water pollution is reduced by dilution and self-purification in rivers and lakes. But when their effectiveness in this respect is exceeded problems develop cumulatively.

There are two main categories of materials that cause pollution namely:- Biodegradable and Non degradable pollutants. Biodegradable pollutants are materials that rapidly decompose by natural processes such as sewage. Ordinarily they do not constitute much problem because nature takes care of them rapidly but when they are added to the environment faster than they can decompose it becomes an environmental problem. Non-degradable pollutants on the other hand are materials that either do not decompose or decomposes slowly in the natural environment. According to Engelking (2000) once contamination occurs, it is difficult or impossible to remove these pollutants from the environment.

Non degradable compounds like dichlorodiphenyltrichloro ethare (DDT) dioxins, polychlorinated biphenyls (PCBS) and radioactive materials can reach dangerous levels of accumulation as they are passed up the food chain into the bodies of progressively larger animals.

Sewage, industrial wastes and agricultural chemicals such as fertilizers and pesticides are the main causes of water pollution. In 1995 the US Environmental Protection Agency (EPA) reported that about 37% of the country's lakes and estuaries are polluted and 36% of its rivers are too polluted for basic uses, such as fishing or swimming during all or parts of the year. In developing Nations such as Nigeria for instance over 95% of urban sewage is discharged untreated into rivers and bays creating a major human hazard (John2000).

Water run-off, a non point source of pollution carries fertilizing chemicals such as phosphates and nitrates from agricultural fields and yards into lakes, streams and rivers these combine with the phosphates and nitrates from sewage to speed up the growth of algae a type of aquatic plant. The water body may become choked with decaying algae, which severely depletes the oxygen supply. This process is called Eutrophication and can cause the death, depletion of fish and other aquatic life. Run-off also carries toxic pesticides, urban and industrial wastes into lakes and streams.

Erosion, the wearing away of topsoil by wind and rain also contributes to water pollution. Soil or silt washed from logged hillsides, ploughed fields or construction sites, can clog waterways and kill aquatic flora. Even small amounts of silt can eliminate desirable fish species. For instance when logging removes the protective plant cover from hillsides and rain wash soil and silt into streams, covering the gravel beds that trout or salmon use for spawning.

Literature will be reviewed on sources of pollution to the water bodies, their effects, types of pollutants, the impact on aquatic ecosystem, effect on water quality, productivity and impacts on human life.

2.1 SOURCES OF POLLUTANT

Water pollutants result from various human activities. As Ofojekwu (1990) stated human activity and a variety of natural processes may directly or indirectly modify the composition and state of a natural water body to the extent that such water body losses its ability to serve designated purposes.

Pollutants from domestic sources arising from the kitchen, waste water from soak-aways in cities and urban areas as well as every other residential community discharge their sewage untreated into rivers and lakes, sometimes with traces of household chemicals mixed in.

Pollutants arising from industrial sources are also poured out from out fall pipes of factories or leaks from pipelines and underground storage tanks. Sometimes too industries discharge pollutants into city sewers, increasing the variety of pollutants in municipal areas. Pollutants from such agricultural sources as farms, pastures, feedlots, and ranches contribute animal wastes, agricultural chemicals and sediment from erosions.

Polluted water from mines finds their way into rivers either by leaching through mineral rich rocks or that has been contaminated by the chemicals used in processing the ores. (See fish 1971) pollutants reach the sea from adjacent shorelines, from ships and from offshore oil platforms. Sewage and food wastes discarded from ships on the open sea also constitute pollutants; plastics thrown overboard can kill birds or marine animals by entangling them, choking them or blocking their digestive tracks when ingested.

Water pollution can also be caused by other types of pollution for instance sulphurdioxide from power plants chimney begins as air pollution. The polluted air mixed with atmospheric moisture to produce airborne sulphuric acid, which falls to the earth as acid rain. The acid rain finds its way to streams and lakes thereby polluting the water and in dangerous cases can harm or even exterminate some species of aquatic organisms as well as Wildlife. Similarly, the garbage in a landfill can create water pollution if rainwater percolating through the garbage absorbs toxins before it sinks into the soil and contaminates the underlying groundwater. The interaction with groundwater is particularly noteworthy. Once a contaminated fluid reaches the water table; it begins to move slowly through the groundwater system towards some ultimate point of discharge, which most commonly is a nearby stream, swamp, lake or water well. (See Imevbore 1982). Natural rates of groundwater movement may be slow as low as a few centimeters a day, usually not more than half metre or so a day. Only a small amount of mixing with the native groundwater takes place so that the contaminated fluid tends to persist as a discrete elongated body referred to as a plume. Several individual contaminants in a plume may move rapidly or more slowly than others due to difference in viscosity and density and sometimes in a direction different from that of natural groundwater flow. Very dense fluids may sink to the bottom of an aquifer, where as oily fluids may float on top of the water table. This kind of pollution persists for a long period and causes a lot of long-term damage.

2.2 POLLUTANTS AND THEIR EFFECTS.

Lloyd (1992) painted out that the first important fact to remember is that all chemicals are harmful if they are present in high concentrations, even those chemicals that are essential to life at lower concentrations.

As mentioned earlier in this project, the major water pollutants are chemical, biological or physical materials that degrade water quality. Based on this, pollutants can be further classed into eight categories each of which presents its own set of hazards. They include the following according to John (2000): -

1. Industrial Wastes (Hazardous Water).
2. Agricultural Wastes (Pesticides, Herbicides, & Fertilizers).
3. Domestic Sewage.
4. Oil and Petroleum.
5. Heavy Metals.
6. Sediments.

7. Thermal Pollution.

8. Infection Organisms.

2.2.1 INDUSTRIAL WASTES.

Industrial effluent discharges are known to exert great impact on the aquatic ecosystem even at low concentrations. Industrial effluents include discharges from paper mills, food processing, plants, breweries, tanneries e.t.c These are usually toxic and cause harm to many living organisms.

Since industrial revolution started in early 18th Century introduction, of toxic substances have created problems for life in many aquatic ecosystem. Often concentration of toxic substances are sometimes high enough to have resounding effects on not only the organisms living in water but also those who harvest these organisms or use the water for sundry other purposes.

Hazardous wastes are chemical wastes that are toxic (poisonous), reactive (capable of producing explosive or toxic gases) corrosive (capable of corroding steel), or ignitable (flammable). If improperly treated or stored, hazardous wastes can pollute water supplies. In 1969, the Cuyahoga River in Cleveland, Ohio, was so polluted with hazardous wastes that it caught fire and burned. PCBs a class of chemical once widely used in electrical equipment such as transformers can get into the environment through oil spills and can reach toxic levels as organisms eat one another.

2.2.2. AGRICULTURAL WASTES.

Chemicals used by farmers for various purposes may be collected by run-off and carried into streams and other water bodies where they cause pollution.

These chemicals include (i) Herbicides: - Used to kill unwanted plants. (ii) Pesticides used to kill unwanted lower animals and. (iii) Fertilizers used as manure to enrich the soil and ensure rich harvest. When these chemicals are applied too lavishly they find their way into streams and cause untold harm to aquatic ecosystem.

Some of these chemicals are biodegradable though and quickly decay into harmless or less harmful forms while others are non-degradable and their dangerous effect last for a long time. These chemicals are mainly Organo-chlorines and polychlorinated compounds such as Dichlorodiphenyl-trichloro ethane (DDT) and polychlorinated biphenyls (PCBs). The herbicides are more easily degradable than the insecticides and pesticides. As a result they cause much environmental hazards.

Fertilizers also constitute major pollutants. As reported by Das et al (1977) about 30% to 60% of the Nitrogen applied in farms during autumn and winter leach into lakes and streams. This results in an increase in Nitrogen and Phosphorous content of rivers enhancing eutrophication. Eutrophication occurs as a result of depleting oxygen levels due to the decomposition of microorganism.

Many drinking water supplies are contaminated with pesticides from widespread agricultural use. More than 14 million Americans drink water contaminated with pesticides and the Environmental Protection Agency (EPA) estimates that 10 percent of wells contain pesticides.

2.2.3. DOMESTIC SEWAGE.

The Oxford Dictionary (Revised Version of 4th edition) described sewage as waste matter from human bodies, factories, towns e.t.c. that flows away in sewers.

While domestic is described as the home or household. So domestic sewage is the waste mater from households channeled into sewers usually underground for carrying of drainage water and sewage from areas of generation to areas of disposal.

This domestic sewage includes all wastewater from baths sinks, basins and similar appliances in the home. It also includes refuse generated in the course of doing one domestic chore or the other in the home e.g. solid wastes from kitchens, and other parts of the house, which are not channeled, to sewers. It comprises human wastes (feaces and urine). The decomposition of sewage results in the oxygen depletion of the water and stimulates eutrophication and its attendant problems of mortality, migration and gene mutation in aquatic life (Sikoki et al 1992).

2.2.4 OIL AND PETROLEUM.

Oil and chemical derived from oil are used for fuel lubrication, manufacturing, factories and many other purposes. These petroleum products get into water mainly by means of accidental spills from ships, tanker, trucks, pipelines and leaky underground storage tanks. Many petroleum products are poisonous if ingested by animals. Spilled oil damages the feathers of birds and furs of animals often causing death. In addition, spilled oil may be contaminated with other harmful substances such as polychlorinated biphenyls (PCBs). Oil is the most obvious form of pollution in marine ecosystems. Oil has caused untold damage in open waters of oceans and estuaries and even in inland rivers. The major source of oil pollution in Nigeria is from broken or damaged pipelines particularly in the Niger-Delta area.

As reported by Awobanjo (1981) between 1972 and 1980, the country recorded over eight hundred and thirty six (836) oil spillage incidences resulting to a loss of over 1, 405, 406 (one million, four humored and five thousand, four hundred and six) barrels of oil to the aquatic environment. Also in 1981 between January and may one hundred and twenty one (121) incidents of oil spillage was recorded with a loss of about nine thousand, seven hundred and fifty (9, 750) barrels of oil.

Crude petroleum contains materials that are resistant to bacteria decomposition and has a long hasting effect when introduced into the aquatic environment especially when they coat the rocks and silt of the benthic zone (Sikoki et al 1992).

According to Uchegbu (1998) pollution can take any or all of these forms

a. Massive single spillage resulting from a spill or overflowing storage tanks, overturned transport vehicle or fractured pipeline.

b. Smaller but perhaps repetitive, losses, which often arises from careless, handling at small factories and similar installations or the surreptitious dumping of their waste oils.

These may arise from leakage at drilling rings, gas flaming and usage of chemicals, leading to the destruction or extinction of wildlife habitats, plant birds and marine life contamination of drinking water, destruction of property and means of livelihood of inheritances, health risks to mankind, fire outbreaks and depletion of ozone layer and forests

2.2.5 HEAVY METALS

Heavy metals such as copper, lead, mercury and selenium get into water from many sources, including industries, automobile exhaust, mines and even natural soil. Like pesticides heavy metals become more concentrated as animals feed on plants and are consumed in turn by other animals. When they reach high levels in the body, heavy metals can be immediately poisonous, or can result in long-term health problems similar to those caused by pesticides and herbicides. For instance crops can absorb calcium in fertilizer derived from sewage sludge. If humans eat these crops in sufficient amount, it can cause diarrhea and over time liver and kidney damage. Lead (Pb) can get into water from lead pipes and solder in older water systems; children exposed to lead in water can suffer from mental retardation.

2.2.6 SEDIMENT

Sediments are soil particles and small rock particles. They are often carried by running waters or wind into streambeds, lake or ocean and can be classed as pollutants especially if present in large amounts. Soil erosion produced by the removal of soil-trapping trees near waterways or carried by rainwater and floodwater from croplands, strip mines and roads, can damage a stream or lake by introducing too much nutrient matter. Sedimentation can also cover streambed gravel in which many fish, such as salmon and trout, lay their eggs. Sometimes the large particles sink to the bottom and increase the bed load component while smaller particles remain in suspension as long as the stream velocity are reduced to nothing. This is the case in River Niger where the suspended matter screens off light and limits the photosynthetic zone to less than 1m (Imevbore 1982). It is this suspended sediment which is also frequently of concern to water supply authorities as it impacts an undesirable appearance to the water and imposes problems in storage and reticulation. In addition, many industries which require water low in sediment have either to cease operations during periods when sediment levels are high or install costly filtration equipment.

2.2.7 THERMAL POLLUTION

This is unwanted heat accumulation in water body. Thermal discharges comes from Power plants and certain industrial facilities. Water is often drawn from rivers, lakes, or the ocean for use as a coolant in factories and power plants. The water is usually returned to the source warmer than when it was taken. Even small temperature changes in a water body can drive away fish and other species that were originally present, and attract other species in place of them. For every kilowatt-hour of electricity generated in a modern coal-fired power station, about 2kilowatt hours must be dissipated by water used to cool the heat exchangers. This increases water temperatures by 5^0c - 8^0c when the cooling water is returned to a river or lake. (Mannionet al 1992) Nuclear power plants are even greater offenders, using about 3 kilowatts for every kilowatt-hour generated which increases the water temperature by over 10^0c. Thermal pollution can accelerate biological processes in plants and animals or deplete oxygen levels in water. The result may be fish and other wildlife deaths near the discharge source. Thermal pollution can also be caused by the removal of trees and vegetation that shade and cool streams.

The effects are complex, but increases of about 2^0c are known to seriously affect fish and other aquatic life. It raises their metabolic rates, doubling it with every 10^0c increase in body temperature. It raises oxygen requirements although there is less oxygen available at higher temperatures. For example dissolved oxygen decreases by over 17%, with an increase in water temperature from 20^0 to 30^0. However the consequences of thermal pollution appear invisible and innocuous in comparison with other pollutants like chemicals and hazardous matters though lethal non-theless.

2.2.8 INFECTIOUS ORGANISMS

These are organisms, which cause diseases and infections in human beings. They can be introduced into rivers through untreated sewage or improperly treated sewage dumped into rivers. A 1994 study by the centres for Disease Control and Prevention (CDC) estimated that about 900, 000 people get sick annually in the United States because of organisms in their drinking water, and around 900 people die. Many disease causing organisms that are present in small numbers in most natural waters are considered pollutants when found in drinking water. Such parasites are Giardia Lamblia and Cryptosporidium parvum occasionally turn up in urban water supplies. These parasites can cause illness, especially in people who are very old or very young and in people who are already suffering from other diseases. In 1993 an outbreak of Cryptosporidium in the water supply of Milwaukee, Wisconsin, sickened more than 400, 000 people and killed more than 100.

2.3 THE EFFECTS OF POLLUTION ON AQUATIC ECOSYSTEM

Effluents channeled into water have the capacity of exerting one or more of the following impact in waters as illustrated by fish (1971).

It causes obvious unpleasant signs of pollution, such as excessive colouring, oil films, odours and so on. These effects are mostly associated with pollution from meat industries, crude oil, wood, plastic industries and domestic sewage. They amount to serious nuisance and damage to aquatic ecology.

Destruction of or inhibition of the activity of microorganisms of water thus preventing self-purification and hence the capacity of waters to contain adequately successive effluent discharges. An example of this can be found around the Sapele Warri areas where sawmills empty wood shavings and saw dust into nearby rivers. The rivers, which flow through most Nigerian towns and villages, also display the same phenomenon.

Poisoning of fish and other aquatic life; oil spills and the discharge of refinery effluent are chief culprits in this area.

Adding residues of persistent chemicals to waters, which are bioconcentrated in aquatic organisms, in fish, fish eating birds and finally humans at the apex of the ecosystem via the consumption of fish.

Biological magnification of metals, pesticides and radionuclids are well known.

Increasing the total and specific salinity of freshwaters, which depreciate their general value and also sometimes increase their capability for developing algae blooms. Example includes the introduction of formation water from oil field to freshwater rivers and the pumping of saline groundwater into freshwaters.

Causing waters for a variety of reasons to be unsuitable for abstraction for public supply or become less wholesome than desirable e.g. pollution from fertilizers.

Adding unnoticeable small residues of persistent chemicals to water which may present unsuspected long term public health hazard e.g. addition of high concentrations of cyanide, lead and other toxic chemicals from effluents from iron, petrochemicals and leather factories.

In terms of life forms, short-term exposures to pollutants could lead to serious consequences such as the impairment of species survival.

Impure/contaminated water has been a leading cause of fatal disease in human. Water borne diseases such as cholera, typhoid fever dysentery and infectious hepatitis are common. According to Halilu (2001) polluted water has direct impact on health in the form of bacterial or viral diseases, production of cancer, genetic defects and varieties of acute and chronic toxicity in humans.

Water pollution affects ecosystems through which an impact on human beings may subsequently be felt. Household detergents that contain phosphates may flow into Oligostrophic lakes and lead to eutrophication of the water bodies. Consequently there will be an over growth of algae and a rapid deterioration of water quality. Sediments resulting from farming, mining and construction operations interfere with spawning of fish by covering gravel beds and cause direct damage to gill structures.

The acute effects of oil on birds, fish and micro-organisms are reasonably well catalogued. The formation of a film of oil in water bodies effectively prevents natural aeration, leading to the death of organisms trapped below. Fish may ingest spilled oil directly or indirectly, becoming unpalatable or even poisonous.

The most serious effect of pollution is the depletion of dissolved (free) oxygen (Halilu 2001). All higher forms of aquatic life exist only in the presence of oxygen. Under anaerobic conditions, aquatic organisms are retarded. Other effects of water pollution are lack of fresh water for domestic use, inadequate water for industrial use, loss of man hour in search of water unemployment among fisher men and possible migration.

According to Kolo and Lamai (1998) the effect of agro-chemicals on human beings was reported in 1997, when the case of 'poisoned beans' consumed by some people in several states of Nigeria resulted in deaths. They went further to state that Agro chemicals have caused unwanted fish kills and residues were often being found in tissues of fish, sometimes at concentrations which have given cause for concern because they might be approaching values having long-term and sublethal adverse effects (Alabaster 1981).

Jabata (1988) tested 27 pesticides on fresh water fish species. The median lethal concentrations ranged from 0.01mgl to mere than 500ml. Sea grasses and fresh water submerged vascular plants have declined in many aquatic systems.

There have been many reported cases of human poisoning by Gammalin 20 (lindane) at University College Hospital, Ibadan also 20 public health field workers were poisoned by malathion in Ondo State of Nigeria. A family of five (5) people died after eating meals contaminated with pesticides (Osibanjo 1989, Alexander and Anderson, 1984). Undoubtedly most effects of aquatic pollution can be minimized, if the general populace is made aware of the sources or activities that promote their prevalence.

2.3.1 EFFECTS ON WATER QUALITY

The most obvious effect of effluents discharges on water quality is that, it renders the water unfit for domestic, agricultural and industrial use. Apart from rendering them unfit for use, they also make the water inhabitable for most of the living organisms in such ecosystems.

Morgan 1972, Moss et al 1980 and Godfrey, 1982 agree that sewage effluents are known to contain a lot of organic matter and other toxic substances, which bring about changes in the chemistry of the water. The changes brought about by sewage include depletion of oxygen by action of biological oxidation and floating scums. When organic materials in excess are introduced into rivers from sewages at first it encourages the growth of plants and algae in water. However when the plant matter and algae die and settle underwater, microorganisms decompose them. In the process of decomposition, these organisms consume oxygen that is dissolved in the water. Oxygen level falls leading to a drastic condition called eutrophication.

2.3.2 EFFECT ON PRIMARY PRODUCTIVITY

The initial trapping of energy by green plants and the photosynthesis of organic compounds in which their energy stored is referred to as primary production.

This implies that primary production is the main source of energy for all ecological systems.

The group of aquatic organisms responsible for this primary production or the trapping of energy from the sun to produce food is known as phytoplanktons. The toxicity of heavy metal complexes to primary productivity such as chlorella, scendemus and microcystis is known to be reflected in the inhibition of reproduction, photosynthesis and survival of species.

Lamai (1981) observed in the River Delimi that the distribution of phytoplankton was regulated by the level of the suspended particles and the heavy metal content of the water.

Berland et al (1976) investigated the effects of heavy metals on the growth of primary producers of eighteen-nonspecific strains of marine algae. Their result indicated that growth inhibition was due to cadmium (Cd) copper (Cu) mercury (Hg) and lead (Pb) levels in water.

The herbicides 2, 4-D Dichlorophenyl acetic acid, which is widely used in the control of aquatic weeds, has been found to be toxic to many aquatic phytoplankton. Das and singh, (1977) observed that it inhibits nitrogen fixation in the blue – green algae Anabalnophis racibokili.

In the same vain many insecticides affect primary productivity of aquatic ecosystem. According to Johnson (1976) DDT used widely for the destruction of insect pest notably termite has been shown to affect the photosynthetic capacity of certain primary producers and thus interfere with their productivity Hardings (1976) also reported that PCBs inhibited photosynthesis in phytoplanktons at doses as low as 10.0mg/g-1.

2.3.3 EFFECTS OF POLLUTION ON OTHER AQUATIC ORGANISMS

Various kinds of pollutants have different effects on organisms, the level of this effect and how positive or negative depends however, on the genetic make up of the species in question, elements such as temperature, PH level and salinity of the water body in question.

According to Sikoki & Kolo (1992). The heavy metals when at high concentration are generally known to be very toxic to all aquatic organisms. At low concentration as well, they have been found to produce significant dysfunction of several physiological and biochemical process of aquatic organisms.

Many industrial wastes are acidic and thus affect many aquatic organisms causing several abnormalities including slow growth and consequently reduces the total number of individuals in the ecosystem as well as the number of species. This leads to loss of biodiversity where only one specie or fewer species are left due to their ability to resist or adapt to the presence of the pollutants.

Pearson (1977) noted that the areas polluted by acid mine wastes (cedar crick basin) had few benthic species, which adapted. When silt and other solids settle to the bottom of the stream they can completely destroy bottom life.

Fine sediments also reduce the capacity of the stream to produce food organisms thereby interfering with the survival of aquatic organisms, especially the juvenile As reported by Gyus (1981) apart from reducing protective cover of juvenile organisms, fine sediments also decrease their survival by reducing stream capacity to produce food organisms. A number of studies have shown that herbicides, insecticides and fertilizers are toxic to many aquatic organisms including fish eggs.

Insecticides are biologically active chemicals used in the control of insects of agricultural pests. Their spectrum of activity persists for a long time and often retains their biocidal activity and is poisonous for many organisms. Fungicides have also been found to be toxic to many aquatic organisms apart from the fungi they are meant to control. Buchans, (1970) reported that sevin fungicide significantly reduced the survival of many crab larvae Caucer majister. Fungicides by their nature have been found to affect the growth of unicellular algae, reducing their productivity in the streams and lakes.

Eutrophication of water bodies usually favours the growth of phytoplankton (e.g. Cyanophyta), which often appears to be nuisance in the water bodies. Many of the blue green algae have bad odour and many are not digestible. When there is algal bloom they use up dissolved oxygen in the night and when they die their decomposition also requires large amount of dissolved oxygen thereby creating an oxygen scarcity in water bodies. The result is that many organisms in the water will not have the oxygen they require for metabolic activities and consequently the organisms go into extinction.

Domestic sewage is known to contain a lot of organic matter and other toxic substances, which introduces some changes in the chemistry of the water as well as in the physical nature of the substratum.

Wright et al (1976) observed that sewage effluent inhibited decomposition of allocthonous organic matter, decrease the number of phytoplankton and zooplankton as well as the benthic invertebrates and promotes the growth of benthic mosses.

Oladimeji (1984) reported the physico-chemical changes which sewage causes in the quality of water in Kubani river and that these changes in turn causes an ecological imbalance especially in the distribution and abundance of organisms. Typical changes in water quality of plant and animal populations of a river as it passes through various zones following the introduction of sewage are shown in fig I.

Geiner and Buikam (1982) worked on the toxicity of crude oil component on some zooplanktons, they exposed Daphnia puley to soluble fractions of hydrocarbon and found that in acute toxicity studies, the most menacing toxics were coaltar, cresote, Noefull oil, Naphinatene and phenanthrene in a decreasing order of toxicity. They concluded that body length and reproductive activities were significantly reduced by the action of molt, and some died during the chronic study.

2.3.4 EFFECTS OF AQAUTIC POLLUTION ON FISH AND THE FISHING INDUSTRY

Fish have suffered greatly from the effects of heavy metals in the aquatic environment.

Saliba and Kenzyz (1976) reported that heavy metals inhibit the hatching of fish eggs and proper development of embryo.

Kolo (1989) also reported the total absence of fish in Ogunpa River in the areas, which were heavily polluted with heavy metals.

Herbicides, insecticides and fertilizers are all toxic to fish and fish eggs. For instance excess fertilizer in aquatic environment can cause gas bubble disease in fish, which may lead to mortality. Excess fertilizers also causes bloom of algae which may lead to eutrophication with its attendant problems of oxygen depletion. Suspended and dissolved solids from industries such as mines, washings are known to cause clogging and abrasion in fish gills leading to death and depletion of fishes. These substances also smother and covers the spawning and feeding grounds of fish. So that their reproductive activities are inhibited and new fishes are not added to the population of fishes in the aquatic community under study.

The effluents from refineries located near the coast discharge directly into coastal waters. Those located inland, such as the NNPC Refinery, Kaduna discharge directly into inland waters. In both cases the receptors are habitat of economically important marine, or freshwater fishes. Many of the compounds in effluents are known to be potentially toxic and thus affect valuable resources. These effects could be direct, resulting in fish mortality or indirectly on the food organisms of the fish. In both cases the fish and the fishing industry suffer because when the food organism of fishes are depleted the fishes will have less food leading to predation, starvation and struggle for survival. Ultimately leading to the death and depletion of fishes.

In Nigeria according to Sikoki & (1992) very little has been done to estimate the toxicity of petroleum and its product on aquatic life in general. Following some of the oil spills in Nigeria, large number of fish kills have occurred.

Odu (1977) reported a decline in the number of fish being caught by fishermen following the cases of oil blowout at Bomu and Obagi in 1970 and 1972 respectively.

Adeniyi et al (1983) in their studies on the effects of oil on the fishing activities of the Ibeno and Oyakama communities in Cross River State showed that considerable damage was done to the fishing sites. According to the report, a total of 300 sites were affected by oil pollution in Ibeno, 74 in the creeks and 226 in the sea in addition to two hundred fishing ponds affected by the spills in Oyakama alone. Estmated amounts of fish damage in Ibeno and Oyakama were ₦ 251, 650 and ₦13, 414 respectively (Adeniyi et al 1983).

2.3.4 IMPACT ON AQUATIC ECOSYSTEM

The ecosystem is referred to as an orderly interaction between living organisms and the natural environment in which they live. According to Areola et al (1992) whenever a set of objects are related to one another and interact with one another in an orderly fashion, they constitute a system. And any charge in any one component of a system sets up a chain reaction, which results in corresponding changes in the other components. The ecosystem is only a miniature model of the earth system and it may be defined as any natural site or area in which living organisms and the physical environment interact with one another. In an aquatic ecosystem the components are water plants, animals, the climatic elements and the water body that supports all of them. The plants could be planktons or benthics (those that live under water or stream beds). The interaction between these components is illustrated very clearly in energy flow and recycling of materials in the ecosystem.

Energy is defined as the ability to do work. Energy is that feature that links every object and every part of the earth together. The main source of energy is the sun. it is this sun's energy that is transformed into other forms of energy and cannot be created or destroyed by man.

To obtain the sun's energy, the earth depends on green plants, which are the only earthly objects capable of fixing the sun's radiant energy and converting it to chemical energy in the process called photosynthesis. Once energy has been fixed in the primary component within an ecosystem, in this case the phytoplanktons, it passes through the ecosystem by means of a food chain, which describes the successive transfer of energy from one trophic level to another, or the successive consumption of one type of organism by another. In this way pollutants can accumulate to lethal doses from one trophic level (energy) to another. This goes along with bioaccumulation (Mannion et al 1992)

According to Kolo and Lamai (1998) Sea grasses and fresh water submerged vascular plants have declined in many aquatic systems. These plants, however, provide food for the habitat. The decline has been associated with an over all decline in the aboundance of fish and wildlife which is attributed to serious ecological disturbances by the introduction of chemicals, heavy metals and other polluting effluents into water bodies.

Denoyelles et al, (1982) and Mayasich et at (1986) observed that atrazine concentrations (chemicals used in agricultural sector) of between 1 to 5mg/1, adversely affect higher levels of the food chain beginning with zooplankton and other aquatic organisms. Adverse effect level to selected species of aquatic invertebrates and fishes ranges from 120ugl - 500ugl, based on life time exposures (Mecek et al 1976). Ambient concentrations as low as 20kg/1 have been associated with adverse effects on fresh water aquatic fauna's including benthic insects.

Most agro chemicals are halogenated hydrocarbon and these have a tendency to accumulate along food chain and effects are also long lasting. High concentration could be lethal to fish, Crustaceans and molluscs (Johnson 1976, Dore, 1993) Data or bioaccumulation of agro chemicals from fresh water into aquatic organisms muscles is not very abundant and food chain biomagnifications is negligible. However, studies have shown that in a farm pond treated once with 300ug/1 atrazon, residues at 120 days post treatment ranged between 20ug and 286ug/1 in mud and water (Ronald 1989).

Gunkel (1981) in his studies with fresh water snail Anchyhes Fluviatilis and fry of white fish coregonins fere, found out that atrazine was rapidly accumulated from medium by both special and Saturation was reached within 12-24 hours. There has been evidence of bioaccumulation of atrazine in carp kidney and toxicity of atrazine to fish, oreochromis niloticus (Muniel 1988, Kolo et al 1998).

The loss of organisms at one trophic level also have a disastrous effect on the whole food web and by implication on the ecosystem because this will create an ecological imbalance and in an attempt to correct this imbalance more organisms will die resulting in the decline of aquatic resources.

Pollution in the water also reduces the aquatic biota to a few opportunistic species that includes polychaetes (fanworm, ragworms) and several Oligochaetes species e.g. sludge worms.

One of the most important considerations in assessing the environmental impact of water pollution is the length of time the damage lasts. According to Mannion et al (1992). For some marine organisms, especially crustaceans, organochlorine and orgnophosphorus compounds need only occur in low closes to be lethal. These compounds are more soluble in fats than in water and so they become increasingly concentrated at each stage of a food chain.

Genetic variability: Marine invertebrates display a high degree of genetic variability and fishes are genetically the most varied of all vertebrates. There is evidence that for some organisms genetic variability is an adaptation to survival in contaminated environments. Selection may occur for whichever genotype (hereditary make up of the individual) is adapted to the prevailing conditions. For instance there is rapid selection for resistance to water-soluble components of crude oil in the copepod Tsibe. Similarly organisms in Cornish estuaries contaminated with copper accumulate amounts of the metal, which would be lethal to members of the same species living in uncontaminated habitats.

To illustrate this loss of species occasioned by the effects of pollution on one specie of organism the following experiment comes in handy.

American ecologist Robert Paine, working in the rocky intertidal region of the pacific coast, found stable invertebrate communities dominated by 15 species of animals, including starfish, mussels, limpets, barnacles and chitons. When Paine removed all of the starfish from the area, the community collapsed and eventually only 8 invertebrate species were common. Although it was not obvious in the undisturbed regions, the starfish were preying heavily on one of the mussel species and keeping its numbers down. With the starfish removed, the population of this mussel increased and the mussel was able to out compete many other species of invertebrates. Thus, the loss of one species, the starfish, indirectly led to the loss of an additional six species and a transformation of community. Typically, because the species that co-exist in natural communities have evolved together for many generations, they have established a balance and their population remain relatively stable. But when humans interfere in the case of water pollution, the aquatic system is destabilized and some times some aquatic resources go into extinction while some that are not desirable may dominate the ecosystem. Leading to diseconomy for those who make their living from aquatic resources e.g. fisherman and those in fish related industries.

CHAPTER THREE

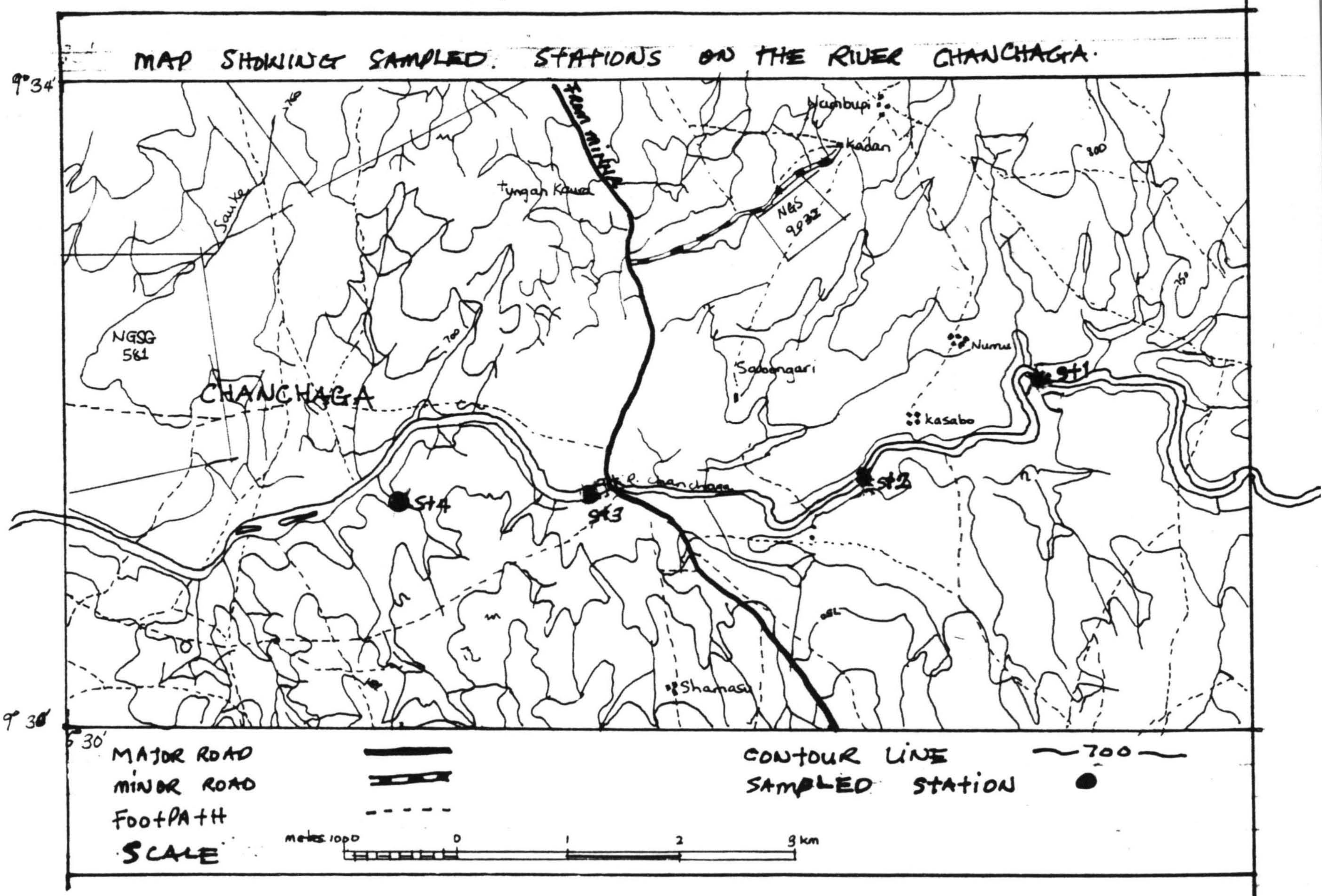
MATERIALS AND METHODS.

3.0 METHODOLOGY

A good understanding of the pollution characteristics of the river chanchaga would require monitoring of all drains and tributaries of the entire river. However, this is logistically complex and extremely expensive. So sampling stations have been located and the control station is obtained using the Tagwai Dam.

The samples were colleted during dry seasons while data for rainy season was collected from the Niger state water board station in chanchaga from four sites or points on the river chanchaga. The duration of the research period was between the months of November and February. The sampling stations were located upstream, beyond possible sources of pollutants on the outskirts of the city at the Tagwai dam (station I) and at possible sources of pollutants, that is within the town directly under the bridge (station III) another station is located just after the water treatment plant where water is turned back into the river after treatment. (station II) and down stream where only residential houses and some flood plain farming take place. (station IV)

Fig 3.1 Map showing sampled stations in River Chanchaga



Source: Department of Works and housing Niger state Secretariate. Minna. Niger state.

3.1 SURVEY AND SAMPLING

In determining the sampling points and sampling strategies the following considerations were taken into account.

(a) A pilot survey was undertaken including a canoe trip along the river.

(b) In deciding on the total number of locations for collecting samples, pollution sources and types were identified. In doing this essential point were identified to cover the area in sufficient detail to permit valid statistical analysis on the results.

(c) Standardized procedures were employed in the collection, preservation and sample identification.

3. 2 PARAMETERS EXAMINED AND METHODS ADOPTED

3.2.1 TEMPERATURE

Temperature of the surface water at each site was measured with mercury – in – glass (0-55^{0}c) thermometer.

3.2.2 DISSOLVED OXYGEN LEVELS, AMMONIA, AND TOTAL ALKALINITY

Samples of water were taken to the laboratory for the determination of their dissolved oxygen levels, ammonia nitrogen and total alkanity by tritrimetric methods as described by Boyd (1979). Biological oxygen demand (BOD) and chemical oxygen demand (COD) of each ample were determined using the methods of AHPA (1985)

3.2.3 THE P.H AND CONDUCTIVITY.

The PH and conductivity of each sample were determined using Beckman's electric PH meter model H5 and table conductivity meter model WPA respectively.

3.2.4 PRESENCES OF HEAVY METALS

Each sample was analysed for concentrations of lead (Pb) Iron (fe) zinc (zn) copper (cu) and Cadmiun using Pye Unicam Atomic Absorption Spectrophotometer (AAS) model SP 1900.

3.3 METHOD OF COLLECTION

3.3.1 SAMPLES FOR PHYSICAL PARAMETERS.

Samples for the determination of dissolved oxygen were collected in all glass bottles fixed with Winkler's solution.

Samples for the determination of other parameters were brought to the laboratory in clear 2L plastic bottles.

3.3.2 HEAVY METALS

Samples for the analysis of levels of heavy metals were collected in 250 ml reagent glass bottles with glass stoppers cleaned to remove all traces of metallic contaminant as recommended by siruempler (1973)

3.3 PROCEEDURE

All containers were rinsed with water at each site before being used for collecting water samples.

Distribution of fishes along the rivers and their tributaries was noted and related to measured environmental characteristics of the waters.

Duplicate samples were collected from each of the designated sampling points (see fig 2) plankton net with 20cm diameter, was swept through the water surface to a distance of five meters and its contents were emptied into labeled 2 litters plastic bottles. Followed by addition of ligol solution.

Benthic micro invertebrates were collected with Ekman grab model No. 923. The major phytoplankton groups and benthic macro invertebrates were sorted and identified with the aid of taxonomic references (pennack 1979) and AHPA (1985).

For dissolved oxygen levels. Water samples were collected in 250 ml reagent glass bottles with stoppers. Water samples were fixed in the field with manganous sulphate followed by iml of alkaline – iodine azide solution. In the laboratory 1ml of conc. Sulphuric acid was added to each sample. 10ml of the sample and addition of a drop of starch solution turned the solution to blue colour. It was titrated with 0.025N solution thiosulphate. The titration continued until the blue colour disappeaned which marked the end point. Dissolved oxygen (mg/1) = (ml titrant) (N) (8) (1000) / Sample vol in ml

Total alkalinity. 10ml of water sample was measured in 250ml Erienmeyer flask, and a drop of methyl orange indicator was then added this was then tirated with 0.02N H_2SO_4 until the colour of the solution changed from yellow to faint orange. The calculation was based on the formular below (lind, 1979).

Total Alkalinity (mg /1) = vol (H_2SO_4) x Normality (H_2SO_4) x 50,000 /vol of the sample in ml.

Biological Oxygen demand (BOD)

Water sample from each station were collected in 250ml BOD stoppered bottles and wrapped with black polythene bag. The samples were incubated at room temperature for five days in the dark before titrating for oxygen content using the Winkler's method. The BOD was calculated using the equation below:

BOD_5 (mg/1) = Dissolved oxygen on day 1 – dissolved oxygen on day 5.

AMMONIA – Nitrogen.

This was determined using the phenoldisulphuric acid method (APHA, 1985), it was measured adding 1ml of phenol-disulphuric acid to each evaporated dry sample of 50ml water sample, this dissolves all the residues. 10ml of distilled water and 5ml of 12N sodium hydroxide was added to each risidue and a yellow colour developed. The intensity of the colour increased with the nitrate concentration each sample was made up to 50ml and a range of Nitrate Standard solutions were prepared. Which were measured using a spectrophotometer.

Ammonia (mg/1) = ml of Hcl x Normality (Hcl) x 17/sample vol in ml.

3.5 DETERMINATION OF PLANKTON & BENTHIC ORGANISMS.

Water sample were collected using silk plankton net of 29cm diameter 73 microns mesh sizes, having a collection vial of 120ml capacity at the base. At each station the net was emersed just below the water surface and then towered through a distance of 2.5m. The content of the collection vial was then poured into a plastic bottle and fixed immediately with lugol solution to preserve the phytoplankton. The procedure was repeated for zooplankton analysis and was immediately fixed in 4% formalin.

2ml was pipetted from each sample (after shaking it gently) into a counting chamber and mounted on a microscope to identify the dominant phytoplankton and zooplankton. The volume of the water filtered was calculated using $\Pi r^2 h$, where r= radius of the net used, h= the distance of towing. The actual number of the phytoplankton group per liter of the water filtered was calculated.

The identification was done with the aid of plankton identification key.

CHAPTER FOUR

RESULTS, DISCUSSION AND IMPLICATIONS

4.0 INTRODUCTION

This chapter presents the results, discussion and the implication of findings around river chanchaga. The results and discussion are presented under nature and distribution of pollution sources, and its implication for aquatic resource conservation.

4.1 PHYSICO-CHEMICAL OBSERVATION

TABLE 1 Means of the physico-chemical characteristics of the stations studied in River Chanchaga.

PARAMETERS	STATION 1	STATION 2	STATION 3	STATION 4
P.H	7.1	12.1	9.1	10.1
Temperature (^{0}c)	23.5	26.3	24.2	26.1
Dissolved Oxygen (mg $0_2/_1$)	7.9	10.3	2.4	1.8
CONDUCTIVITY	80.2	90.6	84.6	78.0
BIOLOGICAL OXYGEN DEMAND (BOD) mg 0_2 1/5/days	42	46.3	116	126
AMONIA- NITROGEN (mgN/1)	0.34	0.8	2.8	6.8
TOTAL ALKALINITY (Mg $CaCO_3$/1)	76.5	128	130	77.5

Laboratory result February 2002

Table 1 shows that the physical and chemical characteristics of the river varied with each station.

TEMPERATURE

There was temperature increase from one station to the other. Station 2 had the highest mean values, closely followed by station 4, station 3 had an almost flat value with station 1 at 24.2 and 23.5 respectively. The range of temperatures of the stations sampled is 23.5 – 26.3 and this is still within Federal Environmental Protection Agency Standard (FEPA), which put it between 20 - 33^0c. Dupree and Hunners (1984) observed that warm water fish grow best at temperature between 25^0c - 32^0c and so the temperature observed at the station is normal and optimum for fish growth and production.

HYDROGEN IONS (PH)

The PH of the river is predominantly alkaline at a range of 7.1 – 12.1; at station 1 the PH observed is neutral 7.1. FEPA STANDARD of PH is between

6 – 9. At stations 3 & 4.The PH value was 9.1 & 10.1 respectively. The death value or alkaline death points having been put at PH 4 and PH 11 respectively. (Calabrase 1969) the high PH observed at stations 3 & 4 may be as a result of intensive algal growth associated with organic pollution. The optimum PH level for good fish production has been put at 6.5 – 9 (Tarzwell 1959) this PH level has been associated with productive waters.

DISSOLVED OXYGEN O_2

Station 2 had the highest mean value followed by station 1 and 3 respectively. Station 4 is lowest at 1.8mg.

The range of dissolved oxygen for the whole station is 1.8 – 10.3. The dissolved oxygen at station 3 is 2.4 and station 4 is 1.8 and this below the FEPA standard of 7.5. The dissolved oxygen is low which could be as a result of discharge of sewage effluents into the river, where the dilution is insufficient to reduce the concentration of organic substances to acceptable levels (appendix 6).

CONDUCTIVITY

The highest mean value was observed in station 2 (Table 1) followed by station 3 and 1 respectively. Station 4 had the lowest mean value.

The fluctuation in conductivity could be due to fluctuations in PH and temperature.

BIOLOGICAL OXYGEN DEMAND

The mean BOD of the river ranged 46.3 to 126. This BOD is high. And this is an indication of pollution pressure (Fagade, et al 1992).

AMMONIA-NITROGEN

Range of the mean concentration of ammonia content of the river at each station is 0.34 – 6.5 mg. By Brat et al's (1971) scale waters with ammonia content 2.7mg/l and BOD 12.0mgo_2/l/5 days are grossly polluted. Station 3 has the value of 2.8 and station 4, 6.8

This implies that stations 3 and 4 of the Chanchaga River are grossly polluted. The implication is that aquatic resources will be negatively affected; there is low productivity in waters with high ammonia content.

ALKALINITY

The alkalinity of the river ranged between 76.5 to130. This is very high with station 3 having the highest mean value of 130 and followed closely by station 2 with a value of 128.

This value indicates that the river have a good buffering characteristics and will not fluctuate with changes in PH value which may occur as a result of algal bloom caused by dumping of untreated or improperly treated sewage into the river as well as other organic pollutants.

Based on the observed parameters at the stations 3 and 4 namely, high BOD 116 and 126, high ammonia content 2.8 and 6.8, low dissolved oxygen 2.4 and 1.8, the stations are said to be under pollution stress. The source of pollution stress is most probably due to the presence of sewage, refuse and other agricultural wastes in the river.

HEAVY METALS:

TABLE II: HEAVY METAL CONCENTRATION (mg/g-1) IN

SAMPLED STATIONS OF RIVER CHANCHAGA.

METALS/ ELEMENTS	**STATION 1**	**STATION 2**	**STATION 3**	**STATION 4**
Iron (fe)	29.32	32.80	30.24	32.80
Copper (Cu)	0.12	0.96	1.82	0.89
Cadmium (Cd)	0.25	1.42	1.25	0.26
Lead (Pb)	0.06	0.45	0.52	0.03
Zinc (Zn)	0.22	0.52	2.01	0.81

Laboratory Results. February 2002

"FEPA STANDARD LESS THAN 1mg/g-1"

The ranges of the levels of the heavy metals were Pb = 0.03-0.52, fe =29.32-32.80, Zn =0.22-2.01, Cu =0.12-1.82 and Cd =0.25-1.25 (Mg/l) in the Chanchaga river. The predominance of Iron in all the station may be associated with high levels of Iron in Minna Soil. The levels of heavy metals are not very high and this could be as a result of low industrial activity in Chanchaga area.

Levels of heavy metals in waters running through much more industrially active towns like Lagos, Kaduna, and Warri are much more higher. (Fagade et al 1992).

4.2 RENEWABLE RESOURCES

Fishes were found in all stations of the river sampled. Station I had the highest number of fishes, with a population of 642 in each 1 litre of water sampled. This may be attributed to less human activities like farming on flood plain and active dumping of refuse and sewage.

Reduction in the number of fishes and species identified at station 2 and 3 respectively may be attributed to the gross pollution of human excreta. As well as the excavations going on especially at Station 3.

SAMPLED STATIONS	STATION 1	STATION 2	STATION 3	STATION 4
NUMBER OF FISHES	642	416	120	142

Laboratory results February 2002

4.3 PLANKTON CHARACTERISTICS

During the study period, four groups of phytoplanktons were found to dominate the river. They are represented as Chlorophyceae, Bacillariophyceae, Cyanophyceae, and Dinoflagela.

Bacillariophyceae was recorded in all the sampled stations. It has the highest population density at station 4 followed by station 1 and 3 respectively. Station 2 had the lowest population density.

This could be attributed to the rate of flow of water, which is very high at this point. And the nutrients build up of nitrate, from organic breakdown.

Chlorophyceae (Green Algae) was recorded in station 3 and 4 throughout the sampling period.

Cyanophyceae (Blue green algae) was recorded in all Stations during the sampling period. It was most abundant in stations 4 and 3, and occurred scantily in stations 2 and 1.

Dinoflagelae was recorded in stations 3 and 2, throughout the sampling period.

TABLE III: TOTAL NUMBER OF PHYTOPLANKTONS RECORDED IN ALL THE STATIONS.

TAXONOMIC GROUP	**STATION 1**	**STATION 2**	**STATION 3**	**STATION 4**
Bacillariophyceae (Diatoms)	400	201	400	700
Chlorophyceae (Green Algae)	140	100	280	400
Cyanophyceae (Blue green algae)	120	80	140	280
Dinoflagela (Flagelatas)	-	10	29	-

Laboratory Result. February 2002

4.4 BENTHIC MACRO INVERTEBRATES

The Benthic macro invertebrates are represented by seven functional groups. Each station consists of distinctive community structure. With Station 4 accounting for the highest population of benthic invertebrates throughout the river. Station 1 have the next highest population followed by stations 3 and 2 respectively.

The population could be accounted for by the clearness of the waters at Station 1 and the high BOD noticed at stations 3 and 4.

TABLE IV: DISTRIBUTION OF BENTHIC MACROINVERTEBRATES IN THE FOUR SAMPLED STATIONS.

TAXONOMIC GROUP	STATION 1	STATION 2	STATION 3	STATION 4
OLIGOCHAETA	62	-	88	52
HYDRACARINA	12	12	10	4
BASTIS SPECIE	108	48	68	204
MICRASEMA SPECIE	260	120	84	200
GASTROPODA	36	2	20	16
SIMULIDAE SPECIE	620	110	70	242
CHIRONOMIDAE SPECIE	409	220	385	1310
TOTAL =	1507	512	725	2028

Laboratory Result, February 2002.

4.5 VISUAL OBSERVATIONS

Human faeces and refuse including leaves, waste food, sheets of Polythene, waste paper, tins, bottles, plastics and clothing materials were dumped indiscriminately into the river, particularly, under the bridge (Sattion 3), which is where human movement is most pronounced. The practice of farming on flood plains was noticed along the river banks, especially at station 3 and 4, water from these activities flow into the river conveying sand and organic matters, washing of vehicles, cloths and bathing was also observed. As the study was done in dry season the depth and current of the river was reduced.

Prolific algal growth and organic decomposition give rise to offensive stench at stations 3 and 4.

4.6 NATURE AND GEOGRAPHICAL DISTRIBUTION OF POLLUTION SOURCES.

Broadly two types of pollutants are generated around the stations sampled and find their way into the water, the pollutants are of domestic and agricultural types. The pollutants generated around the Chanchaga settlement and Korokwo residential areas are domestic in nature, while those generated directly under the bridge are agricultural in nature.

The pollutants mixed with sediments from cloths and car wash along the riverbanks to pollute the water.

4.7 IMPLICATIONS FOR AQUATIC RESOURCE CONSERVATION

The results demonstrate convincingly that pollution levels in aquatic environment reduces the abundance of aquatic resources, evident from the population of fishes, planktons and benthic organisms at each station monitored. The consequence is that fish, which is an essential source of protein particularly, for people in this part of the country, is being threatened into extinction. We are also loosing in the process, the natural beauty of the river which is also an aquatic resource in itself and should be preserved for the coming generation, so that, we do not prove true the French proverb which translates that, "For those who come last, only the bones are left".

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

5.0 INTRODUCTION

This chapter summarizes the findings of the study, Conclusions were drawn from the results presented in chapter four and Recommendations for control measures and further studies were given.

5.1 SUMMARY

The results presented in chapter 4 is the product of the research carried out to examine the physico-chemical parameters of river Chanchaga with a view to assessing the pollution levels and its implication if any on the conservation of aquatic resources and to suggest possible control measures.

Results obtained showed deterioration in the quality of the water in river Chanchaga downstream, the high BOD, Dissolved oxygen and high ammonia content observed in stations 3 and 4 indicate that the stations are under pollution stress. The major polluting sources are domestic sewage and agricultural waste and are both from point and non point sources. This affected the number of aquatic resources identified and the type of species (Phytoplanktons) that dominates the Stations Studied.

The low dissolved oxygen and high biochemical oxygen demand at these stations shows that the river is organically polluted.

The high alkalinity recorded at all stations show a greater degree of buffer characteristic, but does not indicate high productivity. Moyle and Mairs 1956 & 1966 respectively pointed out that greater production does not result directly from higher concentrations of alkalinity, but from higher levels of phosphorus and other essential elements, which increases along with alkalinity.

Among the four groups of phytoplankton (Bacillariophyceae, Chlorophyceae, Cyanophyceae ad Dinoflagelae) observed, Bacillariophyceae (Diatoms) predominated; this could be as a result of the temperature range during the period of this research. Zooplankton was generally scanty.

5.2 CONCLUSION

The results demonstrate convincingly that pollution levels in aquatic environment reduces the abundance of aquatic resources, evident from the population of fishes, planktons and benthic organisms at each station monitored. The consequence is that fish, which is an essential source of protein particularly, for people in this part of the country, is being threatened into extinction. We are also loosing in the process, the natural beauty of the river which is also an aquatic resource in itself and should be preserved for the coming generation, so that, we do not prove true the

French proverb which translates that, "For those who come last, only the bones are left".

5.3 RECOMMENDATIONS

The natural and productive state of the river chanchaga can be improved tremendously, if laws on control and treatment of sewage are adequately enforced in Niger State. The Federal Ministry of Environment has a lot of roles to play. The issue is not laws and policies because we have quite a number of them in existence. The issue is on implementation and enforcement. This calls for public enlightenment, because until the public is educated on the reasons why laws must be obeyed and the environmental consequences of disobedience, they will not see any need to stop dumping their sewage straight into the river. Washing of vehicles, cloths and bathing along the riverbanks should also be banned because it increases sediments in the river.

Logging and mining along river banks and hillsides should be discouraged, because when this happens protective covering of hills are exposed and rain washes off soil and silt into the river, thereby destroying the spawning ground for trout and salmon (aquatic resources).

At construction sites, builders should be required to fight soil erosion by laying down tarps, building sediment traps and seeding grasses.

All these measure will go a long way in maintenance of water quality and conservation of aquatic resources for our benefit and the benefit of the generations yet unborn.

Further studies should be made on the relationship of aquatic resources to the identified pollutants and the adaptation of certain species to high levels of pollution.

Also a wet (rainy) season studies of this same river Chanchaga should be carried out, to coincide with the peak period of farming (fertilizer application). This will give room for comparison with the dry season findings. A comparative analysis of phytoplankton and zooplankton species is also recommended.

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APPENDIX I

RESULTS OF THE PHYSICO-CHEMICAL ANALYSIS OF THE STATIONS

SAMPLING POINT: STATION 1

S/NO.	PARAMETER	FEMA STANDARD	RESULT
1.	PH	6 - 9	7.1
2.	TEMPERATURE (^{0}C)	20 – 33	23.5
3.	DISSOLVED OXYGEN	7.5	7.9
4.	CONDUCTIVITY	-	80.2
5.	BOD $(Mg)_2 1/5/day)$	12	117
6.	AMMONIA NITROGEN	2.7	034.
7.	TOTAL ALKALINITY	-	76.5

APPENDIX II

STATION 2

S/NO.	PARAMETER	FEMA STANDARD	RESULT
1.	PH	6 - 9	12.1
2.	TEMPERATURE (^{0}C)	20 – 33	26.3
3.	DISSOLVED OXYGEN	7.5	10.3
4.	CONDUCTIVITY	-	90.6
5.	BOD	12	46.3
6.	AMMONIA NITROGEN	2.7	0.8
7.	TOTAL ALKALINITY	-	128

APPENDIX III

STATION 3

S/NO.	PARAMETER	FEMA STANDARD	RESULT
1.	PH	6 – 9	9.1
2.	TEMPERATURE (^{0}C)	20 – 33	24.2
3.	DISSOLVED OXYGEN	7.5	2.4
4.	CONDUCTIVITY	-	84.6
5.	BOD	12	116
6.	AMMONIA NITROGEN	2.7	2.8
7.	TOTAL ALKALINITY	-	130

APPENDIX IV

STATION 4

S/NO.	PARAMETER	FEMA STANDARD	RESULT
1.	PH	6 – 9	10.1
2.	TEMPERATURE (^{0}C)	20 – 33	26.1
3.	DISSOLVED OXYGEN	7.5	1.8
4.	CONDUCTIVITY	-	78.0
5.	BOD	12	126
6.	AMMONIA NITROGEN	2.7	6.8
7.	TOTAL ALKALINITY	-	77.5

APPENDIX V

MAY 2001

PARAMETERS	RAW WATER SAMPLE COLLECTION
Temperature	27.9^{0C}
Conductivity	0.09ms/cm
T. D. S.	0.058/L
Turbidity	66 FTU
Colour	334 pt.co
Iron	1.27mg/L
Copper	2.46mg/L
Total Chlorine	0.30mg/L
PH Value	9.5 Many Ph
Silicon Oxide	-
Nitrite	20mg/L
Phosphate	0.32mg/L

JUNE 2001

PARAMETERS	RAW WATER (SAMPLE)
Temperature	28.3^{0C}
Conductivity	0.10ms/cm
T. D. S.	0.068/L
Turbidity	461 FTU
Colour	550 pt.co
Iron	3.30mg/L
Copper	3.87mg/L
Chromium	-
Chlorine	2.20Mg/L
Silicon Oxide	-
Phosphate	144mg/L
PH Value	10.8

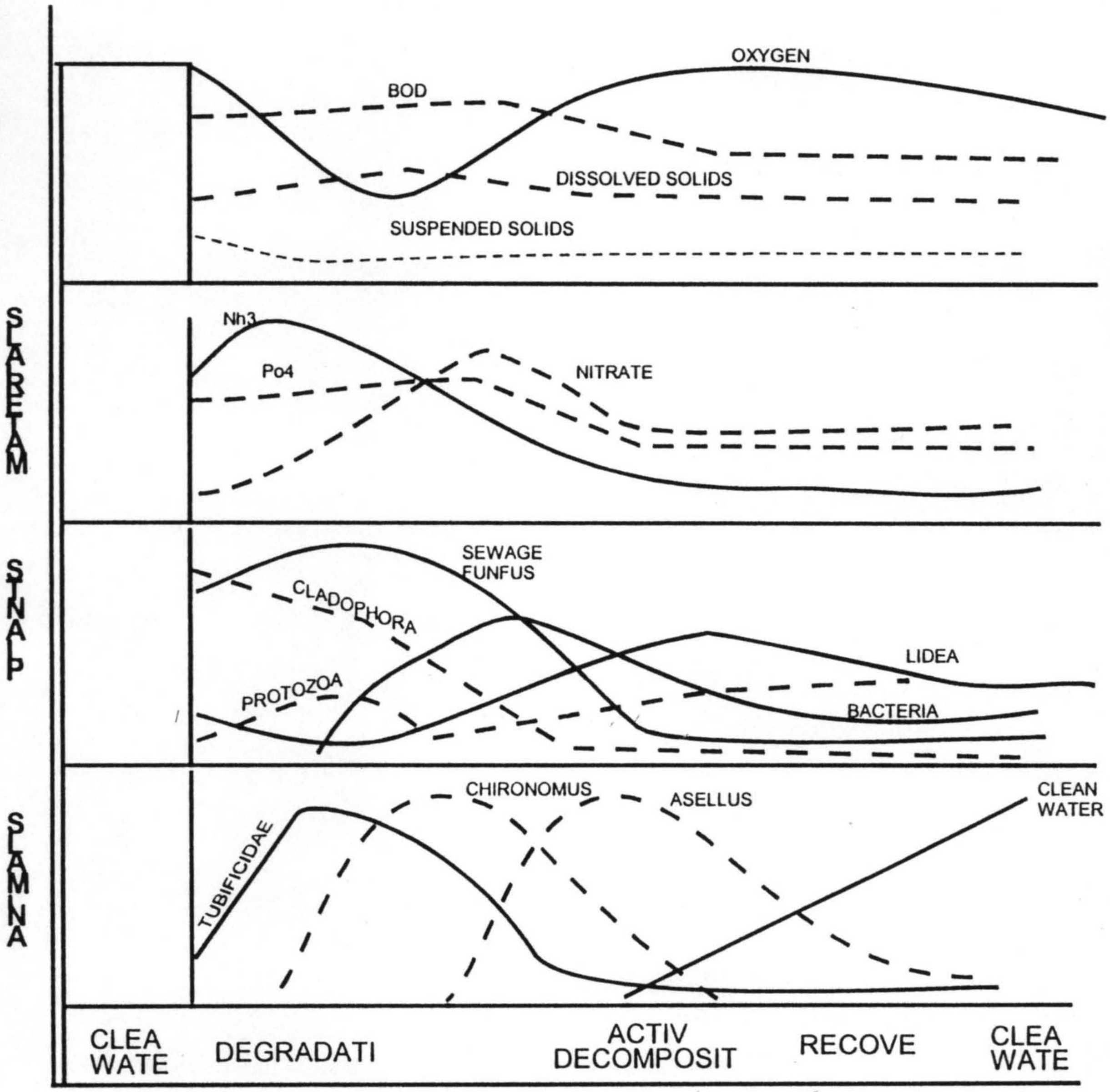
JULY 2001

PARAMETERS	**RAW WATER (SAMPLE)**
Temperature	28.3^{0C}
Conductivity	0.15ms/cm
T. D. S.	0.12g/L
Turbidity	499 FTU
Colour	590 pt.co
Iron	3.30mg/L
Copper	3.88mg/L
Total Chlorine	2.25mg/L
Phosphate	2.00mg/L
PH Value	11.2

Source: Niger State Water Board (2001)

APPENDIX VI

CHANGES IN WATER QUALITY, OF PLANTS AND ANIMALS POPULATIONS FOLLOWING THE INTRODUCTION OF SEWAGE



WASTE INTRODUCTION
DISTANCE DOWN STREAM
(AFTER HYNES, 1960)