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POLLUTION IMPACTS OF INDUSTRIES ALONG ELEYELE RIVER IN OLUYOLE INDUSTRIAL HOUSING ESTATE, IBADAN, NIGERIA

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Abstract

This study focuses on the impacts posed by the concentration of industries along Eleyele River, Oluyole Industrial Estate layout, Ibadan, Oyo State with respect to the quality of the water as related to human health and the aquatic ecosystem. Purposive sampling technique was used to sample water along the river channel. The samples were analyzed for pH, colour, turbidity, total suspended solids (TSS), total dissolved solids (TDS), dissolved oxygen (DO), chemical oxygen demand (COD), biochemical oxygen demand (BOD), total hardness, chloride, calcium, sulphate, and nitrate. Comparisons were made between the upstream part where there is no concentration of industries, the estate layout where industries are well concentrated and the downstream part towards where the river flows. Both descriptive (mean, line graph) and inferential (Student T-test) statistical technique was adopted to check the degree of pollution along the river course. The result revealed significant variations of parameters in the water samples from the analysis that the quality of the water available in the upstream part within WHO drinking water standard while that of the estate layout and the downstream part didn’t fall within and risky for human health. It was however suggested that measures such as construction of industrial wastewater treatment plants and enactment of water use and management laws should be properly put in place to reduce such impacts and increase the quality of water available within the industrial region.

Keywords: Impact, Industrialization, Pollution, Nigeria, River, Water

1.1 Introduction

Water pollution is a major global phenomenon that requires a continuous evaluation at all Levels. It is the leading worldwide cause of death and diseases, and that it account for death of more than 14,000 people daily (Ayoade 2003). Shradha et al (2005) define water pollution as the addition of some foreign substances which degrade the quality of water so that it either becomes health hazard or unfit for use. Water pollution is also defined as any physical, biological, or chemical change in water quality that adversely affects the living organisms or makes water unsuitable for desired use (Cunningham & Cunningham, 2004). Smith (1972) also define water pollution as any man made modification of water quality which renders the water less suitable for uses than its original state.

In addition to the acute problems of water pollution in the developing countries, industrialized (developed) countries struggle with water pollution problems as well. (EPA, 2004)The concentration of industries within a particular environment or area has its various and broad advantages and disadvantages as well. One of the major disadvantages of industrial concentration is environmental pollution (EPA, 2006). This ranges from air pollution to water pollution, noise pollution and so on. In this study, the side effects of industrialization on water are favourably considered. Most industries especially the oil and gas, food processing, mining construction textile, chemical manufacturing etc.,generate a lot of waste materials which easily contaminate the surrounding water bodies. Most of these waste materials are not well treated and when discharged into the environment particularly the water bodies, they contaminate them thereby making them polluted.(Michael Hogan, 2010)

The effects of water pollution range from its impacts on man, its effect on the aquatic ecosystem and the environment in general. According to Shradha et al (2008), the effects can range from the physical effect of altering the characteristics of the water through reduction in dissolved oxygen level, general reduction of the water quality, reduction of light penetration as well as affecting the living organisms such as aquatic plants and animals by hampering their growth.

Of all the effects of water pollution, the health implication on man is very vital as it poses so many threats to the body system both internally and externally. Some of the identifiable implications of polluted water on human health according to Shradha et al (2008) are:

1. A high pH level above 6.5-8.5 standard set by the WHO indicates acidity and this means that the consumption of such water can lead to poisoning.
2. A high level of total suspended and dissolved solids is also an indication of pollution and this can lead to appendicitis as the solids suspended and dissolved in the water can lead to the blockage of the intestinal tracks.
3. A low level of dissolved oxygen in water which is an indication of pollution can lead to de-oxygenation of blood through the consumption of such water and this can lead to death.
4. A high level of biochemical and chemical oxygen demand also has implications on human health as they indicate organic pollution which can also lead to poisoning as well.
5. It is indicated that low level of calcium in water can lead to deformation of bones. That is, water with low hardness level and calcium ions has adverse effect on the health of humans.
6. A high concentration above the standard set by WHO of sulphate ion indicates acidity and this can lead to poisoning of the digestive and respiratory organs of humans.

In the developing countries (Nigeria being one) where the level of development is comparatively low, the discharge of industrial waste materials is not properly organized and thus, its impacts on the environment particularly the water bodies, is high. Therefore, proper attention must be paid to studying and analyzing the impacts and evaluating the risks posed by industrial activities around water bodies especially in a developing nation like Nigeria**,** where there is no standard law guiding the disposal of wastes and where industrial waste disposal is not yet properly being monitored. This study focused on the impacts of industrialization on water pollution by determining the variation that exists between water samples collected from the area concentrated with industries and area not concentrated of along the river channel as well as a comprehensive assessment of the quality of water available within the industrial environment using the WHO drinking water standard and also exposing and revealing the risks posed by the uncontrolled disposal of industrial wastes within the water environment.

1.2 The Study Area

Ibadan is the capital of Oyo state and the third largest metropolitan city in Nigeria, after Lagos and Kano with a population of 1,338,659 according to the 2006 census. Located between coordinates $7^0$23'47"N and 7.39639^0N, $3^0$55'0"E and 3.916667^0E, Ibadan is also the largest metropolitan geographical area in Nigeria. Ibadan is located in south western Nigeria, about 120km east of the border with the Republic of Benin in the forest zone close to the boundary between the forest and the savanna. The city ranges in elevation from 150m in the valley area, to 275m above sea level on the major north-south ridge which crosses the central part of the city. Ibadan had been the centre of administration of the old Western Region since the days of the British Colonial rule and parts of the city's ancient protective walls still stand to this day. The principal inhabitants of the city are Yoruba people.

Ibadan has a tropical wet and dry climate (Koppen climate classification) with a lengthy wet season and relatively constant temperature throughout the course of the year. Ibadan's wet season runs from March to October, August sees somewhat of a lull in precipitation. This will nearly divide the wet season into two (2) different wet seasons. Like a good portion of West Africa, Ibadan experiences the harmattan between the months of November and February. (BBC Weather. 2010.)

The city is naturally drained by four rivers with many tributaries: Ona River in the North and West; Ogbere River towards the East,Ogunpa River flowing through the city and Kudeti River in the Central part of the metropolis. Ogunpa River, is a third-order stream with a channel length of 12.76 km and a catchment area of 54.92 km^2. (Onibokun, P. and Faniran A. 1995)
Other streams such as Onikoko, Onireke, Baale, Koteyomu form tributaries to the Ogbere river while Olojuoro stream, Olokun stream and Osa stream drains into the Ogunpa river. On the northern part of the city where river Ona is the main river, adjoining streams including Eleiyele, Yemoja, Elefun, Elenre drains into the river on the north-western part while Odo Amo, Elesun, Alagbon and Alafara are tributaries to river Ona. Finally, all the other rivers are drained into River Ona with the exception of Osun river and the drainage pattern is dendritic. There are dams

along the upper parts of both the Ogunpa and Eleiyele streams which serve a source of pipe-born water supply to the city.

With its strategic location on the railway line connecting Lagos to Kano, the city is a major trade center for trade in cassava, cocoa, cotton, timber, rubber and palm oil. The main industries in the city area include the processing of agricultural products, tobacco processing and cigarette, flour milling, leather making and furniture making (Lloyd et.al 1967.)

The Oluyole Industrial Estate Layout lies in the heart of Ibadan and is the second most industrialized region of the city after Lagos-Ibadan expressway region in this region, various industries especially food processing and other light manufacturing industries are located. The Eleyele River is an important river which derives its name from the Eleyele area where it is flowing from. It flows from the Eleyele region towards many parts and also passes through the Oluyole industrial Estate. Like many tropical African streams, it is seasonal in nature i.e gets bigger and more voluminous during the rainy season and lesser in quantity and volume in the dry season.

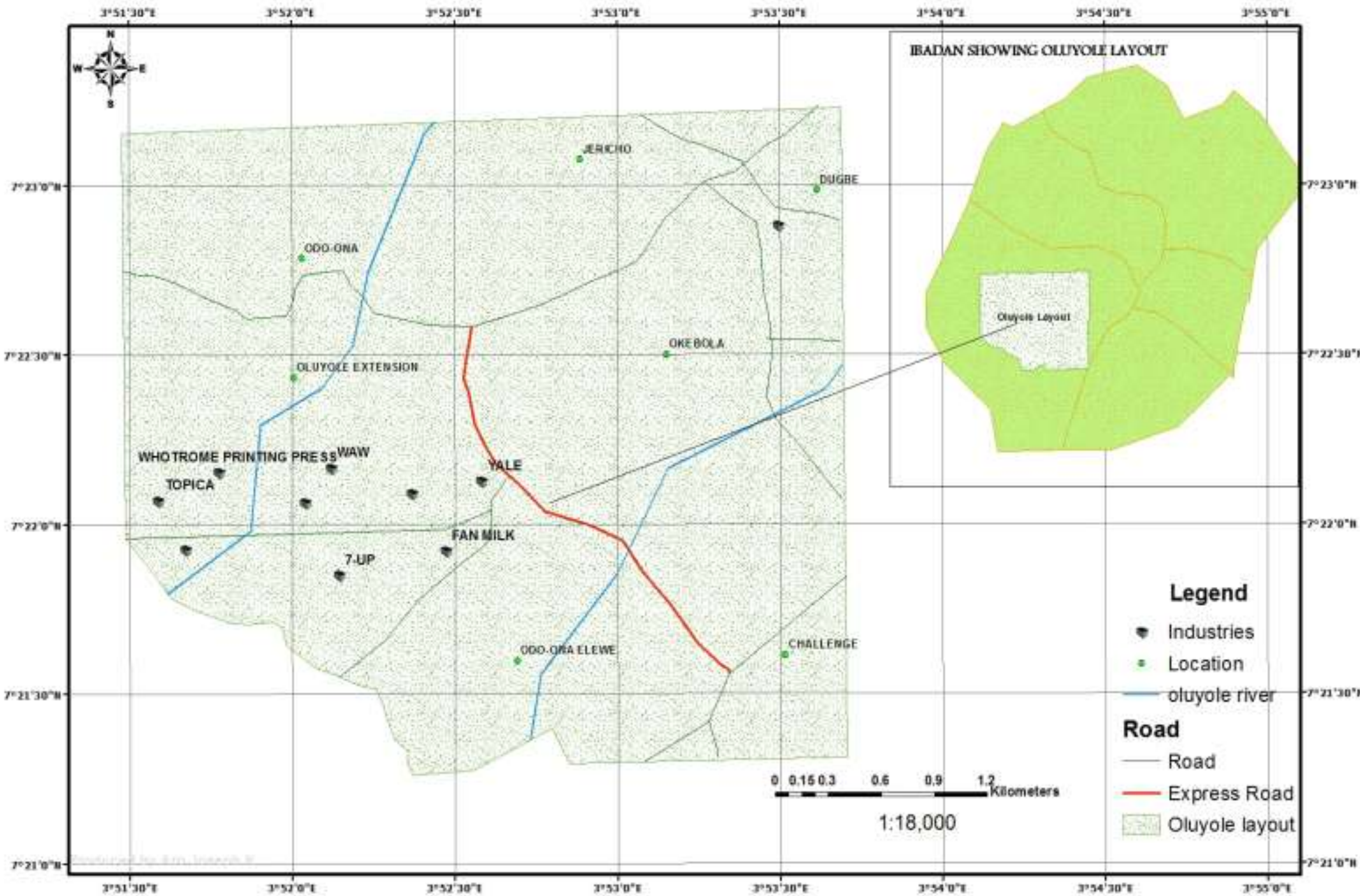


Fig 1.1 Map Of Ibadan Showing Oluyole Industrial Estate Layout

Source: Google Map

2.1 Materials and Methodology

Data for this study were obtained mainly through primary and secondary sources. The primary source involved collection of water samples from the study area using composite sampling procedure where water samples were taken from three different points along the river course (purposive sampling).

The first is the upstream non-industrial part of the river denoted as SAMPLE A. The second sample is taken from the main Industrial region point of the river and it is denoted as SAMPLE B. The third sample is collected from the downstream part of the river and it is denoted as SAMPLE C. The surface water parameters examined in this study are pH, Color, turbidity, total suspeneded solids (TSS), total dissolved solids(TDS), dissolved solids (DO), chemical oxygen demand (COD), biochemical oxygen demand (BOD), total hardness, chloride ion, calcium ion, sulphate ion, and nitrate. The water samples were taken for laboratory analysis at the Biochemistry Laboratory, University of Ilorin. Secondary source of data includes Ibadan city map showing Oluyole industrial estate layout, journals, library and internet sources. In order to determine the variations that exist between sample location, selected water parameters were analyzed in the laboratory.

Descriptive and inferential statistics were used in this study to analyze the data collected. The major descriptive method used to summarize the data was mean and line graph which was used to shows the comparison of the samples with the WHO drinking water standard (2008) and give explanation on the quality level of each of the samples representing each of the points of collection.

T test analysis was used to compare the parameters of various samples taken along the river channel. This was used to determine if there is significant difference in the concentration of water parameters between the area of high concentration of industries and low concentration of industries along the river channel.

3.1 Results and Discussions

3.1.1 Descriptive Analysis of Water Parameters

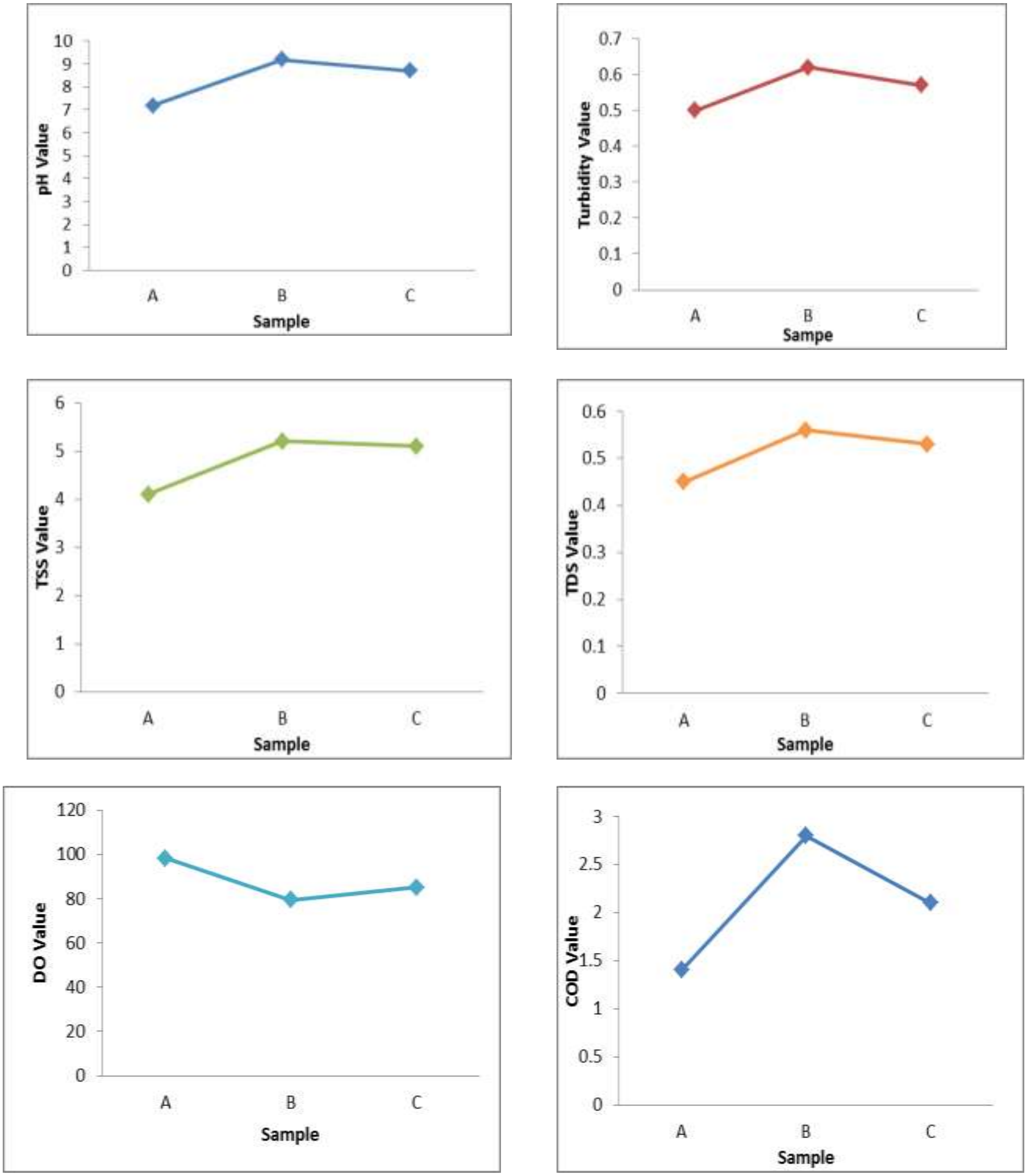
These are the results of the tests carried out on the water samples collected at the Eleyele River, Oluyole Industrial Estate Layout, Ibadan. Oyo state. The mean, standard deviation and coefficient of variation of the laboratory result of the tested water parameters and WHO drinking standard in all the samples is shown in Table 1.

Table 3.1.1: Comparative Analysis of Water Samples with the WHO Standard (2008)

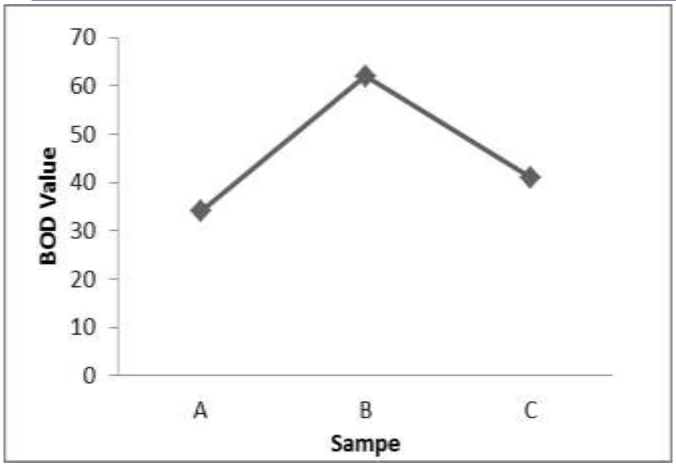
Parameter	Sample A	Sample B	Sample C	Mean	Standard Deviation	Coeffecient Variation	WHO(mg/l) permissible
Ph	7.2	9.2	8.7	8.367	0.849	984.503	6.5-9.2
Turbidity	0.50	0.62	0.57	0.563	0.049	1144.612	0.5
TSS	4.1	5.2	5.1	4.8	0.496	966.4647	-
TDS	0.45	0.56	0.53	0.513	0.046	1105.656	1500
DO	98.2	79.3	85.0	87.5	7.916	1105.383	-
COD	1.40	2.80	2.10	2.1	0.572	367.4235	20
BOD	34.0	62.0	41.0	45.667	11.897	383.8273	2mg/l or less
Hardness	14.4	9.0	12.0	11.8	2.209	534.1609	500
Chloride*	146.0	58.0	68.0	90.667	39.338	230.4754	2.5
Calcium	28.8	8.0	15.5	17.433	8.601	202.6919	20
Sulphate	0.009	0.015	0.011	0.012	0.002	467.7072	100
Nitrate**	48.0	41.20	43.4	44.2	2.833	1560.108	50

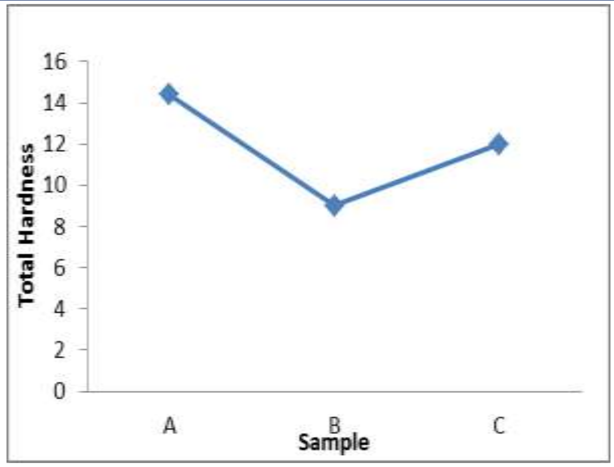
Source: Author's fieldwork, 2012

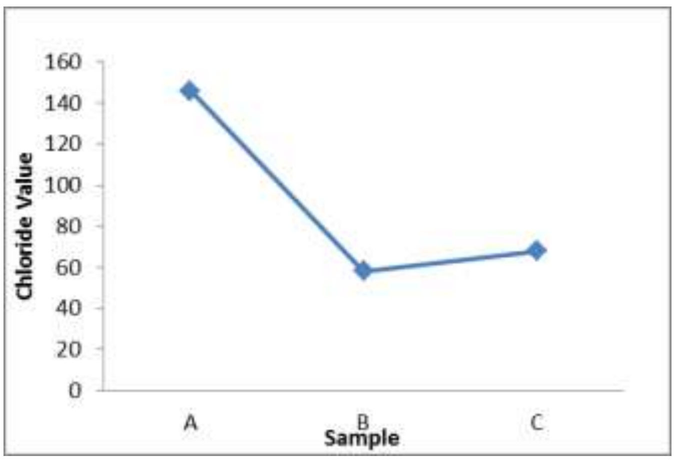
figure3.1.1 : Comparative analysis of water samples among sampling point

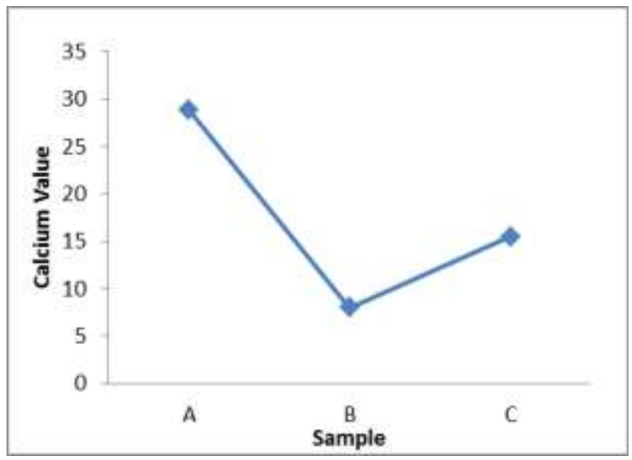


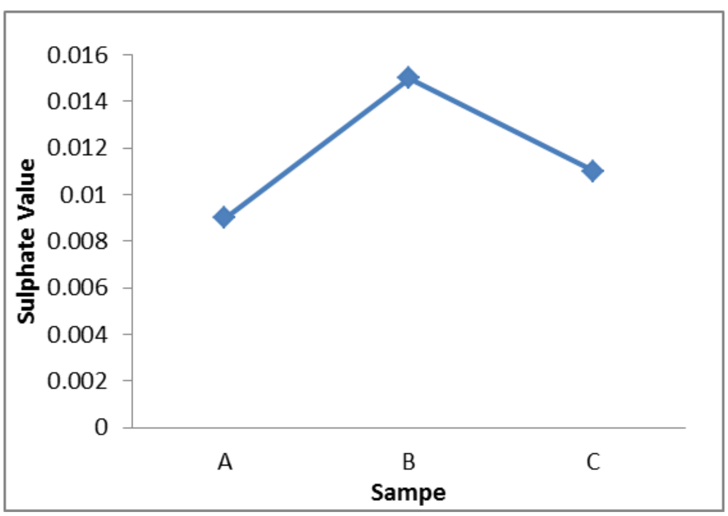
Sample A – Up stream
Sample B – Medium Stream
Sample C – Down Stream

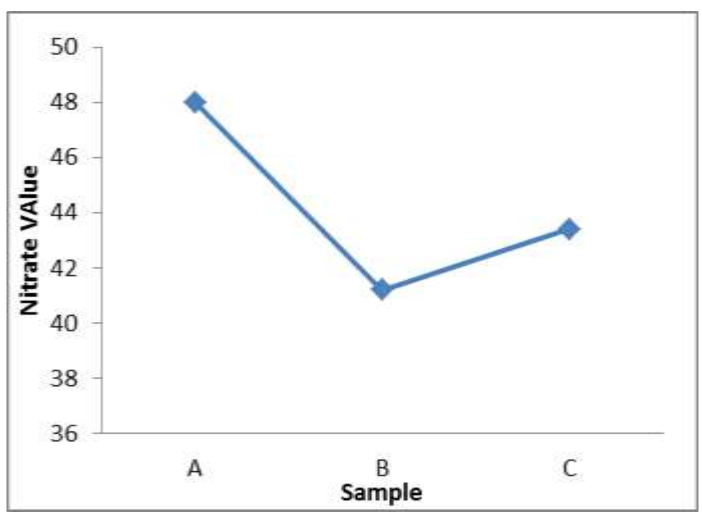












Sample A – Up stream
Sample B – Medium Stream
Sample C – Down Stream

Ph ,Turbidity, Total Suspended Solids (TSS), Total Dissolved Solid (TDS),Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD) and Sulphate shows an increase in concentration from the first sample points A to C while Dissolved Oxygen (DO), Total hardness, Chloride, Calcium and Nitrate experienced a decrease in concentration from the first sampling point A to C.(Fig 2). This variations occurred as a result of the introduction of industrial effluent from the industrial area located at point B i.e. Sample B.

Among the examined variables, Dissolved oxygen has the highest mean(85.0mg/l) followed by Chloride(68.0mg/l) while sulphate remained the least(0.012mg/l). Chloride recorded the highest standard deviation (39.34mg/l),this is followed by BOD (11.90mg/l)while sulphate also recorded the least value(0.002mg/l). Furthermore, nitrate is the most varied parameter among the examined water characteristics within the study area. On the pattern of relative variation, the result of the coefficient of variation shows that all the examined variables are heterogeous. For example, Nitrate tops the lists with 1560.11%, this is followed by Turbidity with 1144.61% and the least is Calcium with 202.69%.

There is an increase in levels of turbidity from sample point A to B and C with mean values 0.56mg/l in contrast to WHO drinking water standard of 5mg/l (Fig 2 and Table 2). EPA (2009) stated that Higher turbidity levels are often associated with higher levels of disease-causing microorganisms such as viruses, parasites and some bacteria. These organisms can cause symptoms such as nausea, cramps, diarrhea, and associated headaches.

For instance, the amount of chlorine dissolved in water is a good indicator of the quality level of water because it is needed for disinfection of harmful substances and micro organisms however, sample B and C which represents the industrial region and the downstream respectively indicate an increase in chloride level with a mean of 90.7 mg/l which falls below WHO standard of 250mg/l making the quality of water questionable. According to (EPA 2009),an increase in chlorine levels can lead eye/nose irritation, stomach discomfort making the water harmful for human consumption

Dissolved oxygen reveal a decrease in concentration from point A to B and C with mean value of 87.5mg/l in contrast to 4mg/l of the WHO standard.(Fig 2 and Table 2). In line with USEPA (1997), dissolved oxygen levels are strongly influenced by point source discharges and for that reason the U.S. Environmental Protection Agency (EPA) uses DO in preliminary evaluation of in-stream water quality and also the implication of a decrease in dissolved oxygen found in samples B and C in Fig 2(industrial area), reveal that microbial activities is greatly reduced affecting the natural aquatic habitat.

3.1.2 Inferential Analysis of Water Samples

The T-test analysis reveals that there is a significant difference in the concentration of parameters of the water between the samples A and B where Tcal (2.27) is greater than Ttab (2.20). Also, for samples A and C, Tcal (2.635) is greater than Ttab (2.20) meaning that there is significant difference in the concentration of parameters of water between samples A and C.But in the case of samples B and C, there is no significant difference in the concentration of parameters of water samples where Tcal (1.634)is less than Ttab (2.20) between sample B and C.

Table3.1.2: T-test Analysis of Water Samples.

SAMPLES	MEAN	DEGREE OF FREEDOM	Tcal	Ttab	REMARKS
Sample A-B	2.909	11	2.727	2.20	There is significant difference.
Sample A-C	2.885	11	2.635	2.20	There is significant difference.
Sample B-C	8.557	11	1.634	2.20	There is no significant difference.

KEY: Tcal is T calculated, Ttab is T tabulated

Source: Author's fieldwork, 2012

It can be deducted that since the concentration of parameters are carried from location A which is upstream to location B which is the mainstream part and also the where industries are concentrated to location C which is the downstream part of the river, the likelihood for the differences in the concentration of parameters is expected. The differences experienced between samples A and B can be attributed to the different land use activities present in the different locations. Few industrial activities and residential houses are found in location A in contrast to the dense industries located at the middle stream (location B) releasing industrial effluent and polluting the stream.

This was opined by Nazari et al (2003) that urban areas continue to degrade the quality of water due to urban land use activities and non-implementation of water protection and management strategies. Also, Schneider et al (2002) submitted that pollutants due to urban land use activities create immense problems for cities such as metropolitan areas in the United States. These pollutants according to Schneider (2002) originate from such diverse activities, such as, industrial waste, soil disturbance by construction, leaking underground storage tanks, and chemical application to golf courses, garden and landscapes.

There is no significant difference in the concentration of water parameters between Samples B and C. In line with Jimoh (2000), this is due to the continuous flow of water from the middle stream (industrial section) to the downstream performing the function of deposition of sediment carried from upstream. Therefore, the industrial effluents released into the river are carried downstream given rise to a maintained water condition from the middle stream.

4.1 Conclusions and Recommendations

The concluding results show that variations exists in the concentration of parameters from Location A to B which is attributed to different types of land use present while there is no significant difference in the concentration of water parameters between sample B and C which is as a result of the river performing the basic function of deposition.

Finally, the analysis carried out has shown that the impact of industrialization is on surface water pollution is much as the comparison with the WHO standard has shown a wide variation from the standard set by the body. According to Ayoade (2003), Careful attention must therefore be given to the problem of industrial effluents since they can be lethal and far more dangerous than domestic sewage. It must also be mentioned that there is a great health risk posed by the concentration of industries along water bodies as disposal of waste by industries into such water bodies can have hazardous implications on man’s health and the aquatic ecosystem.

Based on the conclusions, the study recommends that government and industrialist should take into consideration the construction of wastewater management facilities before the location of an industry (Plate one show an example of such).

Plate 1: Recycling Room of the Table Mountain Office in
Cape Town, South Africa. (Ajibade, 2012)

Also, industrial sites are advised to be situated far from rivers to avoid pollution of the environment. The effects of industries can be reduced by proper waste disposal system and also by the enactment of laws guiding waste disposal by industries as well as proper industrial wastewater management techniques. With all these, the risks posed by industrialization on river water will be greatly reduced to the minimum which will make the water available within an industrial region useful and less harmful. Above all, governments of nations should wake up to their responsibility in respect of provision of portable water to their citizens, for there may not be the need to use river water domestically if this is in place.

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