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INVESTIGATING THE EFFECT OF SAMPLING POINT DISTANCE ON IKPOBA RIVER WATER QUALITY USING LEAST SQUARE REGRESSION MODEL

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Abstract

In this study, the sampling point distance as it affects Ikpoba River water quality was examined in order to ascertain the quality of the river before and after waste discharge. Water samples were taken from eight (8) different locations (at distance 750 m, at 150 m interval); covering the locations of wastewater release, upstream and downstream points. Samples were taken from the river for analysis twice every month in March, May and July, 2014. Samples were analyzed for pH, Electrical conductivity, Ca, colour, turbidity etc; using WHO standard methods for water quality tests. Results obtained showed that the Water Quality Index of the river water was poor at discharge point but improved as the sampling distance increased. The month of March had the worst Water Quality Index value of -5429792.89 at STN1, distance 0 m while the best WQI was in May (-457153.58) STN8 at 750 m. The model equations explaining the correlation between the computed WQI and sampling station distance are: Y = -4.112E6 + 1836.272X (March), Y = -1.848E6 + 2184.649X (May) and Y =-2.185E6 + 678.695X (July) respectively. One-way analysis of variance result (ANOVA) at 95% confidence interval revealed that there is a strong relationship between sampling distance and WQI for months of May and July except March. The study revealed that there is a correlation between sampling distance and water quality and hence recommends adequate effluent treatment before disposal. Also, waste disposal into the stream should be done at considerable distance from downstream users.

Keywords: Regression, water quality index, pollution, monitoring, sampling distance

1.0 INTRODUCTION

Water pollution due to discharge of industrial wastes into water courses is a serious problem in the country. A thorough chemical examination carried out on selected Nigerian rivers in order to ascertain its water quality, revealed that the once rich and good quality nature's gift is fast diminishing in quantity and deteriorating in quality in some parts of the country (Ajayi and Osibanjo, 2013; Adeniji and Mbagu, 2012; Imevbore, 2014; Asuquo, 2015). Streams in industrialized urban areas in Nigeria, are under severe threat of contamination as a result of waste generated by these industries while streams that transverse residential settlements or densely congested areas are severely contaminated with domestic sewage and household waste (Ajayi and Adeleye, 2007). Fishes in these rivers are being killed by pollution while the meat from these fishes is contaminated and not safe for consumption due to high mercury and toxic substances in their flesh. Consumption of fishes and crabs from rivers contaminated with polychlorinated biphenyls (PCBS) are found to cause cardiovascular diseases, endocrine disorders and cancers such as breast cancer and even leukemia (Claudio, 2000). The pollution of water poses severe health danger to animals and human health as it is a medium for bacterial transmission and other water borne diseases. Nitrates in drinking water can cause methemoglobinemia (Hertzman, 2010). In assessment and monitoring of water quality index, it is important to measure, the amount and level of organic matters present in the stream as it is useful in assessing the rate of deterioration of the river water quality. Also, oxygen needed to stabilize the amount of organic matters present in the stream needs to be evaluated. In the past, several methods which include both automatic and manual have been employed in determination of organic matters in contaminated water bodies. Irrespective of these available methods, absolute care in in-situ data acquisition including compliance to standard laboratory ethics are needed to achieve near accurate results which is used to monitor and assess the quality of river water. Some major water quality parameters measured during water (including wastewater and contaminated rivers) quality assessment are; total organic compound (TOC), chemical oxygen demand (COD) and biochemical oxygen demand (BOD). Other include ammonia-nitrogen (NH_3-N), total phosphorous (TP), total nitrogen, trace elements amongst others (Rene and Saidutta, 2008).

Watershed parameters which includes; topography, relief and geology can affect surface water quality (Sliva, L., and Williams, 2001). The changes in water quality characteristics including flow of river is influenced by series of processes. These processes could be developed by various elements in open water bodies, as a result of various man-made events within the basin which can also be hidden by unplanned occurrences (Antonopoulos and Papamichail, 2001). For proper and resourceful water quality planning, it is essential to make use of previous reports in the study area ensuring adequate history of land use and talking the product of used areas by the corresponding loading factor(s) (Metcalf and Eddy, 2003). In other instances, provided there is enough funds and time, the planners may demarcate a small watershed in the area of study, evaluate the water quality sampling events and ascertain the loading factors.

There are two approaches for estimating non-point contamination sources to surface streams. The first approach is an indirect method which uses water quality data from rivers, lakes or streams to deduce the necessity of the pollution source. The other approach is a direct method which deals mainly on the non-point sources and uses mathematically tools to explain the transportation processes of contaminants in water bodies (Haith and Dougherty, 2006). The indirect method uses water quality parameters from the water body sources (rivers, lakes, and streams) and deduce the relevance of non-point source contamination from the observations in streams or rivers. These gives the overall indication of the quantity and quality of non- point contamination. However, the aim of these methods (indirect and direct) is hinged on measured quality of stream instead of on the causes or direction of the contamination. The indirect method is basically not limited to utilization of regression models in loading factors evaluation where land use event is taken as independent variables while the dependent variables are parameters of stream water quality (Haith, 2006). The linear regression model is used to assess the degree of pollution in streams and lakes with respect to the source of discharge of the pollutants. Linear Regression establishes relationships between two (2) variables which make forecasting one of the variables possible provided the other variable is given. The analysis of variance (ANOVA) is an essential tool for the determination of significance difference in a sampled distribution. ANOVA determines whether there is greater variability among sample populations or within population groups (NCTGM, 2000).

The main purpose of this work is to assess the effect of brewery discharge location on the quality of Ikpoba River water using least square regression model. This is to ensure the protection and safety of the water consumers downstream.

2.0 METHODOLOGY

2.1 Details of Site Location

Two brewery industries are sited within Oregbeni community of Benin City, Edo State. Oregbeni community has borders with Ikpoba River, Bendel Brewery and Guinness Nigeria plc. Ikpoba River is a fourth order stream, located in Benin City, in South Western Nigeria. The coordinate of the headwater is within 6.5°N, long 5-8°E and it comes from north-western direction in Benin City and flows southwards into the city (Benka-Coker and Ojior, 2015). The river passes through thick rain forests where allochotonous infusions of organic matters from the border vegetation are obtained by runoff from soil surface. Benin Basin system which is the third largest in Nigeria, receives runoff from Ikpoba River. The river is the major source of drinking water and other domestic uses for the downstream settlers who also use it for fishing. Ikpoba River collects different forms of wastes from agricultural deposits, domestic, industrial and commercial sources. These refuges bring toxic, microorganisms, organic and inorganic matters into the river. The waste products from the various breweries activities which usually have large wastewater volumes are transported through underground channels of about 2.5km and emptied directly into Ikpoba River (Ekhaise, and Anyasi, 2011). Production and marketing of various brands of beer is the sole activity in these breweries. Effluent in variant compositions but with a common characteristic of high organic matters is generated in the course of production. This is responsible for the growth of vegetation within the wastewater discharge location. Figure 1 shows the Map of Ikpoba River with the various sampling points.

2.2 Study Design

This work was carried out to ascertain the physicochemical quality of the effluent from a point source before entering the river and at point of release; the quality of the river water at both upstream and downstream locations will be evaluated. The entire river length in the location was partitioned into two regions depending on the locations of release of wastewater into the river. The regions were basically upstream and downstream regions. The partition line was placed at the point of wastewater release location and was tagged as effluent release point. About 750 m length of the river was monitored downstream while 150 m upstream from this point was also monitored. Water samples were collected for analysis within these two extremes.

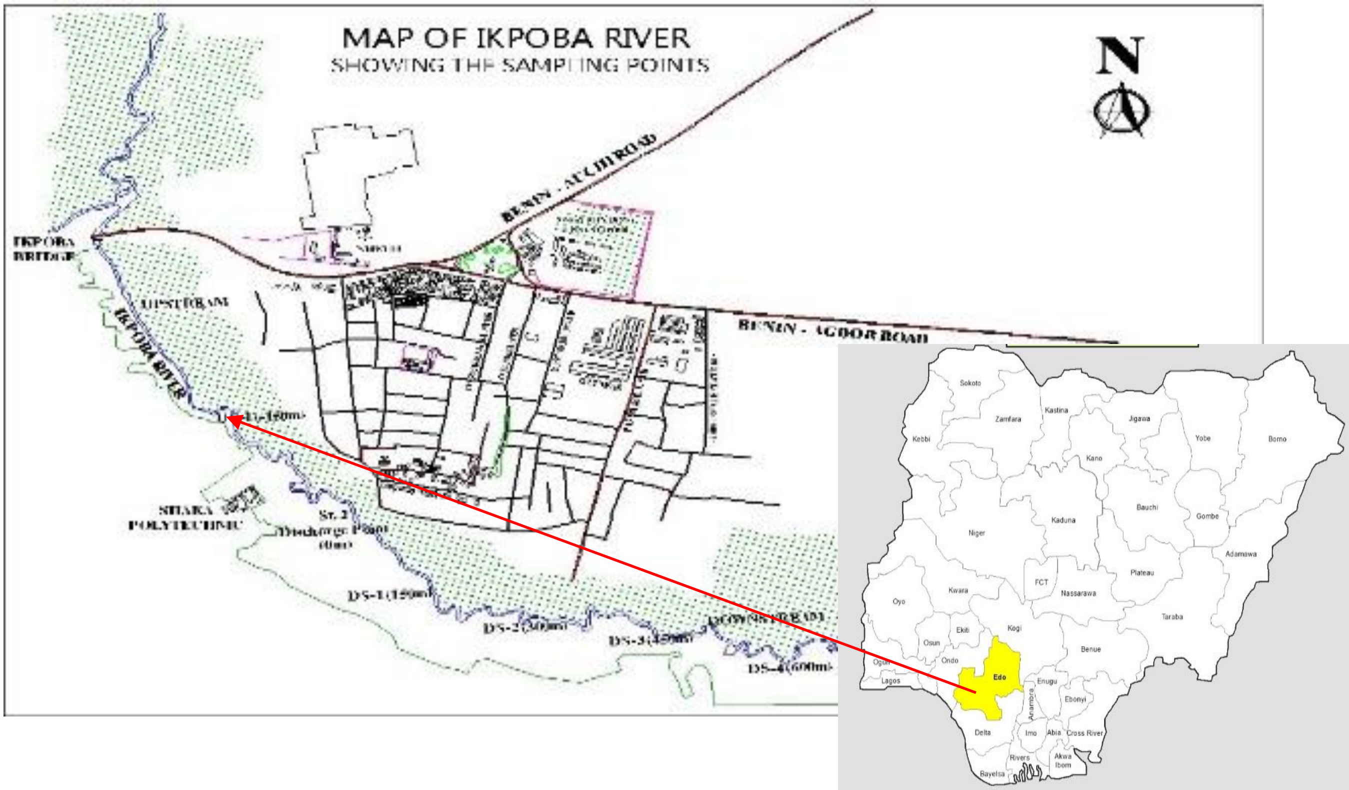

Figure 1 Map of Ikpoba River with sampling locations

2.3 Sampling Points and Geo-Locations

The upstream and downstream points of the wastewater discharge point where mixing was done was based on established geo locations. Table 1 shows the sampling locations within the river channel.

Table 1 Summary of geo-locations for sampling points

Sample Code	Northing	Easting	Elevation
Point source of effluent (STN1)	N06°20′ 016"	E005°39′880"	27m
Discharge point 0m (STN2)	N06°20′019"	E005°39′870"	28m
150m US-1 (STN3)	N06°20′ 024"	E005°39′829"	28m
150m DS 1 (STN4)	N06°20′004"	E005°39′894"	
300m DS 2 (STN5)	N06°20′019"	E005°39′918"	31m
450m DS 3 (STN6)	N06°20′034"	E005°39′942"	
600m DS 4 (STN7)	N06°20′049"	E005°39′966"	
750m DS 5 (STN8)	N06°20′064"	E005°39′900"	

2.4 Sample Recovery and Chemical Analysis of Samples

Water samples were collected bimonthly in March, May and July 2014 at eight sampling locations within the river channel, which was used in monitoring the composition of wastewater discharged, the quality of the water at release (discharge) location and downstream points as well as variations produced by seasonal water cycle within the study duration (March, May and July), a transition from the dry spell to the wet season. Sampling was done by washing the containers using the river water; thereafter the samples are collected and stored in cooler containing ice (ice chest). Additional samples were recovered for analysis of heavy metal and stored in clean plastic containers with 3ml analar grade nitric acid per litre sample. The twenty-five (25) physic-chemical parameters analyzed were sodium, salinity, turbidity, electrical total soluble solids, total dissolved solids, biological oxygen demand, copper, chemical oxygen demand, colour, temperature, concentration of bicarbonate, chloride, phosphates, ammonia, nitrate, nitrite, nitrite iron, magnesium, calcium, cadmium, dissolved oxygen, conductivity, lead, pH, nickel, vanadium, chromium and total hydrocarbon. The water samples were then subjected to full laboratory analysis in other to determine their physico-chemical properties. Some of the World Health Organization (WHO) standard test methods employed in the analysis are described below:

Turbidity Measurement: The amount of colloidal and residual suspended matter present in the water samples was determined using the Jenway 6035 Turbidimeter.

Hydrogen Ion Concentration (pH): The hydrogen ion concentration (pH) of the water samples was determined using a standard laboratory digital micro-processor pH meter; Hanna pH 210 model.

Dissolved Oxygen Content (DO): The dissolved oxygen content (DO) of the water samples was measured using a standard laboratory sized digital dissolved oxygen analyzer model: DO – 5509.

Conductivity Measurement: The conductivity of the water samples was determined using a digital water/sand quality test kit model SN2209

Total Dissolved Solids (TDS): The amount of total dissolved solids (tds) present in the different water samples was determined using a digital water/sand quality test kit model SN2209

Heavy Metal Determination: The concentration of heavy metals present in the different water samples was determined using Atomic Adsorption Spectrophotometer (AAS). (SOLAAR 969 UNICAM SERIES, using air acetylene flame).

Temperature: Temperature was noted by thermometric method at the sampling using portable calibrated Mercury thermometer in the Multi-Parameter Meter.

Electrical Conductivity: The ability of the aqueous solution to covey current was determined using the Conductivity Meter in the Multi-Parameter Meter.

Biological Oxygen Demand (BOD): The samples were incubated for 5days at 20°C in the dark, the reduction in dissolved oxygen concentration during the incubation period yields a measure of the BOD.

Colour: Colour was determined by using GENESYS-10VIS Spectrophotometer, based on the difference between the sample colour and the water colour as shown by the expression below:

Colour of water in mg/l PtCo = (Sample Colour – Water Colour)

2.5 Statistical Analysis of Data

To assess the variation of the overall water quality along the river, Water Quality Index (WQI) modeling was done on twenty-five physic chemical properties of the water samples in March, May and July, 2014. WQI was computed for each sampling period using the following approach;

Determination of Weightage

In calculating WQI, the Weightage of each of the parameters identified is first ascertained. Parameters with higher allowable limit are less toxic because they cannot change ground water quality even when they are in large amount. Therefore, the weightage of tested parameters have inverse relationship with the allowable limit. Hence

$$W_n = \frac{K}{S_n} \tag{1}$$

W_n = Tested Parameter Unit Weight
Sn = WHO Standard Values
K = Constant of proportionality

$$K = \frac{1}{\sum_{i=1}^{s} \frac{1}{S_n}} \tag{2}$$

Quality Rating Computation

Rating scale was assembled for set of values of each parameter. This rating ranged from 0 – 100 and was shared in intervals of five. The rating q_n= 0 indicates severe pollution (the tested parameter indices surpasses the maximum allowable limit). Conversely, q_n= 100 is an indication that parameter indices available in the water has desirable values. Other ratings (q_n= 40, q_n= 60 and q_n= 80) are within these extremes. These values represent excessive pollution, moderate pollution and slightly less pollution respectively. This is the modified version of the rating scale; it is calculated as follows (Ilaboya et. al., 2014; Rocchini and Swain, 2015).

$$q_n = \frac{100(V_n - V_{io})}{(S_n - V_{io})} \tag{3}$$

Where:
q_n = Quality rating or sun index
V_n= Test result for each parameter tested
S_n= Standard value of each parameter
V_{io}= ideal value of selected parameters tested (in pure water V_{io}= 0 for all parameters tested except pH and dissolved oxygen which is 7.0 and 14.6 respectively.

The resulting value is multiplied by a weightage factor which has significance to the water quality. The resulting sums are added to obtain one WQI for the water. It is a mathematical approach for the calculation of a unit number from various test results. The Water Quality Index calculated from the results, is a representation of the level of water quality in any given water body. The steps below were followed in evaluation of WQI in the river:

1. The weightage unit (W_n) were determined for all tested parameters and added to get $\sum W_n$
2. The quality rating of all parameters tested were added to get $\sum q_n$
3. The index W_n*q_n was calculated for each parameter tested and summed up to obtain $\sum W_n.q_n$
4. Mass balance equation was used to compute WQI for each water sample $\frac{\sum W_n.q_n}{W_n}$
5. Water Quality Index (WQI) = 100-Z was used to represent the level of water quality.

Analysis of Variance

Statistical analysis was conducted by using MS Excel 2007 version. In the study, Pearson coefficient of correlation model was applied and τ values were computed to find significant correlation between the sampling points and the WQI of the river water. In order to accurately represent the relationship between two variables, the correlation coefficient τ, is first calculated (NCTGM, analyze data). ANOVA is applied and resulted F values will show the significant difference in the observed seasonal variation of each parameter at 5% level of significance.

3.0 RESULTS AND DISCUSSION

The result of the physcio-chemical analysis of the twenty-five (25) selected parameters is presented in Table 2. The results obtained from the laboratory was compared with WHO and Federal Ministry of Environment Standards. This will form the basis of classifying the values as above limit, below limit or within limit. The pH values at the discharge locations were higher but in other sampling locations were within the recommendation standards although there were some instances where the values were much lower than the standards. The temperature, electrical conductivity, salinity and colour results were within the WHO tolerable limits except at the effluent source where these values were much higher than the guidelines limit. The increase in pH, EC, temperature and salinity values is linked to the slow rate of dilution which is usually noticed at the effluent source. The concentrations of pollutants at source point is usually high and this phenomenon affects the colour of the water but the colour values were within the tolerable limits of WHO. The colour values improved as the sampling distance increased. This is as a result of the effect of dilution and self-cleansing potentials of the stream. The turbidity, TSS, TDS and DO values were relatively higher than WHO limits at the effluent source and discharge points but there was gradual reduction in this values as the sampling location increases. Several particles (insoluble and floating matters) were observed in the samples, this is responsible for the lack of utilization of the stream water at the upstream locations. The DO and BOD_5 values affected the habitation and behaviour of aquatic organisms in the stream as there was insufficient oxygen to maintain eco-balance in the stream. This was responsible for the massive migration of aquatic life towards downstream locations where DO is rich. The suspended particles on the stream surface were mostly unprocessed components of grains and yeast which eventually decay and add to the nitrogenous content of the stream. This process also affects the stream colour and it makes it appear greenish during the day. The results of the metal analysis (ca, Na, K, Mg, Cu, Fe, Pb, Cd and NO_3, Cl^-) were within the recommended limits although the values were also relatively higher at effluent source and points of discharge.

Water Quality Index (WQI) was computed from the values in table 2 and the results are presented in Table 3. The results in Table 3 indicates a serious level of pollution occasioned by the discharge of poorly treated brewery effluent into Ikpoba River. WQI computed for station one (STN1) in March, 2014 was as high as -5429792.89; according to WHO standard, good river water quality index is usually less than 100,000. The high value is an indication that brewery effluent and discharge from other sources are highly polluted and when released in its raw state into the river, the consequences is high degree of water pollution as experienced in all the stations from which water samples were collected.

The computed water quality index was checked against the distance of sampling stations from the point source of pollution, it was observed that within the period under study (March, March and July), there existed a gradual decrease in the pollution load of the river as you move away from the point source of pollution. A graph variation between the water quality index and the distance of each sampling location downstream from the point source of pollution is presented as in Figure 2.

There was progressive decrease in water quality index with increase in distances of sampling stations away from the source of pollution. It was experienced in all the months as shown in Figure 2. From Table 3, WQI calculated revealed that high level of pollution was experienced in the month of March as compared to the other two months. WQI values obtained in March ranged from -457153.58 in STN8 to - 5058205.33 in STN1. The overall status of the river is characterized by high level of pollution occasioned by the discharged of poorly treated brewery effluent.

Least Square Regression Analysis

Least square regression analysis was done to investigate the significant effects of sampling points on the changing water quality for the period under investigation (March, May and July). Result of the Pearson Correlation as present in Tables 4, 5 and 6; the results revealed that there exists a strong statistical correlation between the sampling points and the computed WQI. The correlation equations obtained in May and July were higher than the month of March. This is an indication that the pollution index of the river was high in the month of March.

On the degree of reliability of the least square regression model to predict the correlation between the computed water quality index and the sampling stations, result of the model summary as presented in Table 7, 8 and 9 was employed.

The results of the least square regression model had a better explanation for the physcio-chemical properties obtained in the month of May and July, 2014. This claim is based on the higher coefficient of linear correlation observed in May and July as compared to March. To develop the model equation that defines the correlation between the computed water quality index and the sampling distance, regression coefficient statistics as presented in Table 10, 11 and 12 was utilized.

From the result of Table 10, 11 and 12 the following model equations were developed to explain the correlation between the computed water quality index and sampling station distance.

$$Y = -4.112E6 + 1836.272X \quad \text{(March)}$$
$$Y = -1.848E6 + 2184.649X \quad \text{(May)}$$
$$Y = -2.185E6 + 678.695X \quad \text{(July)}$$

Where; Y is the computed water quality index, X is the sampling station distance. To establish whether the variation in the computed water quality index is due exclusively to distance away from the source of pollution, one-way analysis of variance (ANOVA) result as presented in the Tables 7, 8 and 9 were employed. Since the regression analysis was run at 99.5% confidence interval, which is 0.05 degree of freedom, the probability function P value was gotten as 0.05. It means therefore that the following hypothesis can be formulated:

1. H0: Sig <0.05 varying water quality is exclusive due to sampling point distance
2. H1: Sig > 0.05 varying water quality is not exclusively due to sampling point distance

The result of Table 7 shows that Sig was greater than 0.05 (Sig = 0.138) meaning that the null hypothesis has failed. Thus it was concluded that the changing water quality along the river in the month of March, 2014 is not exclusively due to the sampling point distance. This means that other processes that happen in the river in the month of March, 2014 would have also contributed to the varying water quality observed.

The result of table 8 indicates that Sig was less than 0.05 (Sig =0.022) meaning that the alternative hypothesis has failed. Thus we concluded that the changing water quality along the river is exclusively due to the sampling point distance in the month of May, 2014.

From the result of Table 9, it is seen that Sig was less than 0.05 (Sig = 0.035) meaning that the alternative hypothesis has failed. Thus it was concluded that the changing water quality along the river is exclusively due to the sampling point distance in the month of July, 2014.

The result obtained in the months of May and July, 2014 reflects the sampling point influence on river water quality which can be altered due to closeness of sampling to discharge point. In the month of March 2014, the sig value greater than 0.05 indicates that other processes have undue influence on the river water quality. The month of March as compared to the other months (May and July), is predominantly dry season and this explains the severe pollution of the river water due to poor dilution from precipitation. The concentration from pollutant entering the river during this period is usually high and this is revealed across the entire sampling points.

Table 2 Result of chemical analysis on Ikpoba river sampling Period March, May and July, 2014

Parameter	Effluent source (STN1)	Discharge Point (STN2)	150m US1 (STN3)	150m DS1 (STN4)	300m DS2 (STN5)	450m DS3 (STN6)	600m DS4 (STN7)	750m DS5 (STN8)	*Water Quality Standards*	
									WHO	**FMNEV**
pH	9.8-10.6	7.8-8.6	6.7-8.6	6.5-7.6	6.3-6.8	6.2-6.6	6.0-6.4	6.0-6.3	7-8.5	6-9
Temp(^{0}C)	34.8-37.1	26.5-27.1	25.4-26.4	25.5-26.5	25.7-26.2	25.7-26.6	25.6-25.7	25.4-25.6		<40
EC(μs/m)	1035-1654	130-280	60-90	50-120	40-100	35-90	32-80	30-80		400
Salinity(PSU)	0.374-0.576	0.059-0.081	0.020-0.036	0.027-0.045	0.023-0.032	0.021-0.032	0.0019-0.027	0.0018-0.026		
Colour (NTU)	22-62	13-48	8-15	11-31	9-22	8-22	8-20	7-18		
Turbidity	25-71	17-56	10-18	13-36	10-29	9-25	8-22	8-20		
TSS(mg/l)	25-142.5	19-26.14	5.6-10	10.7-15	15-23.4	17-38.3	21-45.4	23-50		30
TDS(mg/l)	58-827	65-140	30-45	35-60	35-50	30-50	25-40	20-35	100	2000
DO(mg/l)	4.0-5.0	4.5-5.5	5.1-6.3	5.2-5.7	5.7-6.4	6.0-6.6	6.2-6.8	6.3-6.9		
BOD$_5$(mg/l)	4.0-4.4	2.0-4.9	2.6-5.0	3.5-5.7	4.2-5.4	3.8-4.6	3.6-3.9	3.2-3.5		50
COD(mg/l)	196.0-242.4	124.8-182.2	33.6-98	57.8-98.4	41.6-81.6	34.4-69.2	28.8-60.4	25.6-53.8	10-12	150
HCO$_3$(mg/l)	427-579.5	183-390.4	30.5-67.1	97.6-225.7	30.5-73.2	25.6-65.9	21.8-58.2	19.5-53.9		
Na(mg/l)	32.94-53.10	8.76-29.02	0.50-18.31	6.54-23.69	1.13-19.48	1.10-15.73	0.80-13.29	0.62-12.05		
K(mg/l)	14.41-20.72	3.76-8.22	0.10-4.39	0.72-6,60	0.30-4.75	0.16-4.54	0.12-4.35	0.07-4.19		
Ca(mg/l)	4.96-14.41	2.85-10.10	0.45-7.24	1.01-9.60	0.88-7.37	0.76-5.50	0.68-4.26	0.62-3.73		
Mg(mg/l)	1.67-9.51	0.98-7.82	0.17-5.13	0.59-5.28	0.13-6.02	0.074-6.60	0.023-7.02	0.005-7.28		
Cl$^-$(mg/l)	98.7-141.8	65.3-100.7	35.8-70.9	75.1-88.1	50.6-80.6	35.2-74.5	26.3-69.4	20.7-65.6		200
PO$_4$(mg/l)	6.64-9.40	1.32-4.10	0.19-0.92	1.35-2.40	0.23-1.60	0.20-1.10	0.17-0.8	0.15-0.65		
NH$_4$N(mg/l)	0.98-2.63	0.12-1.6	0.05-0.45	0.02-0.05	0.03-0.13	0.05-0.10	0.10-0.43	0.17-0.48		
THC(mg/l)	3.56-5.70	2.48-5.22	0.46-3.20	1.20-3.30	0.97-3.29	0.76-3.27	0.59-3.25	0.48-3.23		
V(mg/l)	0.02-0.27	0.015-0.18	0.005-0.03	0.013-0.19	0.009-0.15	0.006-0.10	0.004-0.04	0.003-0.041		
Ni(mg/l)	0.023-0.3	0.017-0.21	0.007-0.07	0.014-0.21	0.010-0.18	0.007-0.13	0.005-0.07	0.0003-0.054	0.02	<1
Pb(mg/l)	0.074-0.213	0.047-0.151	0.002-0.089	0.02-0.103	0.008-0.056	0.0007-0.017	0.0005-0.009	0.0003-0.006	0.001	<1
Cd(mg/l)	0.036-0.102	0.029-0.068	0.005-0.021	0.024-0.043	0.013-0.040	0.009-0.042	0.003-0.043	0.002-0.043	0.003	<1
Fe(mg/l)	2.68-6.74	1.91-5.33	0.59-3.11	1.96-4.28	1.91-3.91	1.88-3.56	1.85-3.36	1.83-3.33		
Cu(mg/l)	0.043-0.18	0.028-0.10	0.002-0.02	0.016-0.05	0.006-0.03	0.004-0.010	0.002-0.02	0.001-0.01		

DS –Downstream, US – Upstream and STN – Sampling Station

Table 3 Calculated WQI for Ikpoba river from March to July, 2014.

Location	WQI for March	WQI for May	WQI for July
STN1	-5429792.89	-5058205.33	-3391204.569
STN2	-4972507.706	-2362364.493	-2371914.013
STN3	-3048220.184	-438099.5259	-1238278.088
STN4	-3143500.167	-1143041.059	-1924186.205
STN5	-3133970.648	-923931.997	-1895573.043
STN6	-3114917.109	-723883.062	-1847938.082
STN7	-3095865.509	-561939.95	-1800300.78
STN8	-3076813.38	-457153.58	-1743142.885

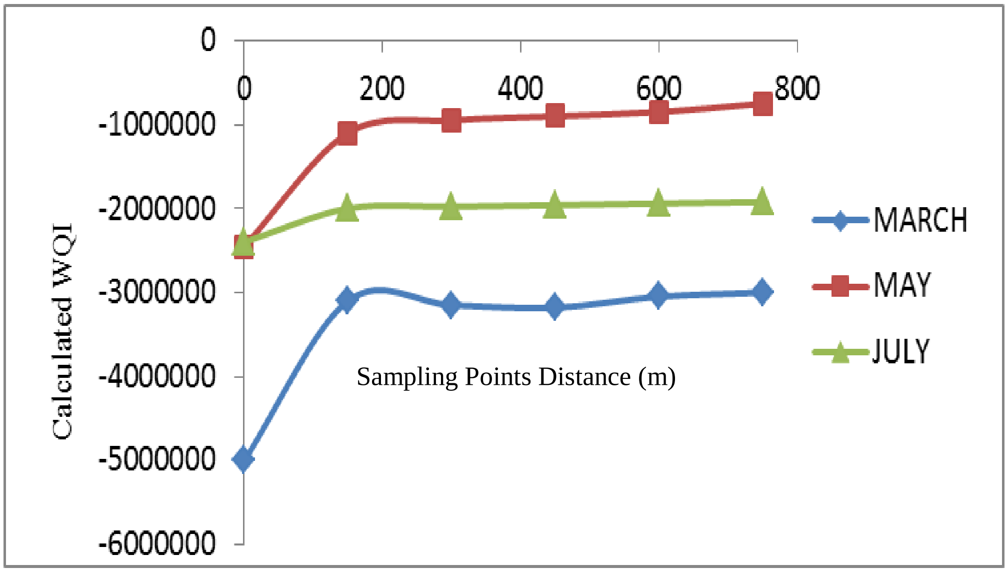

Figure 2 Variation of WQI with distance of sampling stations for different months

Table 4 Descriptive statistics and calculated Pearson Correlation value for March, 2014

	Mean	Std. Deviation	**N**
Computed Water Quality Index	-3.422E6	7.59527E5	6
Sampling Distance (m)	3.75000E2	280.62430	6

Correlations

		Computed WQI	Sampling Distance (m)
Pearson Correlation	Computed Water Quality Index	1.000	.678
	Sampling Distance (m)	.678	1.000
Sig (1-tailed)	Computed Water Quality Index		.069
	Sampling Distance (m)	.069	
N	Computed Water Quality Index	6	6
	Sampling Distance (m)	6	6

Table 5 Descriptive statistics and calculated Pearson Correlation value for May, 2014

	Mean	Std. Deviation	N
Computed Water Quality Index	-1.028E6	6.98592E5	6
Sampling Distance (m)	3.75000E2	280.62430	6

Correlations

		Computed WQI	Sampling Distance (m)
Pearson Correlation	Computed Water Quality Index	1.000	.878
	Sampling Distance (m)	.878	1.000
Sig (1-tailed)	Computed Water Quality Index		.011
	Sampling Distance (m)	.011	
N	Computed Water Quality Index	6	6
	Sampling Distance (m)	6	6

Table 6 Descriptive statistics and calculated Pearson Correlation value for July, 2014

	Mean	Std. Deviation	N
Computed Water Quality Index	-1.930E6	2.25822E5	6
Sampling Distance (m)	3.75000E2	280.62430	6

Correlations

		Computed WQI	Sampling Distance (m)
Pearson Correlation	Computed Water Quality Index	1.000	.843
	Sampling Distance (m)	.843	1.000
Sig (1-tailed)	Computed Water Quality Index		.017
	Sampling Distance (m)	.017	
N	Computed Water Quality Index	6	6
	Sampling Distance (m)	6	6

Table 7 Least square regression summary for March, 2014

Model	R	Std. Error of the estimate	Change Statistics					Durbin-Waston
			R^2 Change	F Change	df1	df2	Sig. F. Change	
1	.678[a]	6.23844E5	.460	3.411	1	4	.138	1.723

a. Predictors: (Constant), Sampling Distance (m)
b. Dependent Variable: Computed Water Quality Index

ANOVA[b]

Model	Sum of Squares	df	Mean Square	F	Sig.
1 Regression	1.328E12	1	1.328E12	3.411	.138[a]
Residual	1.557E12	4	3.892E11		
Total	2.884E12	5			

Table 8 Least square regression summary for May, 2014

Model	R	Std. Error of the estimate	Change Statistics					Durbin-Waston
			R^2 Change	F Change	df1	df2	Sig. F. Change	
1	.878[a]	3.74469E5	.770	13.401	1	4	.022	1.605

a. Predictors: (Constant), Sampling Distance (m)
b. Dependent Variable: Computed Water Quality Index

ANOVA[b]

Model	Sum of Squares	df	Mean Square	F	Sig.
1 Regression	1.879E12	1	1.879E12	13.401	.022[a]
Residual	5.609E12	4	1.402E11		
Total	2.440E12	5			

Table 9 Least square regression summary for July, 2014

Model	R	Std. Error of the estimate	Change Statistics					Durbin-Waston
			R^2 Change	F Change	df1	df2	Sig. F. Change	
1	.678[a]	6.23844E5	.460	3.411	1	4	.138	1.723

a. Predictors: (Constant), Sampling Distance (m)
b. Dependent Variable: Computed Water Quality Index

ANOVA[b]

Model	Sum of Squares	df	Mean Square	F	Sig.
1 Regression	1.328E12	1	1.328E12	3.411	.138[a]
Residual	1.557E12	4	3.892E11		
Total	2.884E12	5			

Table 10 Regression coefficient statistics for March, 2014

Model	Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	95% Confidence Interval B Lower Bound	Upper Bound
1 (Constant)	-4.112E6	451505.2		-5.365E6	-2.858E6
Sampling Distance M)	1836.272	994.2	0.678	-924.019	4596.563

a. Dependent variable: computed water quality index

Table 11 Regression coefficient statistics for May, 2014

Model	Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	Correlations Zero-order	Partial	Collinearity Statistics Tolerance
1 (Constant)	-1.84E6	271020.7				
Sampling Distance (M)	2184.649	596.8	.878	.878	.878	1.00

a. Dependent variable: computed water quality index

Table 12 Regression coefficient statistics for July, 2014

Model	Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	Correlations Zero-order	Partial	Collinearity Statistics Tolerance
1 (Constant)	-2.18E6	98177.4				
Sampling Distance (M)	678.695	216.2	.843	.843	.843	1.00

a. Dependent variable: computed water quality index

4.0 CONCLUSION

This research has shown clearly the effect of discharge point on water quality index on Ikpoba River which serves as recipient of highly polluted effluent from nearby brewery and several abattoirs within the location. The pH, COD, turbidity and TSS of Ikpoba river raw effluents were not within tolerable limits in comparison to standard effluent discharge requirements set by WHO and European discharge standards (see Table 2). The regression analysis carried out on the sampling distance and water quality index in months of March, May and July, 2014, revealed that the water quality index of the river water improved as the sampling distance from the discharge point increased with the month of March being an exception. Low river dilution in the month of March is responsible for the high contaminants concentration which invariably affected the river water quality irrespective of the sampling distance. In view of the fore-going, appropriate effluent treatment should be done before disposal especially in dry season when river dilution is low. Also, there should be considerable distance between the discharge point and end users in the downstream. This will help prevent epidemics since the water quality index improves with increase in distance from discharge point.

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