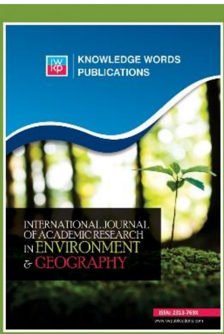


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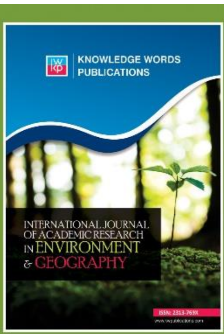


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# Pollution of Surface Water Resources in Nigeria


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**Abstract**

This work is aimed at examining the pollution of surface water resources in Asaba and its environs. This study was concentrated on the lower Niger River from Illah through Asaba/Onitsha to Okpai (Lat $6^{o}$ 25$^{'}$ to Lat $5^{o}$ 40' N and longitude $6^{o}$ 37' to $6^{o}$ 47' E). The data collected from water and were analyzed for the heavy metals (Zn, Cu, Pb, Cd, Ni, Fe, Mn and Co) using urican 929 Atomic Absorption Spectrophotometer. The results showed that the seasonal variation in water quality was caused by geologic and anthropogenic activities of man, amongst others. The following conclusions were reached; the study was able to discover that variation exists in the physio-chemical and biological characteristics of the water quality along the course of the rivers. Thus, the variation was caused by geologic and anthropogenic factors which have impaired the quality of water. There is need to ensure that water resources in Nigeria are protected, used, developed, conserved, managed and controlled in ways as meeting the basic needs of the present and future generations. Also, proper addressing of the problems/ challenges faced by water bodies from wastewater channeling, will not only lead to the restoration of aquatic habitats in the State, but will also restore fishing, recreational and other water activities and boast food production thus contributing to the economy. The establishment of the wastewater treatment plants will create jobs for various levels of manpower (skilled and unskilled). As the State seeks active partnership with private investors in order to harness her abundant human and material resources and diversify its economy, wastewater management should be seen as an industry worth investing in as it has the potentials of complementing every sector of the economy. The following recommendations were made; All governments along the banks of the Niger River to develop stringent regulations to control pollution; All governments are to ensure the enforcement of water pollution control laws and regulations; Pollution control measures must be put in place to assess the impact of industries on the environment and should provide for municipal and industrial waste waters and solid waste control programmes; Industrialization must be married or coordinated with environmental protection activities; Environmental Impact Assessment (EIA) must carried out for any new industries and all industries must have adequate means of treating and disposing industrial effluents and solid wastes arising from the industries, amongst others

**Keywords:** Pollution, Surface water, Resources, Asaba, Environ.

**Introduction**

Most of our water bodies in urban environment have become polluted due to industrial growth; urbanization processes and man -made problems mainly the result of population growth. Poor sanitation and contaminated drinking water arising from human activity and natural phenomena create serious problems in human health. The chief sources of water pollution are sewage and other waste, industrial effluents, agricultural discharges and industrial wastes from chemical industries, fossils fuel plants and nuclear power plants. They create a larger problem of water pollution rendering water unfit for drinking, agriculture as well as for aquatic life. More than 2.6 billion people-40% of the world's population – lack basic sanitation facilities and over one billion people still use unsafe drinking water sources. As a result, thousands of children die every day from diarrhea and other water, and hygiene related diseases and many suffer and are weakened by illness. Also, erosion has led to extensive loss of top soil, large-scale gullying, and silting of ditches and rivers. The link between erosion, increasing fertilizer application, and loss of soil productivity is very direct in many countries (Elwell and Stocking, 1982). Thereby causing heavy metal pollution on the environment and the local population, which has an effect on the economy as fishing and tourism sectors can be affected. The composition of wastewater varies widely depending on the type of activity producing the wastewater. Constituents of wastewater include water (> 95%) which is often added during flushing to carry the waste down a drain, pathogens such as bacteria, viruses, and parasitic worms; organic particles such as faeces, hairs, food, vomit, paper fibres, plant material, humus,etc; soluble organic material such as urea, fruit sugars, soluble proteins, drugs, pharmaceuticals, etc; inorganic particles such as sand, grit, metal particles, ceramics, etc; soluble inorganic material such as ammonia, road-salt, sea-salt, cyanide, etc. animals such as protozoa, insects, arthropods, small fish, etc; macro-solids such as sanitary napkins, nappies/diapers, condoms, needles, children's toys, dead pets, body parts, etc; gases such as carbon dioxide, methane, etc; emulsions such as paints, adhesives, mayonnaise, hair colorants, emulsified oils, etc; toxins such as pesticides, poisons, herbicides, etc. (Rim-Rukeh, 2009; Wikipedia, 2008).

Pollutant has been defined as a substance present in greater amount than the natural concentration as a result of human activities that have a detrimental effect on the environment or upon something of value in that environment. It is well known that the effects of pollution are detrimental to fisheries resources and other aquatic organisms as well as humans through seafood consumption. Pollutant types and sources are diverse and include phosphorus and nitrogen from rural and agricultural practices, heavy metals derived from industrial sources including base metal refining and metallurgical processing and sediment influx in excess of natural levels (Kilby and Batley, 1993). Oladimeji and Onwumeri (1986) observed that in most developing countries, effluents from industrial environments may be discharged untreated into drains that eventually end up in streams where they pollute the aquatic environment. The concentrations of different elements in surface waters may be increased beyond their natural levels due to the release of industrial, agricultural, domestic and other wastes. The discharge from the foregoing is obvious that as a result of man's growing demands for metal bearing compounds in a wide range of manufacturing industries and the direct fabrication of metal artifacts, there is increasing mobilization of metals to the environment. These metals are derived from wastes or from whatever natural sources that is available, but the levels of dispersal by atmospheric and other pathways determine the level of flux of these metals to the sea via the atmosphere, drainage and artificial discharge systems. However, most of the effluents from cities and factories are deposited in coastal waters with the sea appearing to serve as a convenient sink. Generally, substances which are natural products breakdown when they enter the environment or persist for long periods without harm to living things or to amenity. This is however not frequently true with chemical substances such as polychlorinated biphenyls and of brewery effluents and effluents from dyeing industries and tanneries into Ogun River killed thousands of fish. The original non- degradable detergents. Some heavy metals constitute a hazard to food chains if they become combined with organic radicals as in sludge on the sea – bed, stable chemicals which are fat soluble, stable chlorinated compounds and chelating agents.

**Aims and Objectives**

The main purpose of this research is to examine the pollution problem of surface water resources in Asaba and its environs. The specific objectives are therefore designed:

1. To ascertain if the quality of water from the Rivers in Asaba and its environs is good for domestic uses.
2. To compare the seasonal variation of physio-chemical and biological characteristics of the water quality along the course of the rivers.
3. To suggest ways on how to check the seasonal variations of the water quality (if any) and hence achieve sustainable water quality supply for the communities located along the course of the river.

**Literature Review**

Numerous substances may enter surface and groundwater and make the water unsuitable for drinking or cause ecological damage (Okayi, 2003, Ushurhe and Origho, 2009). Common contaminants include salts, suspended solids, chloride, nitrate, arsenic, heavy metals, pathogenic organisms, and a wide variety of organic chemicals including pesticides, petroleum compounds, and solvents (Efe, 2006). Contamination sources can be natural (e.g., arsenic dissolved from aquifer materials) or human, in which case the contamination is referred to as pollution. Pollutants can enter the environment and natural waters via point sources, where a single point can be identified, or non-point sources, where the pollution occurs over a large area. This work discusses pollutants in Asaba arising from human sources, focusing on those that pollute groundwater resources. However, because all water resources are inextricably linked in the hydrologic cycle, surface water and atmospheric pollution are also discussed.

In Asaba, most contamination of aquifers comes from natural sources, such as elevated arsenic concentrations in sand and gravel, the presence of radium and barium in the deep bedrock aquifers, and elevated concentrations of sodium and chloride in both shallow and deep aquifers from localized seeps or regional movement of basin brines into fresh groundwater. Shallow unconfined aquifers are the most susceptible to human sources of pollution. These shallow aquifers are generally sand and gravel but include shallow bedrock aquifers. The Nigerian Environmental Protection Agency classifies the state's aquifers into four main categories, namely sand and gravel, shallow bedrock and down to 500 feet (152.4m), deep bedrock and mixed sand gravel and bedrock.

**Causes of Water Pollution in Nigerian Communities**

**Domestic Sources**

A combination of the increasing population, the flat terrain, and lack of adequate sewage and domestic waste disposal make many localities, potential health hazard areas for their inhabitants. Sanitary and sewage systems in many homes are poor, and where they exist, are poorly managed. Several of the people do not care how they dispose of their trash, and it is not surprising there are serious pollution problems in the communities. The heavy rainfall, flat terrain, poor drainage (blocked drains due to waste dumps, and built up of silt, etc) or lack of drainage system could lead to serious flooding problems even with minimal precipitation. In most houses, only toilet faecal waste is discharged through a septic system and all other household liquids are discharged directly to storm drains where they exist or into the street. In addition, most houses lack indoor plumbing and adequate sources of potable water is limited. The unreliability of water supply from government-owned water board led some of the people to resort to drilling boreholes, or wells. Some buy water from water vendors in tanks. Those who could not afford these obtain their drinking water from shallow wells, less than 5m (16ft) deep. Some of these shallow well waters require treatment before meeting the WHO drinking water standard (Efe, 2006). Lagos like any other coastal region in Nigeria stands the danger of salt-water intrusion. The coastal region of Nigeria consists of Benin and Delta basins, and salt-water intrusion is not closely monitored even though there is reported saltwater intrusion in place like the Lagos metropolitan, Port Harcourt, and Warri areas. Monitoring is limited and the problem is compounded by the uncontrolled development of the groundwater systems. In addition, abandoned boreholes are not properly sealed and ground waters in confined aquifers are corrosive leading to failure of borehole. Lagos with a population of more than 12 million does not have a central sewage system but rather all waste is emptied into a lagoon. This same lagoon and the sea around is the source for most of the fish that the city consumes. Land disposal of solid waste creates an important source of ground water pollution. The problem of pollution from refuse heaps is greatest where heavy rainfall and shallow water table occur. Important pollutant frequently found in leachates from refuse dump includes BOD, iron, manganese, chloride and nitrate (Krist, 2000).

The Nigerian Environmental Protection Agency (2002) reported that groundwater quality was unchanging or slightly improving, based on decreasing numbers of contaminant detections in three of the four major aquifer groups. Based on data collected from 1990 through 2000, only wells in shallow bedrock aquifers showed a slight upward trend in the number of contaminant detections.

The susceptibility of shallow groundwater to pollution depends on the geological and hydrologic conditions. The well-protected shallow aquifers in Nigeria are primarily in west-central and south Nigeria where fine-grained glacial deposits overlie shale. These deposits and rocks have low permeability, and liquids flow through them very slowly, essentially trapping them for many thousands to tens of thousands of years. During that time, toxic chemicals can degrade into less harmful compounds and become dispersed throughout these sediments and rocks. Disposal of hazardous waste should be avoided in areas where sand and gravel or bedrock aquifers are within 300 feet (91.4 m) of land surface and thus lack this long-term filter. Such shallow aquifers exist mainly in riverine areas.

**Local Market Induced Water Pollution**

Local markets refer to shops, super markets, road side markets and commercial centres that are consistently battered by the sellers of different food items and cosmetics, other daily markets and the weekly community markets where rural dwellers and their city associates gather for the buying and selling of farm produces, cattles, donkeys, sheeps, poultry and other household materials. For the purpose of this paper abattoirs are included under this category. These types of markets constitute more than 90% of the markets available in Nigeria, being accessible to most poor people, who live below a US dollar daily. During daily operations reasonable quantities of different wastes that are dumped on fresh surface waterways are consistently generated. Road side sellers, the major culprits, dispose various items such as cans of soft drinks, banana and orange feels, wrappers of sweets, street mechanic dusts. Our abattoirs are generally performing opposite (anti-sanitation) function. Blood, feces and related wastes from animal slaughter find their ways into gutters and the so called "drainage system", the final destinations are surface streams like rivers, lakes, hand dug wells and reservoirs used by people as sources of household water. The waters are generally hard, containing elevated concentrations of CaCO3, MgCO3, sulphates, nitrates, phosphates and heavy metals. A total of 194 kg of solid waste is generated daily in Nsukka metropolitan abattoir, without any hygienic disposal and/or management system. Further studies on the waste raised serious public health concerns, as bacteria such as E. colli, Bacillus sp, and Staphylococcus sp were frequently detected. In addition to these, elevated heavy metals concentration, that is some time more than one thousand (1000) times the permissible limits in drinking water, had been discovered. "Abattoir to water" pollution is a great problem with common phenomenon across the country.

**Oil Spill Based Water Pollution**

Oil spillage is a result of leakage of hydrocarbon from the pipes. To a large extent, poor maintenance of oil pipelines and poor monitoring of pressure regimes of the fluids with respect to the strength of the pipe and reservoir are the main causes. Production of oil and gas is usually accompanied by substantial discharge of wastewater in the form of brines. Constituents of brines include sodium, calcium, ammonia, boron, trace metals, and high total dissolved solids (TDS). In Nigeria the oil must flow at any cost? Yes, it seems so. The local people of the oil rich Niger-Delta, including women and children who are mostly victims of oil spills and other environmental hazards caused by the oil companies, in their own voices, they recount horrifying scenes of killings by agents of the state, destruction of the ecosystem, desecration of sacred sites and the neglect and impoverishment of the people whose lands produce the wealth that sustains the Nigerian nation-state. The environmental problems in Nigeria pose much more threats to life than poverty to the extent that rain water is no longer fit for human consumption due to the acid contamination of rain (acid rain) and ground water by the activities of Nigerian Liquefied Natural Gas Company (NLG) in the wetland area of Niger Delta, owning to gas flaring and other oil companies. Government approach to this problem is most worrisome due to excessive bureaucracy. Thus, Nigerian environmental policies have not been implemented to the latter. The objective of the Federal Ministry of Water Resources to provide safe water to the people has not been achieved. Objections raised by the people of this area on the environmental impacts assessment (EIA) shows a disappointing approach to even reduce the problem. Reports from experts have declared both ground water and rainwater unsafe for consumption. A lot of money is earned from this place through the exportation of crude oil and gas living this people suffering and dying, their life span has been reduced because of environmental pollution and poverty. Oil spill incidents have occurred in various parts and at different times along Nigerian coasts. Some major spills in the coastal zone are the GOCON's Escravos spill in 1978 of about 300,000 barrels, SPDC's Forcados Terminal tank failure in 1978 of about 580,000 barrels and Texaco Funiwa-5 blow out in 1980 of about 400,000 barrels. Other oil spill incidents are those of the Abudu pipe line in 1982 of about 18,818 barrels, The Jesse Fire Incident which claimed about a thousand lives and the Idoho Oil Spill of January 1998, of about 40,000 barrels. The most publicised of all oil spills in Nigeria occurred on January 17 1980 when a total of 37.0 million litres of crude oil got spilled into the environment. This spill occurred as a result of a blow out at Funiwa 5 offshore station. Nigeria's largest spill was an offshore well-blow out in January 1980 when an estimated 200,000 barrels of oil (8.4million US gallons) spilled into the Atlantic Ocean from an oil industry facility and that damaged 340 hectares of mangrove (Nwilo and Badejo, 2005). According to the Department of Petroleum Resources (DPR), between 1976 and 1996 a total of 4647 incidents resulted in the spill of approximately 2,369,470 barrels of oil into the environment. Of this quantity, an estimated 1,820,410.5 barrels (77%) were lost to the environment. A total of 549,060 barrels of oil representing 23.17% of the total oil spilt into the environment was recovered. The heaviest recorded spill so far occurred in 1979 and 1980 with a net volume of 694,117.13 barrels and 600,511.02 barrels respectively. Available records for the period of 1976 to 1996 indicate that approximately 6%, 25%, and 69% respectively, of total oil spilled in the Niger Delta area, were in land, swamp and offshore environments. Also, between 1997 and 2001, Nigeria recorded a total number of 2,097 oil spill incidents. Thousands of barrels of oil have been spilt into the environment through our oil pipelines and tanks in the country. This spillage is as a result of our lack of regular maintenance of the pipelines and storage tanks. Some of these facilities have been in use for decades without replacement. About 40,000 barrels of oil spilled into the environment through the offshore pipeline in Idoho. Sabotage is another major cause of oil spillage in the country. Some of the citizens of this country in collaboration with people from other countries engage in oil bunkering. They damage and destroy oil pipelines in their effort to steal oil from them. SPDC claimed in 1996 that sabotage accounted for more than 60 percent of all oil spilled at its facilities in Nigeria, stating that the percentage has increased over the years both because the number of sabotage incidents has increased and because spills due to corrosion have decreased with programs to replace oil pipelines (SPDC, 1996). Pirates are stealing Nigeria's crude oil at a phenomenal rate, funneling nearly 300,000 barrels per day from our oil and selling it illegally on the international trade market. Nigeria lost about N7.7 billion in 2002 as a result of vandalisation of pipelines carrying petroleum products. The amount, according to the PPMC, a subsidiary of NNPC, represents the estimated value of the products lost in the process. Illegal fuel siphoning as a result of the thriving black market for fuel products has increased the number of oil pipeline explosions in recent years. In July 2000, a pipeline explosion outside the city of Warri caused the death of 250 people. An explosion in Lagos in December 2000 killed at least 60 people. The NNPC reported 800 cases of pipeline vandalization from January through October 2000. In January 2001, Nigeria lost about $4 billion in oil revenues in 2000 due to the activities of vandals on our oil installations. The government estimates that as much as 300,000 bbl/d of Nigerian crude is illegally bunkered (freighted) out of the country. In Nigeria, fifty percent (50%) of oil spills is due to corrosion, twenty eight percent (28%) to sabotage and twenty one percent (21%) to oil production operations. One percent (1%) of oil spills is due to engineering drills, inability to effectively control oil wells, failure of machines, and inadequate care in loading and unloading oil vessels (Peter and Olusegun, 2006).

**Agricultural Pollution**

Agriculture, as the single largest user of freshwater on a global basis and as a major cause of degradation of surface and groundwater resources through erosion and chemical runoff, has cause to be concerned about the global implications of water quality. The associated agro food-processing industry is also a significant source of organic pollution in most countries of the world. Agriculture was a major source of income to Nigeria before oil was discovered in 1950s but still is the major source income to majority of populace in the Northern part of the country who mostly rely on rivers, streams and boreholes water as their source of drinking water. A wide range of contaminants can reach these rivers, lakes and streams either by groundwater or through drainage ditches including artificial fertilizer residues, insecticides, herbicides, pesticides and farmyard waste all of which are potentially very harmful. The primary agricultural pollutants are nutrients (particularly nitrogen and phosphorus), sediment, animal wastes, pesticides, and salts. Agricultural sources enter surface water through direct surface runoff or through seepage to ground water that discharges to a surface water outlet. Various farming activities result in the erosion of soil particles. The sediment produced by erosion can damage fish habitat and wetlands and, in addition, often transports excess agricultural chemicals resulting in contaminated runoff. This runoff in turn affects changes to aquatic habitat such as temperature increases and decreased oxygen. The most common sources of excess nutrients in surface water are chemical fertilizers and manure from animal facilities. Such nutrients cause eutrophication in surface water. Eutrophication is thus depriving the river of oxygen (called oxygen debt). As algae dominates and turn the water green, the growth of other water plants is suppressed; these die first disrupting the food chain. Death of invertebrates and fishes follow on and their dead remains in turn lead to excess bacterial activity and fishing is an occupation to some of the populace in the country (Nigeria) especially areas where they are blessed with rivers, lakes and dams while some eat the aquatic organisms most especially the fishes Pesticides used for pest control in agricultural operations can also contaminate surface as well as ground-water resources. Return flows, runoff, and leachate from irrigated lands may transport sediment, nutrients, salts, and other materials. Finally, improper grazing practices in riparian, as well as upland areas can also cause water quality degradation. Undiluted animal manure (slurry) is about one hundred times more concentrated than domestic sewage and can carry a parasite called Cryptosporidium which is difficult to detect. Silage liquor (from fermented wet grass) is even stronger than slurry with a low pH and higher BOD (Biological Oxygen Demand). With a low pH, silage liquor can be highly corrosive, it can attack synthetic materials causing damage to storage equipment's and leading to accidental spillage. Nitrates also soak into the ground and end up in drinking water. Health problems can occur as a result of this and they contribute to methemoglobinemia or blue baby syndrome which causes death in infants. Ammonia, pesticides as well as oil, degreasing agents, metals and other toxins from farm equipment harm and kill aquatic life and animals and cause health problems when they get into drinking water. Bacteria and parasites from animal waste can get into drinking water which can cause illness and death.

## Research Methodology

### Research Design

Survey research design was adopted in the study. The present research was a survey because the subjects were investigated in their natural settings.

### Area Study

The Niger River is the principle river of West Africa, extending over 2500 miles (about 4180kms). It runs in a crescent through Guinea, Mali, Niger, on the border with Benin and then southwards through Nigeria. Rising in Guinea (just 150 miles (240kms) inland from the Atlantic Ocean), the river flows northeast into Mali, running away from the sea into the Sahara desert. East of Timbuktu, it bends to southeast, flowing across western Niger and forming part of the international boundary between Niger and Benin. The Niger River is therefore said to have one of the most unusual routes of any major river, a boomerang shape. The most important tributary of the Niger River is the Benue River which merges with it at Lokoja in Nigeria. The Niger River then flows predominantly southwards from the confluence with the Benue and finally discharges into the Gulf of Guinea through a network of outlets that constitute an extensive Delta known as the oil rivers. This study is concentrated on the lower Niger River from Illah through Asaba/Onitsha to Okpai (Lat $6^o$ 25' to Lat $5^o$ 40' northings and longitude $6^o$ 37' t0 $6^o$ 47' easting’s). See fig 1:- A sketch map of Delta State and fig 2 is a section of the map with concentration on the River Niger and the location of the sampling stations. Figs. 3, 4 and 5 are sketch diagrams of the three (3) sampling stations. The secondary rainforests along the catchment areas have been subjected to extensive land clearing and farming activities, and as a result the river receives a lot of agricultural waste, through runoff from bordering agricultural lands. A lot of wastes from industrial and domestic activities in and around the fast growing town of Asaba and highly urbanized town of Onitsha as well as surrounding villages of Okoh, Anwai and Ugbolu are all emptied into the river. The Grand hotel, the Ogbonogo market, the Federal Medical Centre, Mami market, Cable market and Delta textile mills Asaba are some of the known contributors to the pollution of the river. Metal fabricators along the catchment areas are involved in the production of car rims, iron beds, cutlasses, pots, underground and surface tanks etc, in and around Asaba/Onitsha axis of the river catchments and are some of the major contributors to the Heavy Metal pollution of the river. During the rains, some of the waters enter the river through runoff and sewage, while others are dumped directly. The study area is underlain by three subsurface depositional structures, namely the Benin, Ogwashi-Asaba and Ameki formations. The Benin formation immediately underlies the Asaba terrain and extends from surface to about 59m. It is composed of pinkish to whitish, medium to coarse grained sands and lenticular clay (Okagbare, 2004).Below the Benin formation lies the Ogwashi- Asaba formation which extends from 59m to 180m.it also extends laterally to neighboring towns of Ibusa, Okpanam and Azagba Ogwashi -Uku where it is thickest. Strategically the formation is characterized by alternation of sand, lenticular sandstones, clay, shales with subordinate sandstones and lignite. In some places such as at Ibusa and Azagba-Ogwashi-uku the lignites even grade into coal.The third formation that underlies the Asaba terrain in a descending order of depositional episode is the Ameki formation. This is the most important aquiferous formation and also extends across Onitsha and beyond. It is generally very permeable with the coarse grained sands being recharged by the river Niger. The above geologic features also cover the Illah environment of the lower Niger River and fall within the Onitsha sombreiro. Okpai area is however part of the sombreiro of Warri Deltaic plain and represents the remnants of a Delta which was formed in late Pleistocene to early Holocene times and later was largely eroded away (Allen 1964). This area is overlayed by the sandy Benin formation up to 200m in thickness and is influenced by a continuous interplay between subsidence and deposition. Sand, silt, clay and organic rich sediments are complexly interbedded to form lithofacies. The climate can be said to be stable but not uniform. It has two distinct seasons, the rainy season and the dry season. The timing however varies from year to year. The rainy season during the period of study lasted from April to October and an august break in August / September. The dry season extended from November to March but was interrupted from December to January by the dry dusty harmattan season. The harmattan season in Asaba station however extended to early February. The mean annual rainfall in Asaba sombreiro was 155.3 inches and at the Warri sombreiro which covers the Okpai station, the mean annual rainfall was 255.7 inches.

**Sample Stretch**

This research was limited to the lower Niger river and three sampling stations were chosen. these stretch from Illah through Asaba/ Onitsha axis down to okpai (the gas gathering project site. the sampling stretch rests within latitude $6^{o}$ 25' and $5^{o}$ 40' northings and longitude $6^{0}$ 37 to $6^{0}$ 47 easting. these sampling stretches were characterized by flowing water and were much affected by surface run off during the raining season from the catchment areas of the river especially in the Asaba/Onitsha station where various developmental projects were on the rise. aside this, much of the shore areas of the sampling stretch were flooded in the raining season.

**Water Studies, Collection and Pre-treatment**

On each sampling day, surface water samples were collected in pre-treated polypropylene sample bottles at an approximate depth of 30cm below the water surface using a hydro bios water sampler. Water samples were immediately preserved by acidifying with concentrated nitric acid (HNO3 analytical grade) to $P^{H}< 2$ (APHA, 1989). After acidification of the samples, they were stored in an iced cooler in the field and later transferred to a refrigerator at approximately $4^{o}$C to prevent change in volume due to evaporation. Water samples for chemical analysis were also collected in sample bottles without fixing with acid and treated like other samples in a refrigerator.

**Pre-treatment and Digestion of Water Samples**

The water samples that had already been fixed in Nitric Acid were filtered through what man filter paper No. 1 and aspirated directly into the AAS for heavy metals such as Cd, Cu, Pb, Mn, Ni Cr, Co and Zn.

**Determination of Iron by the Phenanthroline Method**

The concentrations of iron in all samples of water, bottom sediments and fish were determined by the 1 -10 Phenanthroline method of APHA (1989) 2mls of the digestate was put in a flask. 2mls of 1 -10 Phenanthroline, 20mls of sodium citrate and 2mls of hydroxylamine hydrochloride was added. This was mixed thoroughly and left to stand for two hours. The percentage absorbance was read off from a spectrophotometer at 465nm wavelength. Iron concentrations were determined from the standard curve.

**Preparation of Standard Curve**
The standard stock solutions were prepared by dissolving various amounts of 1ppm, 5ppm, 10ppm and 20ppm, 40ppm of dried annular grade Iron nitrate in distilled water. The percentage absorbance of each standard solution was measured and the calibration curve drawn for the different concentrations. A blank sample was prepared using distilled water.

**Bottom Sediment Studies**
Samples of the bottom sediment were obtained from each station for the period with the aid of bottom sediment 'Eckman Grab' attached to a polypropylene rope. The samples were immediately placed into plastic bags and cooled in an iced cooler in the field and later transferred to the refrigerator in the laboratory prior to analysis.
The samples were pre – treated of debris and dried at 105$^o$c in a moisture extraction oven. The dried samples were then passed through 100mm mesh sieve and stored in plastic bags (Ajayi and Mombeshora, 1989) all containers used were soaked in 30% Nitric Acid for 84 hours and then rised with deionized water. When not in use, the glassware's were stored in deionized water acidified with Nitric Acid to a $P^H$ of 3. All reagents used for analysis were of the analytical grade and fresh supply free from trace metal contamination.

**Percentage Organic Matter Content**
The total organic matter contents of the sediments were estimated from the percentage loss on Ignition as described by Allen (1989). 1g of Oven dried soil was put into a pre – weighed crucible. The crucible with its contents were placed to rise slowly to 55$^o$C and left for 2 hours. The crucible with its contents was transferred to desiccators, cooled to room temperature and reweighed. The % loss on Ignition was calculated from the weight loss during combustion using the formula.

$$\textbf{\% loss on ignition} = \frac{\textbf{wt. loss (g) x 100}}{\textbf{Oven dry wt (g)}}$$

**Digestion of Bottom Sediment Samples**
Bottom sediment samples were digested using the Nitric Acid – perchloric acid method as described by Adams et al (1980). 25g of bottom sediment sample was oven dried at 105$^o$C to constant weight. 0.5g of the dried sample was acidified with $HNO_3$. 20mls $HCLO_4$ was added to the filtrate and evaporated until white fumes of $HCLO_4$ appeared. When the solution became clear, the digest was filtered with a No 40 what man filter paper and diluted to 25ml mark for analysis.

**Water Analysis**
**Temperature**
Water temperatures of the Niger River were recorded using mercury in glass centigrade thermometer. The thermometer was held in the water for 3-5 minutes and the readings (for water temperatures) were taken while the thermometer was still inside water. Air temperature

readings were taken from the same spot the water temperature readings were taken but in this case outside the water of the Niger River.

**Conductivity**

The conductivity of the water samples was determined using the Hach Model 44600 conductivity / Total dissolved solid meter (T.D.S. Meter 4076 Jenway). The conductivity was measured in µdcm.

**Hydrogen-Ion concentration($P^h$)**

The hydrogen ion concentration ($P^H$) of the water samples were estimated with the aid of Hach Model ($P^H$) meter (or $P^H$ meter Model 3305 Jenway).

**Total Solids**

An evaporating dish was properly washed and rinsed with distilled, oven dried, put in desiccators to cool and then weighed (W1). 100ml of unfiltered water sample was put in the evaporating dish and evaporated to complete dryness at 150 -180$^o$ C. The dish was transferred to the desiccators to cool and then reweighed, until a constant weight was obtained (W2).

Weight of the dried sample = (W1-W2)g. The total solid in 1L of water was extrapolated using the formula (W1-W2)* 1000*10 mg/L.

(ii) **Total dissolved solids**

This was done like total solids except that water used were filtered through Whatman filter paper No 41.

(vi) **Total suspended solids**

The total suspended solid was got by subtracting the total dissolved solid from the total solids i.e.

Total suspended solids = Total solids (mg/l) – Total dissolved solids (mg/L).

**Dissolved Oxygen**

Winkler's method as described by Mackereth (1963) was used to determine Dissolved Oxygen. In the field, narrow mouthed glass-stopper 250ml bottles were used to collect water and were immediately stoppered eliminating air bubbles. 2ml each of Winkler's solution A (Manganous sulphate) and solution B (Potassium hydroxide in Potassium iodide) were added well below the neck of the bottle. With the stopper firmly replaced, the contents were thoroughly mixed.

In the laboratory, the precipitate formed was dissolved by adding 2ml of concentrated sulphuric acid, to form a golden brown solution. 100ml of this solution with 2 drops of starch indicator was titrated against 0.8N sodium thiosulphate solution. The disappearance of the initial blue-black coloration indicated the end point.

The dissolved oxygen (D.O) was estimated in mg/L using equation:

D. O = Vol. of titrant *N of thiosulphate*1000 / Vol. of sample used

**Alkalinity**

Alkalinity was determined by titration using the method of Golterman et al (1978). Phenolphthalein alkanity (P.A.) was first determined by titrating 100mls of each sample against 0.02N sulphuric acid with two drops of phenolphthalein indicator in all samples, Phenolphthalein alkalinity (P.A) was zero (i.e. samples remained colourless). Two (2) drops of methyl orange indicator was added to the colourless solution and was titrated against the acid until the appearance of a faint pink coloration.

The total alkalinity was calculated from the equation:

T.A (meq/L) = Vol. of titrate*n of acid*1000/Vol of sample used

A correction factor of 0.02 meq/L was subtracted from the value obtained as suggested by Sutcliffe et al (1982) and converted to mg/L with a multiplication factor of 50

**Total Hardness**

The total hardness was measured using a portable field kit of total hardness (Aquamerch 8039) Gesumtharte instrument. The method is a complexometric titration with titriplex III against mixed indicator.

The measuring cylinder was washed with the water sample and filled to the 5ml mark. With 3 drops of the indicator solution was added and the mixture swirled. The color changed to red in the presence of hardness formers.

The titrating pipette was used to drop the regent solution slowly to the prepared water sample. The appearance of a greenish color indicated the end point.

**Rainfall**

The rainfall data for Asaba and Illah sampling stations were collected from the Asaba meteorological station during the sampling period while that of Okpai station were collected from the Warri meteorological station G.R.A Warri during the period.

Of 1 -10 Phenanthroline, 20mls of sodium citrate and 2mls of hydroxylamine hydrochloride was added. This was mixed thoroughly and left to stand for two hours. The percentage absorbance was read off from a spectrophotometer at 465nm wavelength. Iron concentrations were determined from the standard curve.

**Digestions and Analysis**

The method used was the mixed acid procedure described by Allen (1989) and modified by Sveedevi (1992). The dried fish samples were ground to a fine powder in a porcelain mortar. 1g of each sample was used for digestion using perchloric – nitric – sulphuric acid method in the ratio of 1:5:1 (Sveedevi, 1992). Digestion was completed by the appearance of dense white fumes and colourless solution. The solution was filtered through what man filter paper No. 42 into 50mls volumetric flask and made up to mark with deionized water. The solution was then analyzed for the heavy metals (Zn, Cu, Pb, Cd, Ni, Fe, Mn and Co) using urican 929 Atomic Absorption Spectrophotometer.

## Results and Discussion of Findings

### Physical and Chemical Conditions of the Lower Niger River

The lower Niger River showed significant variations in the physical and chemical conditions. Some of the properties studies were as follows:

### Temperature

The temperatures were high and tended to follow a seasonal pattern of being higher in the dry season than in the rainy season (Table 1). The trend has been reported in most tropical rivers and lakes such as the Asejire lake (Egborge, 1981), Benin River (Fufeyin, 1997) the Warri River (Tetsola and Egborge, 1991) and Ikpoba reservoir (Fufeyin, 1994). The air and water temperatures were typical of the geographical location of the lower Niger River. Whilst, air temperatures ranged between 25°c and 35°c, water temperature ranged from 26°C to 33°C. Tropical Rivers were reported by Fufeyin, 1987, Oyewo et al, 1982 and Fufeyin, 1994 to have temperatures that fluctuate narrowly. There were no marked differences in ranges of air and water temperature between the Illah, Asaba and Okpai stations of the lower Niger River.

**Table 1. Air and water temperature at three locations in lower Niger river**.

| | | | |
|---|---|---|---|
| ILLAH | 1 | Air Temperature | 31˚C |
| | 2 | Water Temperature | 29˚C |
| ASABA | 1 | Air Temperature | 31˚C |
| | 2 | Water Temperature | 28˚C |
| OKPAI | 1 | Air Temperature | 33˚C |
| | 2 | Water Temperature | 30˚C |

Source: Field work 2011

**Table 2. Effect of three locations on the concentration of Elements River.**

| Location | Concentration of elements | | | |
|---|---|---|---|---|
| | Cr | Mn | Fe | Co |
| Asaba | 0.22 | 3.41 | 19.91 | 0.11 |
| Illah | 0.18 | 2.76 | 18.74 | 0.51 |
| Okpai | 0.15 | 2.58 | 15.95 | 0.03 |
| L.S.D (0.05) | 0.11 | 1.71 | 3.07 | 0.07 |

Source: Field work 2011

**Table 3. Effect of three locations on the concentration of Elements River.**

| Location | Concentration of elements | | | |
|---|---|---|---|---|
| | | | Zn | Pb |
| Asaba | 1.22 | 12.92 | 2.66 | 0.05 |
| Illah | 0.29 | 5.86 | 1.78 | 0.03 |
| Okpai | 0.15 | 6.36 | 3.25 | 0.05 |
| L.S.D (0.05) | 1.0 | 5.66 | 0.10 | 0.03 |

**Source:** Field work 2011

**Table 4. Effect of three locations on the concentration of Elements River**

| Location | Concentration of elements | |
|---|---|---|
| | Cd | Ph |
| Asaba | 0.005 | 5.80 |
| Illah | 0.0001 | 6.33 |
| Okpai | 0.007 | 5.50 |
| L.S.D (0.05) | 0.002 | 0.07 |

**Findings**

A comparative assessment of the seasonal variation of the water quality from Rivers in Asaba and its environs revealed that:

i. There is seasonal variation in the physico-chemical and biological characteristics of some of the parameters examined along the course of River in illah, okpai and Asaba when compared to WHO (2010) threshold for drinking water quality.
ii. Coliform concentration varies from a mean of 22.40count/100 in Illah to 33.24count/100 in okpai and a mean of 29.57count/100 in Asaba relative to 10count/100 WHO (2010) standard.
iii. The test result of the posited hypothesis showed that there is significant seasonal variation in water quality along the course of the rivers. The calculated value of 7105.196 was greater than the table value of 19.675 at 0.05 significant levels.
iv. The seasonal variation in water quality was caused by geologic and anthropogenic activities of man.

**Conclusion**

In conclusion, the study has been able to discover that variation exists in the physio-chemical and biological characteristics of the water quality along the course of the rivers. Thus, the variation was caused by geologic and anthropogenic factors which have impaired the quality of water. There is need to ensure that water resources in Nigeria are protected, used, developed, conserved, managed and controlled in ways as meeting the basic needs of the present and future generations. Also, proper addressing of the problems/ challenges faced by water bodies from wastewater channeling, will not only lead to the restoration of aquatic habitats in the State, but will also restore fishing, recreational and other water activities and boast food production thus contributing to the economy. The establishment of the wastewater treatment plants will create jobs for various levels of manpower (skilled and unskilled). As the State seeks active partnership with private investors in order to harness her abundant human and material resources and diversify its economy, wastewater management should be seen as an industry worth investing in as it has the potentials of complementing every sector of the economy.

**Recommendations**

1. All governments within the Niger Delta wetland should develop stringent regulations to control pollution of the surface water resources in the area.
2. All governments should ensure the enforcement of water pollution control laws and regulations.

3. Pollution control measures must be put in place to assess the impact of industries on the environment and should provide for municipal and industrial waste waters and solid waste control programmes.
4. Industrialization should be coordinated with environmental protection activities.
5. Environmental Impact Assessment (EIA) should be carried out for any new industries and all industries must have adequate means of treating and disposing of industrial effluents and solid wastes arising from the industries.
6. The Ministry of Environment should be compelled to carry out independent Post Impact Assessment (PIA) of all aquatic systems to determine the state of contamination and locate the point sources for immediate correction and application of polluter pays principle.

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