

Hazardous Effects of Industrial Effluents on Ukwaka Stream and the Ecosystem in Nnewi, Nigeria

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ABSTRACT: Careless disposal of untreated industrial waste on surface water might affect the physicochemical characteristics of stream ecosystem. The aim of this study was to evaluate the effects of industrial waste disposal on surface water quality of Ukwaka stream and the soil. Water samples were taken at the effluent discharge points labeled: site A (0m); sites B (300m) and C (600m); and downstream site D (900m) along the stream from the discharge point with geo-reference using Garmin Global Positioning (GPS) reference system (Site A, 6.820 °E, 5.885 °N; Site B, 6.915 °E, 5.996 °N; Site C, 6.911 °E, 5.996 °N; Site D, 6.906 °E, 5.995 °N), and were analyzed for pH, dissolved oxygen, biological oxygen demand, electrical conductivity, suspended solids, chloride, salinity, phosphate, and heavy metals, in the dry and wet seasons. The results of study showed that the effluents were acidic in both dry and wet seasons on most of sampling stations. While the levels of biological oxygen demand, electrical conductivity, were relatively high in dry season. Water sample was slightly acidic with high dissolved oxygen. There was moderate contamination of the environment by the metals studied. All the metals were high with iron and zinc being exceptionally high and above the specified international standards. This study indicates that industrialization has contributed to the large scale pollution and this polluted water is not good for human consumption. It is therefore recommended that the disposal of untreated wastes should be stopped to save the stream water from further deterioration.

KEYWORDS- Ecosystem, Effluents, Hazardous, Industrial, Ukwaka

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I INTRODUCTION

Water pollution remains a major problem in the Nigeria environment. Both urbanization and industrialization have contributed to the scale of pollution. Water pollution is unarguably one of the most fundamental environmental issues globally and locally, as untreated or inadequately treated waste is being discharged into streams, estuaries and seas [1] Pollution from wastewater depreciates land values, increases municipal costs and causes numerous adverse biological and human health effects. Untreated wastes from processing factories located in cities are discharged into inland water bodies resulting to stench, discoloration and a greasy oily nature of such water bodies [2],[3] Effluent discharge is the most devastating pollution source because pollution of water, air and land are very closely interrelated and if not properly managed, pollutants from one medium could be transferred to other media [4] Industrialization and human activities have partially or totally turned our environment into dumping sites for waste materials. This has often rendered these natural resources unsuitable for both primary and/or secondary usage [5], [6], [7]

Industrial effluents contain toxic and hazardous materials from the wastes that settle in river water as bottom sediments and constitute health hazards to the urban population that depend on the water as source of supply for domestic uses [8]. The careless disposal of industrial effluents and other wastes contributes greatly to the contamination of the water [9]. Increased pollution load in fresh water bodies increases the nutrient level of water [10], [11]; and causes a violent alteration in pH, reduction in oxygen content and high osmotic pressure. [12] pointed out that acids and alkalis discharged by chemical and allied industrial plants make streams

unsuitable not only for recreational uses, but also for propagation of fish and other aquatic life. To buttress the above point, [13] affirmed that the water from these sources is contaminated with domestic, agricultural, and industrial wastes and likely to cause water related diseases. The effects are usually subtle and before any obvious changes are noticeable, extensive damage would have been done [14]

Many industries in Nigeria discharge their wastewater into surface waters (Oceans, Seas, Rivers and Stream) without any form of remediation or treatment. This paper highlights the hazards done to Ukwaka stream and the ecosystem. More challenging is the unsafe disposal of these wastes into the ambient environment. Equally, the wastewaters are not properly treated before they are disposed off. An estimated 90 percent of all wastewater in developing countries is discharged untreated directly into rivers, lake or the oceans [15], [16].

1.1 Impacts of Effluent on the Environment

The impact of industrial effluent on the environment is not limited to water bodies alone, rather it cuts across all portion of the environment. The various component of the environment interact with each other, hence sooner or later, the harm done to the water bodies would soon be felt by the land and the atmosphere [17]. The release of such effluents into agricultural lands via the water bodies adversely affect the quality of crops grown on these soils, making them unfit for consumption for animals and human beings [18]. For the fact that all waterways are connected, the unregulated discharge of wastewater therefore has far reaching implications for the health of all aquatic ecosystems, which threatens to undermine the resilience of biodiversity and the ecosystem services on which human wellbeing depends [19]. Plants may survive under high metal concentrations by sequestering metal ions into their tissues, exposing secondary consumers (human or animals) to the risk of metal toxicity [20]

1.2 How the ecosystem is affected

According to [17], the impact of industrial effluent would be discussed as it affects each component of the ecosystem namely

1.2.1 Impact of industrial effluent on water bodies (Hydrosphere)

Industries that use large amounts of water for processing have the potential to pollute waterways through the discharge of their waste into streams and rivers [21]. Industrial waste consists of both organic and inorganic substances. A number of toxic substances including metals and some non-metals that human beings encounter regularly may pose serious health risks and have serious environmental effects on the waters [2], [22].

1.2.2 Impact of industrial effluent on the soil (Lithosphere)

Soil is a key part of the earth system as it controls the hydrological, biological, and geochemical cycles. The soil system also offers goods, services, and resources to mankind [23], [24], [25], [26]. Sometimes, effluent especially sludge from the water or wastewater treatment facility are disposed of by using them as soil amendment, or just indiscriminately to dump sites. [27] stated that when these effluent or sludge contains toxic materials and heavy metals, they immediately become part of the soil and they could be picked by the root of the plant and bioaccumulation in the tissues of the plant. The activities of bacterial and other micro-organisms could be altered by the presence of these pollutants [28]. Many toxins added to soils can build up to concentrations that become serious threat to plant and animal health. Soil has an intimate and extensive role to maintain a suitable environment and to minimize pollution [29], [30]. Heavy metals in effluents are poorly soluble in water, and cannot be degraded; they tend to accumulate in soils and could be picked by the root of the plant and bioaccumulation in the tissues of the plant [31], [32].

1.2.3 Impact of industrial effluent on the air (Atmosphere)

[33] stated that effluent especially when it contains high BOD and other organic pollutant tends to give off foul smell. This worsens when the waste is not properly dosed off with the required oxygen to effectively digest the complex organic matter to simpler form. Disgusting gases like hydrogen sulphide (H₂S) and cyanide among others are very notorious in this regards. With uncontrolled release of effluent, the undesirable foul smell could become a threat to the inhabitants of such locality [28].

1.2.4 Impact of industrial effluent on human

Effluents contain heavy metals which are harmful to human health either through direct ingestion or from fish and other animals or plants. The untreated effluent when released to the environment would interact with all components of the environment. The effect would not only be felt in the water bodies alone, but cuts across all

the components. The toxic component would definitely move round the food web [22]. Excessive intake of the Pb to human body can damage the nervous, skeletal, endocrine, enzymatic, circulatory, and immune system [34], [35], [24].

II MATERIALS AND METHODS

2.1 Study area Description

The study area is located close to Uru Industrial Estate in Nnewi about 22 km south east of Onitsha, Nigeria. It lies on the latitude of $6^{\circ} 1' N$ and longitude of $6^{\circ} 55' E$, [36]. It has altitude that ranges from 105m to 300m above sea level. It is a commercial city in Anambra, [37] state, in the south east of Nigeria. Its commercial nature influences its rapid urbanization [38]. Generally, the soil is composed mainly of iron rich tropical soils which may be in the form of loamy clay, and sandstones. The climate is hot and humid; Nnewi has two major seasons namely: raining season (April to October) and dry season (November to March). The annual rainfall ranges from 165 mm in April to 1025 mm in September. The mean annual temperature ranges from $13^{\circ} C$ in February to $22^{\circ} C$ in October [39]. The study area (Ukwaka stream) shown in Fig. 2.1 is a unique place where industrial effluents from Chicason Group of Industries are dumped regularly in an unscientific manner into Ukwaka, an ephemeral stream..

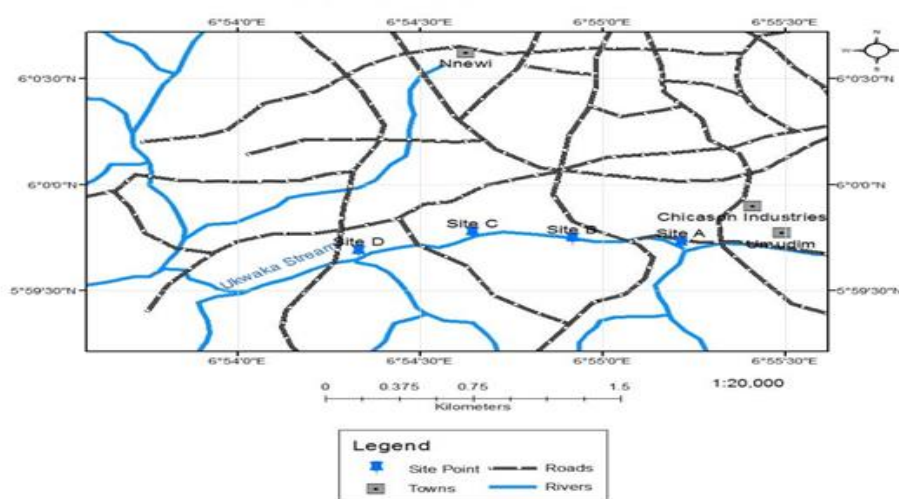


Fig 2.1 Map Of Some Part Of Nnewi Showing Ukwaka Stream

2.2 Outline of Methodology

2.2.1 Water Sampling and Preservation

The Ukwaka water samples were collected from four different points of the stream for a period of six months (July to December 2017). The GPS co-ordinates in UTM were recorded for each sampling site as follows: point 0m tagged site A ($6.820^{\circ} E$, $5.885^{\circ} N$), point 300m labelled site B ($6.915^{\circ} E$, $5.996^{\circ} N$), point 600m, labelled site C ($6.911^{\circ} E$, $5.996^{\circ} N$) and point 900m named site D ($6.906^{\circ} E$, $5.995^{\circ} N$). The effluent samples were collected from the effluent channel leading to the stream. Solid wastes are dumped at the bank of the stream before point 600m (site C). The Samples were collected in 1 litre plastic bottles at a distance of about 300 meters from each other point. They were taken from the mid-stream at approximately 0.20 meters below the surface. These effluent samples were collected monthly in the first week of the month, from July to December, 2017; while the samples of Ukwaka stream water from the four different points were collected every week from July to December, 2017. The GPS co-ordinates were recorded for each site as shown in Fig 2.2. The collections were done on the first day of every week between 8.00 am and 12 noon and put in an iced block stocked cooler for preservation.

To provide necessary information for each sample taken, it was collected into appropriately well labeled plastic bottle with a unique identification number. While collecting, the bottles containing samples were sealed immediately under the water to avoid exposure to air. The dates of collection, location were recorded in the note book and each sample collected was labelled separately. Prior to this, all the bottles were washed and rinsed three times with the water to be sampled. They were transported within 48 hours to the laboratory,

preserved according to the standard method of American Public Health Association (APHA, 2012), ready for the Physical, Chemical and Heavy Metals parameters analyses.

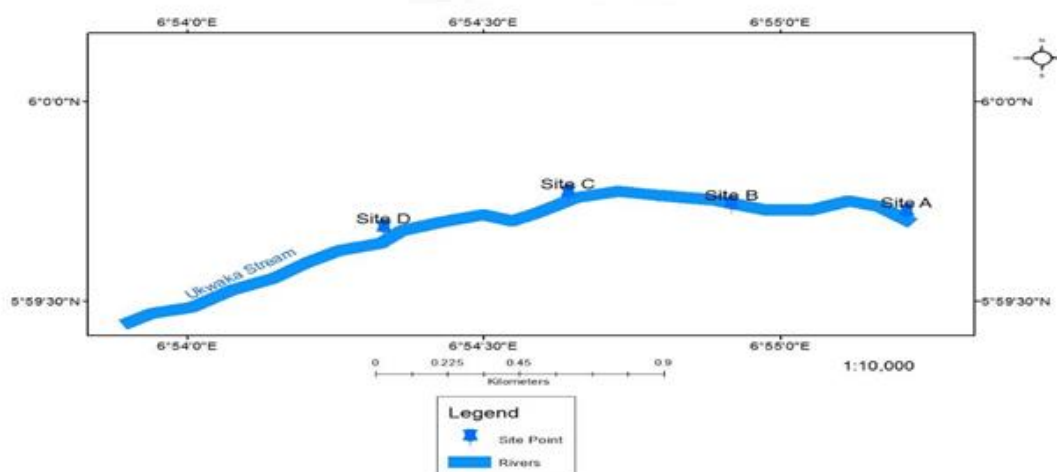


Fig 2.1 Sampling Points With GPS Positions: A (6.820 °E, 5.885 °N); B (6.915 °E, 5.996 °N); C (6.911 °E, 5.996 °N); D (6.906 °E, 5.995 °N).

To provide necessary information for each sample taken, they are collected into appropriately well labeled plastic bottles with a unique identification numbers as shown in plate 2.1. After collection, the bottles containing samples were sealed immediately to avoid exposure to air. The dates of collection, location were recorded in the note book and each sample collected was labelled separately. Prior to this, all the bottles were washed and rinsed three times with the water to be sampled. They were transported within 48 hours to the laboratory, preserved according to the standard method of American Public Health Association (APHA), ready for the Physical, Chemical and Heavy Metals parameters analyses. A total of 96 water samples, 6 Effluent samples were analysed for 18 parameters in each.



Plate 2.1 labelled samples

2.2.2 Determination of physicochemical characteristics

Physicochemical characteristics determinations were carried out according to the Standard Methods for the Examination of Water and Waste water [36]. Various standard methods were followed and a number of sophisticated instruments were used. Water colour was observed by naked eyes and odor was felt with nose. The water temperatures, electrical conductivity (EC), were taken immediately in the field by using pocket instruments for that.

2.3 Physical Parameters taken

2.3.1 pH

Values of pH were measured by portable digital pH water analyses kit with pH electrodes. The instrument was calibrated with buffer solutions having pH values of 4 to 9. A pH of 7.0 indicates a neutral solution, pH values smaller than 7.0 indicate acidity, pH values larger than 7.0 indicate alkalinity.

- the sample was measured into a conical flask.
- the pH electrode was inserted into the sample
- the value of the pH was then read on the calibration on it.

2.3.2 Specific conductance

The value of Electrical Conductivity (EC) is a measure of the ability of ions in a solution to carry electric current. A measure of the ability of water to conduct an electrical current varies with temperature. Magnitude depends on concentration, kind, and degree of ionization of dissolved constituents. The EC values were measured by portable kit with electrodes. The meter was switched on and its probe dipped into the sample contained in a beaker. The electrical conductivity was read directly and recorded in micro-Siemens per centimeter.

2.3.3 Temperature

Thermometer was used to measure this. The thermometric bulb containing the mercury was vertically immersed in the effluent and allowed to stand for some minutes till the temperature reading was steady before taking reading.

2.3.4 Turbidity

The turbidity levels were measured in Nephelometric units. The turbid meter was first of all calibrated in order to make sure the instrument is capable of giving accurate results for analyzing the water samples. The water sample was shaken to mix thoroughly. After the disappearance of air bubbles, turbidity was determined by filling the water sample into a curvature and inserted into the Digital turbidometer compartment to allow light pass through it. The reading displayed was the turbidity value.

2.3.5 Total Suspended Solids (TSS)

- Filter paper of diameter 5.5cm was dried to a constant weight (w_1) at 103-105°C in an oven.
- cooled to room temperature in a desiccators and the weight was noted.
- Gooch funnel and rubber adapter were fixed to a filtering flask,
- the glass fiber was placed into the Gooch funnel carefully with the aid of a pair of tongs.
- The water sample was thoroughly mixed on a magnetic stirrer, after which 50ml was quickly measured into the filtering apparatus.
- After filtration elapsed, the filter paper containing the suspended particles was put into the oven for 1 hour at 103±2°C to dry.
- This was allowed to cool in a desiccators and reweighed w_2 . The weight (w_2) was taken.
- The difference in the two weights $w_2 - w_1$ was noted.

Where w_1 = Initial weight of filter, w_2 = Final weight of filter

$$\text{TSS} = \frac{\text{Weight loss}(w_2 - w_1) \times 1000}{\text{Volume of sample}} \dots\dots\dots(2.1)$$

The Equipment and materials used were:

Electronic hot plate (Gallenkamp, 125567AMP, England), Crucible, Whatman filter paper (No.4), Measuring cylinder (Pirex), Weighing balance (Ohaus – CP413).

2.3.6 Total Dissolved Solids

- The sample was stirred with a magnetic stirrer and a measured volume was taken onto a glass fiber.
- The glass beaker was earlier washed successively three times with distilled water, allowing complete drainage between washings.
- The beaker was dried to a constant weight.

- A known volume of the sample was measured in a volumetric cylinder and filtered into the weighed dried beaker (using previously dried filter).
 - Total filtrate was weighed w_1 . The beaker containing the suspended particles was put into the oven for 1 hour at $103 \pm 2^\circ\text{C}$ to dry.
 - This is allowed to cool in a desiccators and weighed again to get w_2 .
- Where w_1 = Initial weight of beaker
 w_2 = Final weight of beaker

$$\text{TDS} = \frac{\text{Weight loss}(w_2 - w_1) \times 1000}{\text{Volume of sample}} \dots\dots\dots(2.2)$$

The Equipment and materials used were:

Electronic hot plate (Gallenkamp, 125567AMP, England), Crucible, Whatman filter paper (No.4), Measuring cylinder (Pirex), Weighing balance (Ohaus – CP413).

2.3.7 Alkalinity by Titration

- 50ml burette was severally rinsed with 0.02 N HCL.
- The burette was filled with the HCL solution, making sure there were no air bubbles in the tip, and that the meniscus was readable at close to 0.00ml on the burette scale.
- 100 ml of the water sample to be analysed was measured into a 250 ml Erlenmeyer flask.
- This was titrated to a bromo cresol green (pH = 4.5) end point.

Calculations

$$\text{Alkalinity} = \frac{\text{titre} \times \text{normality of HCL} \times 50,000}{\text{Volume of sample used}} \dots\dots\dots(2.3)$$

This is expressed in terms of milligrams of calcium carbonate per liter.

.Equipment used-

Retort stand, Burette, Funnel, Beaker, pH meter (labtech 1167).

Reagents

Hydrochloric acid (0.02 N)
 Bromo cresol green indicator

2.3.8 Phosphate determination

- Exactly 100ml of the homogenized and filtered sample was pipetted into a conical flask.
- The same volume of distilled water (serving as control) was also pipetted into another conical flask.
- 1ml of 18M H_2SO_4 and 0.89g of ammonium persulphate were added to both conical flasks and gently boiled for $1\frac{1}{2}$ hrs, keeping the volume to 25-50 cm^3 with distilled water. It was then cooled.
- A drop of phenolphthalein indicator was added. This was neutralized to a faint pink colour with the 2M NaOH solution.
- The pink colour was discharged by drop-wise addition of 2M HCl.
- Distilled water was added to the solution to make up to 100ml.
- For the colorimetric analysis, 20ml of the sample was pipette into test tubes.
- 10ml of the combined reagent was added, shaken and left to stand for 10mins before reading the absorbance at 690nm on a spectrophotometer, using 20ml of distilled water plus 1ml of the reagent as reference.

Methods for Calibration

- Standard phosphate solution: 219.5 mg of dried AR potassium hydrogen phosphate was dissolved in distilled water and made up to 100ml, where 1ml = 50.mg. of phosphate.
- 10ml of the stock solution was made up to 1000ml to give 1 ml = 0.05 mg.
- Standards of strength ranging from 0 (blank) to 0.05mg/L at intervals of 0.01mg were prepared by diluting the stock with distilled water.

$$\text{Concentration of sample} = \frac{\text{Absorbance of sample} \times \text{Concentration of standard}}{\text{Absorbance of standard}} \dots\dots\dots(2.4)$$

The Equipment and materials used were

UV Spectrophotometer (Apel PD-3000 UV), Beaker (pyrex), Measuring cylinder (pyrex), Pipette, Pipette pump (pyrex), Cuvette.

Reagents used-

SO_4 (18M), Ammonium persulphate (0.8g), Phenolphthalein indicator, HCl (2M), Distilled water

2.3.9 Chloride Determination

Chloride was analysed according to APHA standard method (APHA; 1998)

Procedure:

- A 100ml of the clear sample was measured through pipette into an Erlenmeyer flask
- the pH was adjusted to 7 – 10 with either H₂SO₄ solution.
- Then 1ml of K₂CrO₄ indicator solution was added
- it was titrated using standard solution of AgNO₃ which made it to turn to a permanent reddish brown colouration. End point is pinkish yellow.
- The titer volume was noted.
- The AgNO₃ titrant was standardized and a reagent blank established. A blank of 0.2-0.3ml is usual for the method.

Calculation: Chloride concentration = Titre value (x) 10 = mg/l

The Equipment and materials used were

Pipette (pyrex), Burette (pyrex), Retort stand, Beaker (pyrex), Funnel

Reagents:

Standard Silver nitrate AgNO₃ (1 ml = 0.5 mg chloride)

Potassium chromate K₂CrO₄ (5%) (Indicator)

2.3.10Determination of Salinity

To determine the salinity, the result gotten from the determination of the chloride was multiplied by 0.0018066.

Salinity = chloride content x 0.0018066 (ppt)

2.3.11Sulphate Determination

Method: Sulphate was analysed according to APHA standard method (APHA; 1998)

Procedure:

- 250m⁻³ of the sample was measured out and dried in a crucible.
- Three (3) drops of concentrated Hydrochloric acid was added into the dry crucible to moisten it.
- 30cm³ of distilled water was added to this, and all the content were mixed together by stirring.
- The mixture was boiled and filtered into a beaker.
- The crucible was washed three times with 30cm³ of distilled water.

Digestion

- The filtrate was heated to boiling
- 10cm³ of 10% BaCl₂ solution was added to it, drop by drop with constant stirring for the development of turbid suspensions of barium sulphate.
- The mixture was digested for about 30 minutes, filtered and the filter paper was washed with warm distilled water.
- This was allowed to cool before filtering through a pre-weighed filter paper.
- The filter paper containing the precipitate was dried in an oven and was allowed to cool in desiccators.
- Thereafter, it was weighed. The difference in weight was noted.
- The sulphate concentration was calculated with the formula below;

Calculation

Mg/dm³SO₄ = Mg BaSO₄ x 411.5cm³ of water sample.

MgBaSO₄²⁻ concentration = MgBaSO₄²⁻ x 411.5 of calibrate the volume.

The Equipment and materials used were

Crucible, Electric hot plate, Measuring cylinder, Filter paper, Oven (Mammert 12880KL, Germany), Desiccators, Weighing balance

Reagents: Concentrated HCl, 10% BaCl

2.4.12Dissolved Oxygen Determination

- The water sample was put in a 250ml bottle,
- 1ml of MnSO₄ solution and 1ml alkali-iodide-azide reagent were added well below the surface of the liquid.
- It was stoppered with care to exclude air bubbles and mixed by inverting and rotating until clear supernatant water was formed. It was then allowed to settle for 2 minutes,
- After the settlement, 1ml of concentrated H₂SO₄ was added by allowing the acid to run down the neck of the bottle,

- the stopper was replaced, and mixed by gentle inversion until dissolution of the precipitate was completed. At this stage, the iodine must have been uniformly distributed through the solution.
- 2ml of the solution was titrated with 0.0125M Na₂ S₂O₃. 5H₂O (sodium thiosulphate) solution to a pale straw color
- 2ml of starch solution was added as indicator, which turns the color blue;
- the titration was preceded by adding the thiosulphate solution drop wise until the blue color disappears. The reappearance of blue color was disregarded.

$$D.O = \frac{\text{mole of titrant} \times \text{normality of titrant} \times 8000}{\text{ml of sample}} \dots\dots\dots (2.5)$$

The Equipment and materials used were

Refrigerator (L.G, Model GL 2250M), Sample bottle, Measuring cylinder, Conical flask, Pipette pump, Stopper
Reagents: MnSO₄, sodium thiosulphate, MnSO₄,alkali-iodide-azide, H₂SO₄, starch solution

2.4.13Determination of Biochemical Oxygen Demand

- The water sample was put in a 250ml bottle,
- 1ml of MnSO₄ solution and 1ml alkali-iodide-azide reagent were added well below the surface of the liquid.
- It was stoppered with care to exclude air bubbles and mixed by inverting and rotating until clear supernatant water was formed. It was then allowed to settle for 2 minutes,
- After the settlement, 1ml of concentrated H₂SO₄ was added by allowing the acid to run down the neck of the bottle,
- the stopper was replaced, and mixed by gentle inversion until dissolution of the precipitate was completed. At this stage, the iodine must have been uniformly distributed through the solution.
- 2ml of the solution was titrated with 0.0125M Na₂ S₂O₃. 5H₂O (sodium thiosulphate) solution to a pale straw color
- 2ml of starch solution was added as indicator, which turns the color blue;
- the titration was preceded by adding the thiosulphate solution drop wise until the blue color disappears. The reappearance of blue color was disregarded.
- Carry out the titration in duplicate

$$D.O = \frac{\text{mole of titrant} \times \text{normality of titrant} \times 8000}{\text{ml of sample}} \dots\dots\dots (2.6)$$

The general equation for the determination of a BOD value is

$$BOD (mg/l) = D_1 - D_5 \dots\dots\dots(2.7)$$

Where D₁ is the initial DO of the sample, D₅ is the final DO of the sample after 5 days.

The BOD was not diluted because the concentrations were not high.

The Equipment and materials used were

Refrigerator (L.G, Model GL 2250M), Sample bottle, Measuring cylinder, Conical flask, Pipette pump, Stopper
Reagents: MnSO₄, sodium thiosulphate, MnSO₄,alkali-iodide-azide, H₂SO₄, starch solution

2.4.14Determination of Chemical Oxygen Demand

- 1ml of the sample was measured into a 250 beaker.
- 2.5ml of 5% K₂CrO₄ digestion reagent was slowly added and mixed.
- 3.5 ml of concentrated sulphuric acid reagent was added into the tube, making sure it reached the bottom.
- This was capped and the content mixed together.
- Then it was transferred into a water bath and heated at50 degree.
- A blank test was also conducted.
- Distilled water was added to make up the volume to 50 ml.
- 2 drops of phenolphthronlein indicator was added.
- It was then titrated with 0.05M of Ferrous ammonium sulphate solution (Morh salt).

$$\text{Calculation= COD as mg/l= } \frac{A - B \times 8000}{\text{ml of sample}} \dots\dots\dots 3.8$$

Where

A= Titre of blank

B= Titre of sample

M= Molarity of FAS (0.05m)

The Equipment and materials used were

Electric hot plate (Gallenkamp 125567 Amp, England), Water bath, Beaker, Burette, Measuring cylinder, Conical flask (pirex), Pipette, Pipette pump (pirex),

Reagents:

K_2CrO_4 (5%), Ferrous ammonium sulphate (0.05M), Sulphuric acid (concentrated), Phenolphthronlein (indicator),

2.4.15 Determination of heavy metals

Heavy metal analysis was conducted using Atomic Absorption Spectrometer according to the method of APHA 1995 (American Public Health Association).

Working principle:

Atomic Absorption Spectrometer's working principle is based on the sample being aspirated into the flame and atomized when the AAS light beam is directed through the flame into the monochromator and onto the detector that measures the amount of light absorbed by the atomized element in the flame. Since metals have their own characteristics absorption wavelength, a source lamp composed of that element is used making the method relatively free from spectral or radiational interferences. The amount of energy of the characteristic wavelength absorbed in the flame is proportional to the concentration of the element in the sample.

Earlier before now, the metals were digested using concentrated nitric acid.

The Equipment and materials used were

Electric hot plate (Gallenkamp 125567 Amp, England), Whatman filter paper, Reagent bottle, Volumetric flask (pirex), Pipette, Pipette pump (pirex), Atomic Absorption Spectrometer, AAS (240 FS AA Agilent, USA)

Reagents:

Nitric acid (concentrated)

2.5 Soil Sampling

The soil samples were collected at three stations of **300m, 600m and 900m**. At each station, four 4 points of **0m, 5m, 10m and 15m** were chosen for collection starting from the center **0m** of the stream. Samples collected were stored in clean, well labelled polypropylene bag for proper identification as shown in **plate 2.2**, and transported to the Springboard laboratory for analyses. The samples of soils which are very much affected by effluent and those soils which have little or no effect of industrial effluent were collected and analyzed. The samples were categorized into four classes. The first samples, (3 in number) comprised those samples from the center of the stream, which are continuously receiving industrial effluent and solid waste contaminants. The second are those soil samples (3 samples) which are 5m from the centre of the stream. The third are those samples (3 samples) at a distance of 10m from the center of the stream which are not immediately affected by the industrial effluent discharges but are still in the nearby area and the forth are those samples (3 samples) at a distance of 15m from the center of the stream.



Plate 2.2 Soil samples

2.5.1 Soil analyses

A total of 49 soil samples were taken to the soil laboratory for soil parameter analysis. Several analyses were performed in order to study the parameters that evaluate soil quality. Each soil sample was analysed for pH, Manganese, Magnesium, Phosphate, Calcium, Potassium, and Zinc. The soil acid digests were prepared for the determination of total content of soil nutrients and heavy metals.

2.5.2 Soil Digestion /Dry preparation of Sample for Minerals

2g of the soil sample was collected, heated in a furnace for 2 hrs at 550°C. After that, it was collected and put into beaker, diluted with 20ml of 20% H₂SO₄, and filtered with filter paper. This is again boiled for 10 minutes, filtered. The volume is then made up to 50mls. The sample filtrates were analysed for the heavy metals Nutrient concentrations of Calcium (Ca), Magnesium (Mg), and Potassium (K) and heavy metal concentrations of Zinc in the soil acid digests were measured using atomic absorption spectrophotometer AAS.,

III RESULTS AND DISCUSSION

3.1 Results

Table 3.1 Mean concentration of Ukwaka stream on different points for the period (July to December 2017)

Parameters	Units	Stream Sampling Points				WHO 1993	Comment
		0m, site A	300m, site B	600m site C	900m site D		
pH	-	6.77	6.77	6.83	6.97	6.5- 85.	Within limit
Temp	°C	31.80	32.00	32.00	31.70	40	ok
EC	µS/cm	163.80	169.67	197.0	140.30	250	ok
TDS	mg/l	15.07	16.41	16.82	12.28	5	Not ok
TS	mg/l	21.70	20.34	18.82	16.81	500	ok
Turbidity	ntu	338.54	251.54	243.88	180.00	5	Not ok
COD	mg/l	311.27	293.13	342.45	264.89	NG	No guideline
BOD	mg/l	20.55	17.94	15.80	12.67	NG	No guideline
DO	mg/l	43.04	50.61	56.96	63.93	NG	No guideline
Alkalinity	mg/l	25.19	24.97	26.40	33.87	100	ok
Phosphate	mg/l	6.19	6.13	6.85	7.25	NG	No guideline
Chloride	mg/l	122.93	123.71	164.82	137.38	250	ok
Sulphate	mg/l	204.06	219.13	239.17	211.66	500	ok
Cadmium	ppm	0.103	0.050	0.038	0.040	0.003	Not accepted
Zinc	ppm	0.456	0.402	1.422	0.484	3.0	ok
Copper	ppm	0.084	0.048	0.043	0.045	2.0	ok
Iron	ppm	6.420	4.832	2.074	1.466	0.3	Not accepted
Lead	ppm	0.299	0.231	0.260	0.310	0.01	Not accepted

Footnote:NG : No Guideline

3.2 Discussion

pH

The World Health Organisation (WHO 2010) recommends a pH value of 6.5 or higher for drinking water to prevent corrosion. The study revealed that the pH values of the stream appeared to be slightly acidic as it had values that ranged from 6.77- 6.97 though within the permissible limit of WHO standard of 6.5-8.5 for drinking water..

The temperature

The results of the physical water quality characteristics of water samples from Ukwaka stream are shown in **Tables 3.1**The result shows variations in the physical properties of the water from the point of effluent discharge into the stream (0m), to downstream waters (900m). The mean temperature for July to December ranged from 31.7 to 32.0°C. From this, it was observed that all the water samples conformed well to the permitted temperature range for surface water [40].. This suggests that the temperature is good for consumption for consumers who prefer cool to warm water, since high temperature negatively impact water quality by enhancing the growth of microorganisms which may increase taste and corrosion problems [41].. High Temperature affects biological, chemical and physical activities in the water [42].. This was supported by[43] who opined that temperature of stream water is reported to be an important index as it governs the biological species in the water and their activities to a large extent.

Total Solids

The mean total solids in the stream water at point of the discharge of the industrial effluent site A (0m) and other sites B (300m), C (600m), and D (900m) were 21.70, 20.34, 18.82, 16.81, respectively, It was

observed that the total solids in the stream water was below the 500 mg/L permitted by regulatory bodies. The reduction in the solids downstream could be attributed to self-purification of the stream. [44]. observed similar reduction and attributed it to physiochemical reactions such as sedimentation, coagulation, fixation as well as possible oxidation and precipitation. Similarly, both the total dissolved solids (TDS) and suspended solids (SS) varied in line with the total solids as described above

Turbidity

Turbidity in water is caused by the presence of suspended matters such as clay, silts, finely divided organic and inorganic matters, plankton and other microscopic organisms. The turbidity of water samples showed variation between the sampling points. The water samples at the effluent receiving point (site A) and the downstream water beyond the point have turbidity values well beyond the recommended level for surface water (5 NTU) as set by the World Health Organization [40]. From Tables 4.1 to 4.6, the turbidity value was increasing as the TDS value increased. These observations agreed with the submission of [45]. that the high turbidity of water could be linked to the presence of dissolved solids in the effluents released into the water. Surface water is open to receiving soil washout from slopes into the water sometimes including animal and human faeces, carcass of dead wild animals etc., and high turbidity is not desirable in surface water as it leads to restriction in light penetration processes such as flocculation and filtration which increases cost of purification. [46] reported that high turbidity is associated with microbial contamination as high turbidity makes it difficult to disinfect water properly.. [47] observed that highly turbid water is disqualified as source of water for domestic use in the community..

Alkalinity

The alkalinity level of the upstream was in the range of 24.97 to 33.87 mg/l. The effluent polluted water at the entry point (0m) recorded 025.19, the other points of 300m, 600m and 900m recorded 24.97, 26.40, and 33.87 mg/l respectively. The alkalinity value rose with the distance except at point 300m that dropped a little. This might be caused by the influx of flood from the upland into the stream just immediately after point 0m

Phosphates

Phosphates in the water samples varied significantly. The phosphate levels varied along the sampling points and time. In the upstream, (site A, point 0m), the value obtained for phosphate was 6.19 mg/l while on the other hand, values recorded at points 300m, 600m and 900m were, 6.13 mg/l, 6.85mg/l and 7.25mg/l respectively. This result showed that the value of the phosphates increased much at point 600m in the water following pollution by the solid waste dump. The range of the values obtained in this study agrees with the high to moderate levels of phosphates in southern Nigeria Rivers [48]. Although phosphates are not toxic and do not represent a direct threat to animals and other organisms, they do represent a serious indirect threat to water quality [49].

Chloride and Sulphate

Table 3.1 shows the recorded values of the Chloride and Sulphate in the stream for the given period. The chloride values ranged from 122.93mg/l to 164.83mg/l. while the sulphate value ranged from 204.06 mg/l to 239.17 mg/l. in both of them, site C recorded the highest value of 164.82mg/l and 239.17mg/l respectively. This was contributed by the solid wastes dumped into the stream just before site C. Though chloride was high but it is within the stipulated WHO limit of 250 mg/l. Presence of chloride ion in Ukwaka stream agrees with the report of [50]. that chloride is commonly found in streams and freshwater. Figs..3.1 and 3.2 respectively show the trends of Chloride and Sulphate along the stream

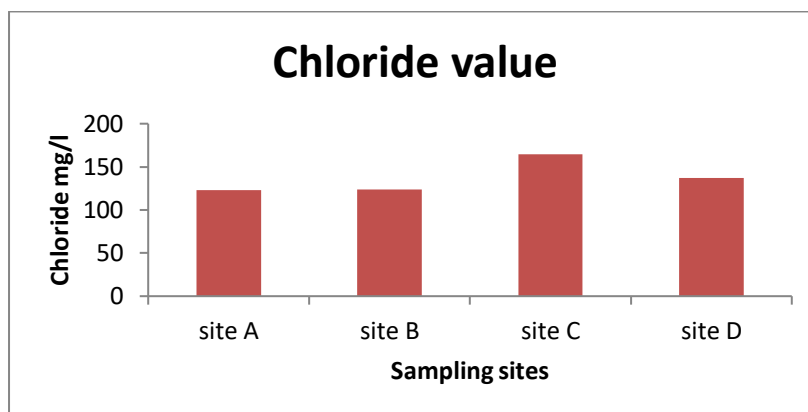


Fig. 3.1 Trend of Chloride Value Along The Ukwaka Stream

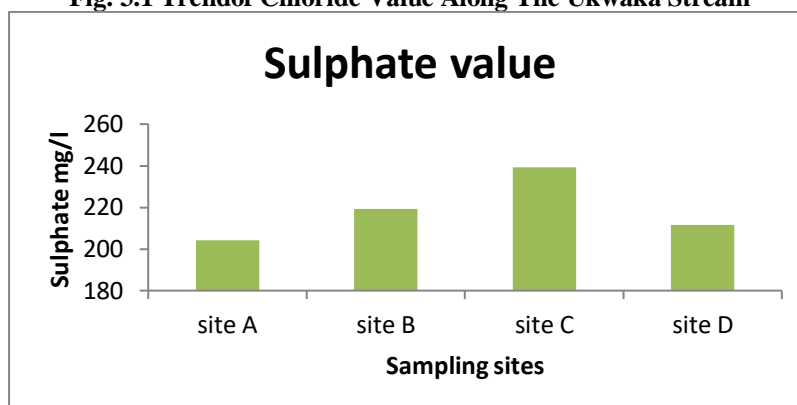


Fig. 3.2 Trend of Sulphate value along the Ukwaka stream

Dissolved Oxygen

Dissolved Oxygen (DO) of the stream had values of 43.04, 50.61, 56.96 and 63.93 mg/l respectively for sites A, B, C and D. There was no guideline from the WHO, 1993. However, the DO levels of the stream water samples were higher than the acceptable limits for aquatic life (6.8 mg/l) and for recreational water quality (7.5 mg/l) in accordance with the Nigerian government regulatory body (FEMA), [51]. In general, DO levels less than 5 mg/l are stressful to most aquatic organisms. Dissolved oxygen is an important indicator of water quality and its productivity. The low Dissolved oxygen (DO) recorded in all the sites in October to December could be traced to the low level of water during the dry season with little self-purification of the pollutants. The continuous introduction of effluents into the water might likely support the growth of aquatic weeds and formation of flocs on the surface of the water, hence a reduction in the dissolution of oxygen into water. [52], however opined that the depletion of dissolved oxygen in a water body could be attributed to increase in plant and algal growth on the surface of water as a result of common practice of dumping of wastes

Biochemical Oxygen Demand

BOD is a chemical procedure for determining the amount of dissolved oxygen needed by aerobic biological organisms in a body of water to break down organic material present in a given sample at certain temperature over a specific time period. Biological Oxygen Demand (BOD) test is useful in determining the relative waste loading and higher degree therefore indicates the presence of large amount of organic pollutant and relatively higher level of microbial activities with consequent depletion of oxygen content. Generally speaking, there were significantly different variations in the biochemical and biological quantity of the ukwaka stream water. It was observed that the industrial effluent impacted negatively on the biochemical and biological quality of the stream water. This negative impact was attributed to the poor quality of the effluent discharged into the river. The BOD values of the different sampling points were recorded from -2.44-0.86 ppm. The study revealed (Table 4.7) that the water upstream, site A had a higher value of BOD (20.55 mg/l). The least value was recorded at site D (12.67 mg/l). This may be due to the nearness of site A, upstream to the industrial disposal point. It was reported that natural water with the BOD values of 4 mg/l is considered to be slightly polluted with organic matter, but safe for drinking. Stream keeper's field guide [51], reported that unpolluted

natural waters should have a BOD of 5 mg/L or less. From the result of the table the BOD values were more than 5 mg/l. The BOD values ranged from 12.67 to 20.55 mg/l .

Chemical Oxygen Demand (COD)

COD is a measure of the capacity of water to consume oxygen during the decomposition of organic matter and the oxidation of inorganic chemical such as ammonia and nitrite. The COD varied significantly along sampling sites, and ranged from 264.89mg/l to 311.27 mg/l. Figure 4.3 shows the trend of the COD along the stream. COD values conveyed the amount of dissolve oxidizable organic matter including non-biodegradable matter present in it. The high COD values, of 264.89 to 342.45 mg/l in the sample recorded shows that the effluent had high organic load [53].

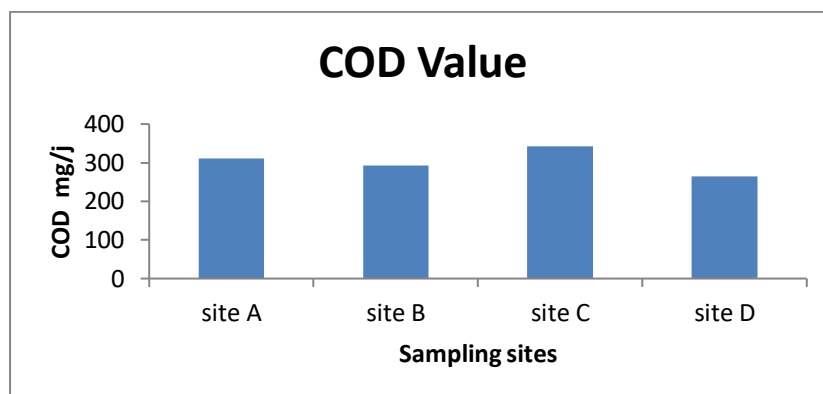


Fig. 3.3 Trend Of Cod Value Along The Ukwaka Stream

Generally it is observed that the following parameters: EC, TDS, Chloride, and sulphate, determined, were higher at point 600m (site C) than other points. This is due to the fact that site C got more effect of the solid waste dump. The EC and TDS of the downstream water were much higher than the upstream. The higher EC and TDS were found at the point C, which indicates the greater amount of salts in the water due to dumping of solid waste [54].The degree of relationship between EC and TDS of the water samples depicted that the value of TDS is increasing with the increasing of EC value. Heavy Metals (cadmium, zinc, copper, iron and lead)

Table 3.2 Heavy Metals of Ukwakafor the period July to December 2017

Parameters	Units	Sampling Points				Range
		0m	300m	600m	900m	
Cadmium	ppm	0.103	0.050	0.038	0.040	0.038-0.103
Zinc	ppm	0.456	0.402	1.422	0.484	0.402-1.422
Copper	ppm	0.084	0.048	0.043	0.045	0.043-0.084
Iron	ppm	6.420	4.832	2.074	1.466	1.466-6.420
Lead	ppm	0.299	0.231	0.260	0.310	0.231-0.310

Figure 3.4 below shows the trend of the Heavy Metals along the stream

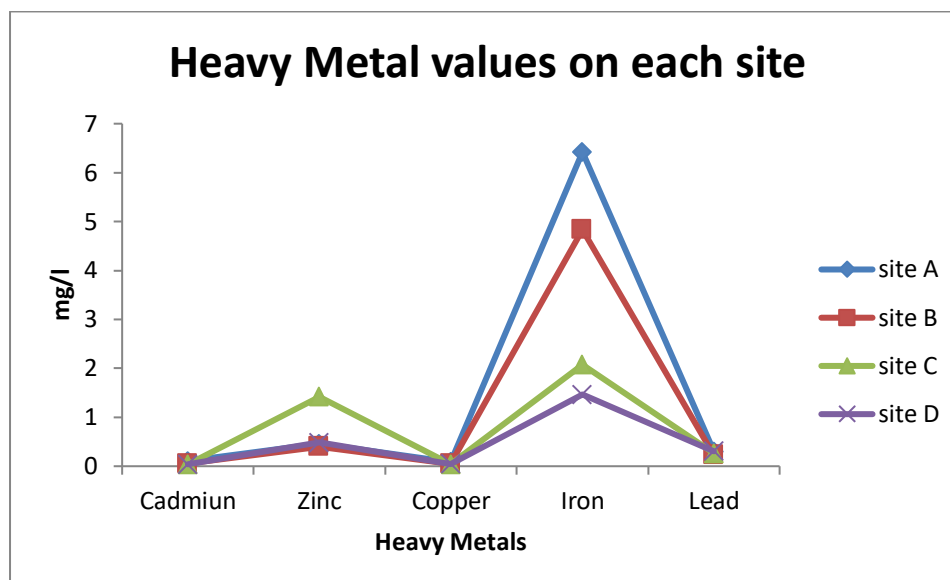


Fig. 3.4 Trend of Heavy Metals values along the Ukwaka stream

Heavy metals (lead, copper, cadmium etc) are among the major toxic pollutants in surface water. These have been found to be a problem in stream abutted by catchment with industries dealing with tanning, renovation petroleum and oil. Heavy metals are very toxic; when consumed causes many effect to health. Some of the metals are cacogenic which affect the cell. Table 3.2 shows the concentration of the heavy metals in the samples

Cadmium

Cadmium has highly toxic effect in all chemical form [55]. It detected at all the sites. The minimal detected value was 0.038ppm at site C. the highest was at site A (0.103ppm). The WHO set a maximum contaminant level goal for cadmium at 0.003 parts per million. At all the sites the value exceeds the set standard.

Zinc

Zinc concentration greater than 15ppm is undesirable. Zinc is not considered detrimental to health, but it will impact undesirable taste to drinking water. In the analysis, the values of zinc ranged from 0.402ppm to 1.422ppm with site C having the highest value of 1.422ppm. This high value was caused by the scrapped metal dumped before site C. The WHO set a maximum contaminant level goal for zinc at 5.00 parts per million. However, none of the values gotten at the sites exceeded the WHO standards,

Copper

Copper is not present in significant quantity in natural water. The presence of copper is therefore an indication of pollution. The value of copper in the result ranged from 0.043 to 0.084ppm which shows that it was below the maximum permissible limit of 2.00 stipulated by the WHO.

Iron

Iron has the highest record of 6.420ppm at site A. this might be perhaps due to some rust in the pipe that conveyed the effluent from the industry. The least value was recorded at site D (1.466ppm). The recorded values exceeded the limit of 0.3 set by the WHO. The high level of iron in the samples could be attributed to rust in the pipe.

Lead

The presence of lead in water causes lead poisoning because of its tendency to accumulate in the body. Lead is a toxic element that accumulates in the skeletal structures. The recorded values of lead (0.231 -0.310), were generally above the limit of 0.01 set by the WHO. The highest value of 0.310ppm recorded at site D could be ascribed to lead originating from the use of leaded fuel released by the smoke into the stream since site D is by the heavy traffic road.

From the results obtained, it can be observed that the level of zinc and iron in the samples were high when compared to the level of other metals in the samples

3.3 Results of the Chicason effluent for the period

Parameter	Unit	July	August	Sept.	October	Nov.	Dec	FEPA
pH	-	6.12	6.00	6.80	6.80	6.45	6.85	6.0-9.0
Temp	^o C	30.8	29.8	31.20	31.20	34.2	34.8	34-40
Colour		Greenish	Greenish	Greenish	Greenish	Greenish	Greenish	
Odour		Foul	Foul	Foul	Foul	Foul	Foul	
EC	μ S/cm	142	139.9	203	203	220.00	330	400
TDS	mg/l	31.0	27.80	8.16	8.16	19.32	9.24	2000
TSS	mg/l	18.0	10	2.16	2.16	8.80	2.22	50
TS	mg/l	49.0	37.80	10.32	10.32	45.12	14.46	500
Turbidity	Ntu	60.25	50	150.80	150.80	250	200	1.0
COD	mg/l	192	224	269.33	269.33	328.00	208.00	50
BOD	mg/l	17..20	7.00	14.40	14.40	20.40	18.20	50
DO	mg/l	72.80	44	64.00	64.00	76.80	56.60	7.5
Alkalinity	mg/l	5.0	48	18	18	26.14	34	10
Phosphate	mg/l	1.509	1.109	8.155	8.155	9.053	10.44	5.0
Chloride	mg/l	46.00	96	152	152	92.00	264	250
Salinity	ppt	0.083	0.173	0.274	0.274	0.173	0.477	
Sulphate	mg/l	222.21	178.18	204.9	204.9	99.583	130.86	500
Cadmium	ppm	.009	0.066	0.000	0.000	0.014	0.032	0.01
Zinc	ppm	0.220	0.406	1.359	1.359	0.220	0.273	0.5
Copper	ppm	0.000	0.000	0.007	0.007	0.112	0.000	1.0
Iron	ppm	1.371	0.530	9.914	9.914	0.456	1.050	10
Lead	ppm	0.226	0.324	0.562	0.562	0.134	0.126	0.01

Table 3.3 Comparison of the Chicason effluent for July to Dec. 2017 with FEPA

IV RESULTS AND DISCUSSION

The results of the effluent laboratory analysis, and comparative assessment of effluent quality are presented in Table 3.3. The variations in the physical characteristics of the effluent at the different sampling times could be attributed to the fact that the effluent discharges represented wastes from different batches of production.

pH.

From Table 3.3 above, the pH values in the range of 6.00 -6.85 were within the 6.0-9.0 the permissible limits of FEMA standard for the effluents. However the study revealed that the pH values of the stream appeared to be slightly acidic. According to [56], the pH of all the effluents should be greater than 8.5. The reduction in pH level of the stream is probably due to the organic waste that is discharged into it. The pH can be decreased by the carbon dioxide released by the bacteria breaking down the organic wastes [56]. It can also be due to the fact that the areas where this occurred are used as a urinal. The urine contains uric acid that can increase the acidity of water [57]. Carbon dioxide dissolves in water to form carbonic acid. Although this is weak acid, large amounts of it will lower the pH and when waters with low pH values come into contact with certain chemicals and metals, this often makes them more poisonous than normal.

Temperature:

With reference to Table 4.9 the temperature ranged between 29.8 -34.8^oC, while FEPA specified a limit of 40^oC for effluent for discharge into our environment. It is therefore, significant to note, that the temperature was within permissible limit throughout the period. Thus, the effluent cannot be associated with thermal pollution [58].

EC

The highest value of EC was recorded in the month of December (330 μ S/cm). There was a significant variation in the EC values among the sampling points. An EC value ranged from 139 μ S/cm to 330.00 μ S/cm for the stream and was generally low in all the points when compared to FEPA permissible limit. The low EC along the stream can be attributed to the dilution effect and other natural processes along the stream. Similar result was observed by [59].

TDS

Total Dissolved Solids(TDS) range of 8.16 – 31.00 mg/L was within FEPA limit of 2000 mg/L. Thus, the effluent TDS conformed to FEPA standard throughout the experimental period. Since the TDS and EC are indices for salinity hazard in water (Schwab et al, 1993). The EC values confirmed the low level of TDS in the river water..

The total solids content of the industrial effluent was 31.0 mg/l in July, 27.8 mg/l in August, 8.18 mg/l in September, 8.16 mg/l in October 19.32 mg/l in November and 9.24 mg/l in December. Similarly, the suspended solids were 18, 10, 2.16, 2.16, 8.80, and 2.22.mg/l in July, August, September, October, November and December respectively. These results show that there were variations in physical characteristics of the effluents at the different times of sampling (July, August, September, October and November, December). The total solid (TS) content was in the range of 10.32 mg/L to 49 mg/l, and conformed to regulations since it did not exceeded the 2000 mg/L acceptable limit for effluent discharged into the stream. High solid content of effluent discharge into surface water is undesirable as it may contain organic and inorganic solids which reduce light penetration hence reducing the ability of microorganisms in the recipient water body (algae) to photosynthesize.

TS

Total solids in the stream water at point of the discharge of the industrial effluent were 49.0,37.8, 10.32, 10.32, 45.10 and 14.46 mg/l in the months of July, August, September, October, November and December, respectively. It was observed that the total solids in the stream water were below the 500 mg/l permitted by regulatory bodies. There were reductions of TS in the months of October to December. The reduction in the solids downstream could be attributed to self-purification of the stream. [44].observed similar reduction and attributed it to physiochemical reactions such as sedimentation, coagulation, fixation as well as possible oxidation and precipitation.

Turbidity

The turbidity was high (50- 250 NTU). The solid content of the effluents could have manifested in high level of turbidity This could be indicative of need to dilute the effluents further before discharge into the Ukwaka stream

Chloride and Sulphate

Table 4.9showed the recorded values of the Chloride and Sulphate in the effluent for the given period. The chloride values ranged from 46 mg/l to 264 mg/l. while the sulphate value ranged from 99.58 mg/l to 222.21 mg/l. Chloride recorded the highest value of 264mg/l in December; and this was above the FEPA limit of 250 mg/l. the values recorded for sulphate were all below the FEPA limit of 500 mg/l.

Phosphate

The range of the values obtained in this study agrees with the high to moderate levels of PO_4^{3-} in southern Nigeria Rivers [48].though phosphates are not toxic and do not represent a direct threat to animals and other organisms; they do represent a serious indirect threat to water quality [49].

BOD and DO

The effluent BOD values ranged from 7.00 - 20.40 mg/l. (Table 4.9). When compared with the FEPA set limit of 50 mg/L, the following inferences can be made: none of the BOD values exceeded FEPA limit. From the result of the tables, the BOD values were less than the standards. It was reported that natural water with the BOD values of 4 mg/L is considered to be slightly polluted with organic matter, but safe for drinking. Stream keeper's field guide [51].reported that unpolluted natural waters should have a BOD of 5 mg/L or less. Raw sewage may cause increase in BOD values up to 150 to 300 mg/L. Biological Oxygen Demand (BOD) test is useful in determining the relative waste loading and higher degree therefore indicates the presence of large amount of organic pollutant and relatively higher level of microbial activities with consequent depletion of oxygen content. Also from table 4.9, the DO concentration of the effluent ranged from 44.00 –76.80 mg/. The values for DO are higher than FEPA saturation value which is 7.5 mg/l.

COD

COD values conveyed the amount of dissolve oxidizable organic matter including non-biodegradable matter present in it. The high COD value in the sample effluent recorded determines that the effluent had high organic load [53].The values of the COD were higher than the FEPA set limit of 50mg/l. the high level of COD

recorded across the stream course could therefore suggest that there were direct influence of effluent discharge to the stream

Table 3.4 The Soil Quality mean of the five categorized classes

Parameter	Unit	0m	5m	10m	15m	30m
pH		6.87	6.90	7.17	7.22	7.06
Phosphate	mg/kg	5.62	6.80	5.71	5.25	2.25
Magnesium	ppm	16.35	15.66	16.79	16.84	18.53
Zinc	ppm	4.48	7.23	7.89	8.64	13.46
Manganese	ppm	0.65	1.15	2.10	2.98	5.97
Calcium	ppm	6.41	8.25	8.42	8.46	11.43
Potassium	ppm	4.94	5.00	5.16	5.76	7.01

The soil samples were categorized into five classes. The first sample is the mean of those samples from the center of the stream **0 meter**, which are continuously receiving industrial effluent and solid waste contaminants. The second those soil samples which are **5 meters** from the centre of the stream. The third are those samples at a distance of **10 meters** from the center of the stream which are not supposedly immediately affected by the industrial effluent discharges but are still in the nearby area and the fourth are those samples at a distance of **15 meters** from the center of the stream. While the last class (reference samples) are those soils at a distance of about **30 meters** from the center of the stream at the different stations. These soils are not receiving industrial effluent discharges.

Based on the data, it is observed that the farther the point, the more the pH is. However, the pH of the reference sample is about the mean of all. Perhaps this may be based on the season (September) of collection. At the center of the stream, the mean value of the phosphate was 5.62 mg/kg. It increased at point 5m to 6.80mg/kg and started decreasing as the point increased. Magnesium has a high value at the centre of the stream, but dropped at point 5m. After this point, values started increasing. The changes in the values of zinc, manganese, calcium and potassium follow the same pattern. They increased as the distance from the center of the stream increased. This showed that the further the distance, the more the accumulation of the metals.

V CONCLUSION AND RECOMMENDATION

5.1 Conclusion

From the results of the study, effluent and water samples were above the permissible criteria by different regulatory bodies as it affects its physicochemical and biological quality. The poor quality of the Chicason industrial effluent was seen as an indication of non-treatment or improper treatment of the effluents prior to its discharge into the Ukwaka stream. Secondly, there were variations in the constituents of the effluents at the different test times (July, August, September, October, November, and December) and these variations were attributed to possible differences in the batches of production at the different test time. The discharge of effluents into the stream caused changes in the quality of the stream water. It was also observed that the water quality characteristics, varied with sampling points (site A 0m; site B 300m; site C 600m; and site D 900m) and with sampling time (July August, September, October and November and December).

It would be stated that the results of the analyses indicate that the discharge of industrial wastes and waste dump into the Ukwaka stream has contributed to the large scale pollution. Results showed that Chicason industrial effluents is an acidic complex aqueous media composed of widely-distributed organic and inorganic materials dissolved as well as suspended in water. It contains some hazardous substances e.g. lead, cadmium and iron. The organic contaminants leading to high BOD and COD values are possibly due to soluble and stable emulsified organic matter, which the physicochemical treatment system, if any, does not remove from the effluents. The study also showed that effluent from Chicason group of industries that produces vegetable oil, animal feeds, variety of soap, plastic pipes contains some hazardous substances e.g. lead, cadmium and iron. Their concentrations exceeds the permissible limit of national and international standards, hence, the effluent should be well treated and the concentration of some or all of the hazardous substance should be reduced before the effluent are discharged into the environment so as to circumvent their adverse effect on aquatic life and man. Their concentrations exceeds the permissible limit of national and international standards, hence, the effluent should be well treated and the concentration of some or all of the hazardous substance should be reduced before the effluent are discharged into the environment so as to circumvent their adverse effect on aquatic life and man. The continued discharge of the effluents may result in severe accumulation of the contaminants. This can constitute dense growth of microbial population due to the changes in physical status and presence of anions and cations in the receiving water bodies which hampers the quality of water and also affects the aquatic life form; affect the lives of human as well as animals around this river. This study deduced

that volume of effluent discharged into the Ukwaka stream was already overtaxing their capacity for self-purification. The discharge of effluent by industries can constitute dense growth of microbial population due to the changes in physical status and presence of anions and cations in the receiving water bodies which hampers the quality of water and also affects the aquatic life form.

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