Original Research Article

THE EFFECT OF INDUSTRIAL WASTE EFFLUENT ON WATERQUALITY

(A CASE STUDY OF OTAMIRI RIVER, OWERRI, IMO STATE)

Abstract: The study assessed the impact of effluent discharges on the quality of Otamiri River in Imo state, Nigeria. Six water samples were collected at discharge points where the industries discharge their effluents and abattoir. Standard methods were adopted for field and laboratory analysis of samples collected upstream and downstream. The source of pollution is attributable to industrial and abattoir activities whose effluent discharges impact the quality of Otamiri River. The River can therefore not be used in its present form for any domestic purpose without treatments. Periodic monitoring of the river and introduction of cost-effective methods of production technologies, such as, on site waste separation and reduction; and effluent recycling methods are recommended.

Key Words: River, Water Quality, Effluent Discharge, Treatment

1 INTRODUCTION

For humans to survive, as well as for animals and plants, water is a vital essential. It is wished for consumption as well as for an increase in agricultural output, which supports life on earth. In addition, water is used for a multitude of reasons, such as recreation, navigation, and the production of hydropower. If water is properly used, it can be a great benefit and cost to humanity. If it is not properly regulated, it could turn out to be a curse and the source of human suffering and disaster. A. Abdulrzak (2004)

Life is dependent on water. Water is necessary for maintaining both human and animal life. of other amazing living things. In underdeveloped nations in general, it can be exceedingly difficult to have access to potable water. Only a third of the earth's water—found in lakes, rivers, and groundwater—is available for human use. But because of the reality of population expansion and industrialization, the demand for these constrained brilliant waters is increasing. Depending on physical activity, age, health conditions, and environmental factors, different amounts of water are required. In both cases, evaluations that seem to be for unstable contaminants are used to assess the water's safety. People lack access to enough clean water in many locations in Africa and the rest of the world. They should have full access to water sources that are contaminated with infections, poisons, health problem vectors, or suspended particles.

People may also no longer place a great deal of thought into the quality of their water supply in wealthy nations. Residents of many first-world countries may turn on a faucet to get fresh, drinkable water that may also be supplemented with health-promoting ingredients. However, a significant portion of the population in emerging nations, particularly frequently in Africa, no longer has access to a water body that is tightly closed (Ukpong) (2006). Water's physical, chemical, and biological characteristics are referred to as "water splendid." An extreme top environmental component that has an impact on health is the quality of drinking water. Water that is no longer safe to drink might become more contaminated with heavy metals and other diseases. Drinkers of this water risk developing terrible health and passing away. Unfortunately, even in places where the water is reportedly no longer safe, individuals would still recklessly drink it out of desperation. Specific sanitary issues, such as open sewers and insufficient trash collection, may coexist with a lack of access to drinkable water. The despicable is the character that is most impacted by many of these public health problems.

It is vital for people to have access to readily transportable water in order to survive and maintain their health and wellbeing. However, many people who reside in high-density, low-income communities continue to be without access to the basic options (Marian, E. (ed) (1991). The United Nations (UN) interagency institution for freshwater and sanitation issues, UN-Water, estimates that 748 million men, women, and young adults lack access to an adequate supply of drinking water in its Global Analysis and Assessment of Sanitation and Drinking Water (GLAAS, 2014) study. According to a study by Maloma, Okufarasin, Olorunniwo, and Omode (A.A.), 81,000 people in Nigeria, a country with a reported population of around 177 million, died of diarrhea as a result of poor water quality, sanitation, and hygiene (1990). Effluent have an impact on water great is a aspect of pinnacle notch concern. This is because, it has been placed that the remarkable of water human beings use has a pinnacle notch have an effect on their health. If great care is no longer taken to affirm the characteristics or composition of the discharged effluent, then environment is uncovered to a differ of hazards. One may additionally moreover ask what an effluent truly is. An effluent is described as an industrial liquid waste. It is characterized through feasible of the elements used in such industries. This implies that the composition or points of effluent varies from enterprise to industry.

Subsurface liquid

Ground water is defined as water that percolates through the ground and drains into bodies of water including rivers, lakes, ponds, and impoundments. Surface water must be treated before use because it is susceptible to pollution by natural and inorganic pollutants, gases, and microbes. It is possible to step up efforts to monitor what is happening internally in the areas around the flooring water. The most essential freshwater resources for man are rivers. Unfortunately, runoff from numerous human activities, industrial waste, and sewage disposal results in river waters becoming contaminated, This influences its physical, chemical, and biological diversity (AIRBDA, 2014).

Fluvial Otamiri

The Otamiri, a significant river in Imo State, flows through Owerri Municipal City. The river begins at Egbu and travels through Owerri town, Nekede, Ihiagwa, Eziobodo, Olokwu, Umuisi, Mgbirichi, and Umuagwo in Rivers State before reaching the Atlantic Ocean. The Otamiri River spans around 105 kilometers (Nwachukwu, 1989). From its source to where it converges with the Uramiriukwa River near Emeabiam, the Otamiri River is 30 kilometers long.

2. REVIEW OF RELATED LITERATURE

Water (chemical formula H2O) is an inorganic, transparent, tasteless, odorless, and nearly colorless liquid or chemical substance, which is the main constituent of Earth's hydrosphere and the fluids of all known living organisms (in which it acts as a solvent. It is vital for all known forms of life, even though it provides neither food, energy, nor organic micronutrients. Its chemical formula, H2O, indicates that each of its molecules contains one oxygen and two hydrogen atoms, connected by covalent bonds. The hydrogen atoms are attached to the oxygen atom at an angle of 104.45°."Water" is the name of the liquid state of H2O at standard conditions for temperature and pressure. Water quality is a term used to describe the chemical, physical and biological characteristics of water, usually in respect to its suitability for a particular purpose. Scientific measurements are used to define water quality; it is the quality of natural water suitable for aquatic plants and animals. Water quality is closely linked to water use and to the state of economic development.

Wastewater is water generated after the use of freshwater, raw water, drinking water or saline water in a variety of deliberate applications or processes. Another definition of wastewater is "Used water from any combination of domestic, industrial, commercial or agricultural activities, surface runoff / storm water, and any sewer inflow or sewer infiltration". In everyday usage, wastewater is commonly a synonym for sewage (also called sewerage, domestic wastewater, or municipal wastewater), which is wastewater that is produced by a community of people. Wastewater treatment is the process of converting wastewater – water that is no longer needed or is no longer suitable for use – into bilge water that can be discharged back into environment. It may be formed by a number of activities including bathing, washing, using the toilet, and rainwater runoff. Wastewater treatment is a process used to remove contaminants from wastewater and convert it into an effluent that can be returned to the water cycle. Once returned to the water cycle, the effluent creates an acceptable impact on the environment or is reused for various purposes (called water reclamation).

The treatment process takes place in a wastewater treatment plant. There are several kinds of wastewater which are treated at the appropriate type of wastewater treatment plant. For domestic wastewater (also called municipal wastewater or sewage), the treatment plant is called a sewage treatment plant. For industrial wastewater, treatment either takes place in a separate industrial wastewater treatment plant, or in a sewage treatment plant (usually after some form of pre-treatment). Further types of wastewater treatment plants include agricultural wastewater treatment plants and leachate treatment plants.

Wastewater treatment plants may be distinguished by the type of wastewater to be treated. There are numerous processes that can be used to treat wastewater depending on the type and extent of contamination. The treatment steps include physical, chemical and biological treatment processes.

Types of wastewater treatment plants include:

- Sewage treatment plants
- Industrial wastewater treatment plants
- Agricultural wastewater treatment plants
- Leachate treatment plants

Industrial waste management treatment plant describes the processes used for treating wastewater that is produced by industries as an undesirable by-product. After treatment, the treated industrial wastewater (or effluent) may be reused or released to a sanitary sewer or to a surface water in the environment. Some industrial facilities generate wastewater that can be treated in sewage treatment plants.

Most industrial processes, such as petroleum refineries, chemical and petrochemical plants have their own specialized facilities to treat their waste-waters so that the pollutant concentrations in the treated wastewater comply with the regulations regarding disposal of wastewater into sewers or into rivers, lakes or oceans. This applies to industries that generate wastewater with high concentrations of organic matter (e.g. oil and grease), toxic pollutants (e.g. heavy metals, volatile organic compounds) or nutrients such as ammonia. Some industries install a pre-treatment system to remove some pollutants (e.g., toxic compounds), and then discharge the partially treated wastewater to the municipal sewer system.

3. MATERIALS AND METHODS

3.1 Materials

The following materials were used for the study

i. Reagent bottles: Pieces of 50ml reagent bottles needful for the collection of samples and specimens

ii. Winkler's solutions A and B: They are needed for oxygen fixation.

iii. 1-liter plastic containers useful for the collection of samples meant for heavy metal analysis.

iv. Nitric Acid

v. Distilled water: 2ml distilled water required for the dilution of nitric acid. The diluted nitric acid is important for maintenance of the oxidation state of the elements and to prevent metals from adhering to the walls of the container

vi. Ice chest and refrigerator: These are required to preserve samples before analysis

vii. Spectrophotometer: Unicam919 model atomic absorption spectrophotometer was used for the determination of the quantity of the heavy metals in the samples

viii. Thermometer: Mercury- in- glass thermometer (0-100ºc) was used for the measurement of the temperature of the samples.

ix. pH meter: An HATCH pH meter was used for hydrogen-ion concentration (pH) determination.

x. Indicator: In determining the COD by titration, ferrous ammonia, sulphate and ferroin were used as indicators. River water samples for physiochemical, microbiological and heavy metal analysis were collected from four predetermined sampling stations along the course of the river .

3.2. Methods

3.2.1. Sample Collection

Samples for bacteriological and physiochemical analysis were collected in clean sterile one-liter plastic container.

Sample for dissolved oxygen (DO) and biochemical oxygen demand (BOD) were collected in 50ml reagent bottle; 1ml each of Winkler's solution A and B were added to samples in situ to fix the oxygen. For heavy metals analysis, samples were collected in clean sterile one - litre plastic container; 2 ml of distilled water-diluted Nitric acid was added to each sample, kept in ice chests and taken to the laboratory where they were further preserved in a refrigerator before analysis. This was to ensure stability of samples, maintenance of the oxidation state of the elements and to prevent the metals from adhering to the walls of the container. The samples for DO, BOD, heavy metals and all the other parameters were taken in two replicates in both upstream and downstream of each point source. The procedure was repeated for each of the pollution determining parameters.

3.2.2 Sampling

The sampling points were designed in relation to industries as depicted by All samples for laboratory analysis were placed into thoroughly cleaned (cleaned with dilute nitric acid and rinsed with distilled water before use) one liter plastic bottles and tightly closed. Each bottle was rinsed with the appropriate amount of sample before final sample collection. These samples were placed in a cooler box and protected from direct sunlight and then taken to the laboratory for analysis.

3.2.3 Sample Analysis

Na+, K+, Cl,-1Ca2+, Pb2+, Cd2+ and Cu2+ were determined from the Uganda National Bureau of Standards (UNBS) Chemistry Laboratory while COD, BOD, turbidity, colour, TP, and TN were determined from National Water and Sewerage Corporation (NWSC) analytical laboratory. Samples were analysed according to Standard Methods for Examination of Water and Waste water (APHA, 1998) and the Association of Official Analytical Chemists (AOAC).

3.2.4 Laboratory Analysis

The Unicam 919 model atomic absorption spectrophotometer was used for the determination of the heavy metals including Cadmium (Cd), Copper (Cu) Iron (Fe) and Lead (Pb). The temperature was measured using calibrated mercury in glass thermometer (0-1000 C) to the nearest 0.050C. An HACH pH meter was used for hydrogen ion concentration (pH) determination. Dissolved oxygen (DO) and biochemical oxygen demand (BOD5) were determined by the Winkler's method. Phosphate and Nitrate were determined using calorimeter. Chemical oxygen demand (COD) was determined by titration method, using ferrous ammonia, sulphate and ferroin as indicator. The turbidity was measured on site using a micro processor turbidimeter .The bacteriological parameter monitored was fecal coliform according to the method of. Also, the isolation and identification of bacterial .

3.2.5 Physicochemical Analysis

A. pH

The pH of samples analysed at different sites ranged from 4.38 to 8.42 upstream and downstream respectively. pH was measured using a pH meter (mettle Toledo 320 model), The obtained results indicates that water samples at site 1, site 2, and site 5 are slightly alkaline whereas the samples at sites 3 and 4 are acidic in nature. The desirable range pH set by WHO is 6.5 to 8.5,

B. Turbidity

Turbidity levels were measured in nephelometric turbidity unity (NTU`s) using the HACH2100A turbidity meter. The maximum permissible limit of turbidity in surface water by WHO is any value than or equal to 29, turbidity at sites 1, 2 and 4 are within WHO standard limit for both upstream and downstream samples.

C. Total hardness

Results from the test showed that total hardness concentrations were highest (19.87-14.16) in effluents from the abattoir site and lowest (2.3-4.4mg/I) from Star-line industry location Hardness of water generally indicates the concentration of calcium and magnesium ions in the water and the high level of this may be attributed to the mixing of sewage effluents into the river water.

D. Total alkalinity

Total alkalinity values in the present study as recorded range from 4.89mg/I to 67.22mg/I. The maximum permissible limit of alkalinity according to WHO standards in surface water is 600mg/I. Water samples collected from the various sites had concentrations of alkalinity below the maximum limit set by WHO.

E. Chloride

This anion was determined by titration of the sample with silver nitrate. To 100ml sample was added potassium chromate and titrated with 0.1m silver nitrate solution to the first appearance of a buff colour. The values of waste and effluents from the chemical industries for chlorides in all the sites are within the concentrations of chloride in water and can impart undesirable limits. The higher content of chlorides taste, may cause corrosion in the distribution system and the upstream could be attributed to the heavy discharge sewage.

F. Sulphate

It is important to note that sulphate concentrations of water samples varied from concentration from abattoir samples. Sulphates are highest even 3.25mg/I which are all less than the standard through lower than WHO limit.

G. Nitrate

Nitrate concentration of water samples in the study ranged concentration greater than the permissible levels may indicate from 0.54mg/I to 55.22mg/I at both upstream and downstream pollution effects from feedlot runoff, sewage or fertilizers locations. It can be deduced that the upstream value at both results from studies show that consumption of waters with concentrations greater than 10mg/I, as nitrogen may be injurious to pregnant women, children, and the elderly.

H. Phosphate

The concentration of phosphate in water samples in the present study varied from 3.32mg/I to 12.97mg/I. The study clearly shows that content of all the water samples area well within the desirable limit (Table.1).

I. Total Dissolved Solids (TDS)

The desirable and maximum levels at TDS in the surface water prescribed by WHO are 500mg/I and 1000mg/I respectively. From the study, the water sample collected from the entire sites has an acceptable value because they ranged from 16.32mg/I to 56.14mg/I.

J. Total Suspended Solids (TSS)

In the study, the highest TSS value was obtained in water sample collected from site 3 with a value of 10.54mg/I at the upstream. However, all the TSS concentration are below the acceptable WHO concentration standard. However all the TSS concentration are below the acceptable WHO standards. High concentration of TSS in river water is an index that it is severely polluted.

K. Biochemical oxygen demand (BOD)

BOD values of water samples in the study varied from 1.89mg/I to 14.86mg/I. Four of the sites have concentration values higher than WHO acceptable standards. BOD values clearly indicate pollution and may be attributed to the percolation of waste water loaded with biodegradable compounds, which might be result of untreated sewage solid and industrial waste discharged from each site into the Otamiri River.

L. Chemical Oxygen Demand (COD)

All water samples analyzed showed that they are all below the WHO standard. The low levels of COD in water sample at different sites clearly indicate that the waste materials discharged into these water bodies are low oxygen demanding materials, which do not cause depletion of dissolved oxygen in water.

M. Electrical Conductivity (EC)

The values obtained from the study ranged from 20.01 to 69.10 /cm and the standard is any value less than or equal to 100/cm and the values obtained are less than 100 specified in WHO standard (WHO, 2007). Earlier studies show that there is a high positive correlation between electrical conductance and chloride concentration.

4. RESULTS AND DISCUSSION

This table presents result of the physiochemical texts on the samples collected upstream and downstream of the selected locations,

Table1: MEASURED PHYSIOCHEMICAL PARAMETERS AND WHO STANDARD (WHO, 2007)[8]

Parameters	Site 1		Site 2		Site 3		
	NBC (UPS)	NBC (DS)	PZ (UPS)	PZ (DS)	Abattoir (UPS)	Abattoir (DS)	WHO STD
pH(at 29c)	8.42	7.94	6.33	4.23	7.90	7.01	6.5-8.5
Total dissolved solids	37.64	32.40	27.22	19.32	22.44	18.32	500-1000
Total hardness	11.02	8.12	13.21	9.34	19.87	14.16	-
Sulphate	9.30	7.63	8.50	5.45	20.32	3.41	250
Electrical Conductivity	51.19	48.16	30.54	22.43	41.54	20.01	
Alkalinity	51.26	39,91	23.30	19.72	67.22	9.01	600
Total suspended solid	3.87	2.96	10.54	4.54	9.23	3.52	35
Biochemical Oxygen demand	12.87	9.88	2.90	1.87	4.48	3.52	4-7
Chemical Oxygen Demand(COD)	42.43	20.64	16.43	11.87	32.23	24.64	120

A. pH

The pH of samples analyzed at different sites ranged from 4.38 to 8.42 upstream and downstream respectively. pH was measured using a pH meter . The desirable range pH set by WHO is 6.5 to 8.5. Water with a pH outside the normal range may cause a nutritional imbalance or may contain a toxic ion which can adversely affect the growth and development of aquatic life. As pH affects the unit processes in water treatment that contribute to the removal of harmful organisms, it could be argued that pH has an indirect effect on health. Water generally becomes more corrosive with decreasing pH; however, excessively alkaline water also may be corrosive.

B. Total hardness

Results from the test showed that total hardness concentrations were highest (19.87-14.16) in effluents from the abattoir site and lowest (2.3-4.4mg/I) from pz industry location Hardness of water generally indicates the concentration of calcium and magnesium ions in the water and the high level of this may be attributed to the mixing of sewage effluents into the river water. Hardness causes incrustations in water distribution systems and excessive soap consumption in washing.

C. Total alkalinity

Total alkalinity values in the present study as recorded range from 4.89mg/I to 67.22mg/I. The maximum permissible limit of alkalinity according to WHO standards in surface water is 600mg/I. Water samples collected from the various sites had concentrations of alkalinity below the maximum limit set by WHO. The high alkalinity level may be associated with comparatively higher pH values and higher concentrations of chlorides, sulphates, phosphates and other ions present in the river which may have been impacted by the effluent discharges.

D. Sulphate

It is important to note that sulphate concentrations of water samples varied from concentration from abattoir samples. Sulphates are highest even 3.25mg/I which are all less than the standard through lower than WHO limit.

E. Total Dissolved Solids (TDS)

The desirable and maximum levels at TDS in the surface water prescribed by WHO are 500mg/I and 1000mg/I respectively. From the study, the water sample collected from the entire sites has an acceptable value because they ranged from 16.32mg/I to 56.14mg/I. Increased level of TDS might be impacted by the dissolution of higher concentration of chlorides, calcium, magnesium, sulphates, organic and other inorganic particles which resulted from the discharge of sewage, industrial and solid waste into the river. Excessive TDS in water can cause changes in taste, excessive scales in water pipes, water heaters, boilers and household appliances. Concentration of TDS that are too high or too low may limit growth and lead to death of many aquatic life forms.

F. Biochemical oxygen demand (BOD)

BOD values of water samples in the study varied from 1.89mg/I to 14.86mg/I. Four of the sites have concentration values higher than WHO acceptable standards. BOD values clearly indicate pollution and may be attributed to the percolation of waste water loaded with biodegradable compounds, which might be result of untreated sewage solid and industrial waste discharged from each site into the Otamiri River.

G. Chemical Oxygen Demand (COD)

All water samples analyzed showed that they are all below the WHO standard. The low levels of COD in water sample at different sites clearly indicate that the waste materials discharged into these water bodies are low oxygen demanding materials, which do not cause depletion of dissolved oxygen in water. Higher BOD and COD levels of any water sample indicate that such water sample are highly polluted. It may be attributed to the high demand od dissolved oxygen by the wastes discharged in to the water bodies and which render them unfit for drinking, irrigation and also its use for recreational purpose greatly reduced.

H. Electrical Conductivity (EC)

The values obtained from the study ranged from 20.01 to 69.10 /cm and the standard is any value less than or equal to 100/cm and the values obtained are less than 100 specified in WHO standard (WHO, 2007). Earlier studies show that there is a high positive correlation between electrical conductance and chloride concentration. Also, a high positive correlation between electrical conductance and total dissolved solids of water.

I. Pollution Index

The pollution index of the river based on the results above was computed as 1.317 using (1). This indicates that river is moderately polluted.

5 CONCLUSION AND RECOMMENDATION

Conclusion

The study has shown that effluents from industries have significant effects on the water quality of the receiving river. This is depicted by the fact that there is a general increase in concentration of the parameters analyzed upstream as opposed to downstream. Although the values in some cases were lower than maximum allowable limits by WHO, the continued discharged of untreated effluents into the river may result in severe accumulation of those contaminants. With the present obsolete processing technologies of the area, the numerous manufacturing and animal processing activities will continue to enrich the receiving river with key pollutants and easily degradable carbon compounds leading to further oxygen depletion in the river.

Conclusively, the quality of Otamiri river is influenced by waste water from industrial and abattoir activities; understanding the condition of rivers is critical if Nigeria is to develop an effective surface water quality monitoring in the country. It changes with seasons and geographic areas, even when there is no pollution present, therefore we must pay close attention to water quality by monitoring and testing, the provision of quality water the ever increasing population of Nigerians cannot be over emphasized. Without an adequate water supply, the millions off Nigerians will suffer, agriculture will be hampered, and the recreational industry will suffer.

Recommendation

It is recommended that local regulating bodies and environment legal authorities should revise and adopt current international standard.

The local bodies and environmental legal authorities should interfere with the situation to produce an internally cohesive institutional framework for waste management. The pollution levels should be reduced by strict enforcement of Environment Management Act and waste effluents regulations to ensure that the effluent discharged is within the permissible limits. It is thus recommended that waste treatment plants must be established with each industry with proper follow-up. Furthermore, efficient environment laws and social awareness program must be undertaken with respect to potential threat of industrial and other waste to the environment.

REFERENCE

1. Abdulrzak, A. (2004). Industrial Waste Water Vi & V" USA, California State pp 1-21.

2. Maloma, S., Okufarasin, V.A, Olorunniwo, M.A, and Omode, A.A. (1990). Ground waterchemistry of weathered zone acquifers of an area underlain by basement complexrocks. Journal of Africa Earth Sciences 11:357371.

3. Marian, E. (ed.) (1991). Metals and Their Compounds in the Environment; Occurrence,Analysis and Biological Relevance, UCH, Weiheim, New York. Pp3-11

4. Ukpong. E.C. (2006). Water Quality parameters of domestic water sources in Uyo LocalGovernment Area, Nigeria. International Journal of Environment issues:Development universal Consortium 4 (1&2): 1-11