Nigerian Journal of Technology (NIJOTECH)
Vol. 32. No. 2. July 2013, pp. 294 – 303

University of Nigeria, Nsukka, ISSN 1115-8443
www.nijotech.com

INFLUENCE OF EFFLUENT DISCHARGE AND RUNOFFS INTO IKPOBA RIVER ON ITS WATER QUALITY

A. C. Igboango *, L. I. N. Ezemonye†, C. M. Chiejine[Φ]
*PRODUCTION ENGINEERING DEPARTMENT, UNIVERSITY OF BENIN,BENIN CITY, NIGERIA
†NATIONAL CENTRE FOR ENERGY AND ENVIRONMENT, UNIVERSITY OF BENIN, BENIN CITY, NIGERIA
[Φ]ELECTRICAL ENGINEERING DEPT., DELTA STATE POLYTECHNIC OGWASHI-UKU,DELTA STATE, NIGERIA

[Φ]pstchiejine@yahoo.com, *anthony.igboanugo@uniben.edu

Abstract

Unfettered effluent discharge, in addition to seasonal runoffs, into Ikpoba River, have been blamed for the ever poor water quality noticed in the river. This study seeks to investigate the role of industrialization and/ or urbanization on the degraded water quality of the river. Chemical analyses of samples of the river water collected at predetermined sampling points were undertaken and the observations obtained were subjected to ANOVA, correlation, and eigenvalue analysis. Results obtained showed that each point source has its relative contribution to the overall degradation of the river water quality. In merit order, the eigenvalue analyses carried out suggests that phosphate, nitrate, cadmium, copper, iron, lead and turbidity are the most offensive factors showing values of 0.868, 0.933, 0.770, 0.503, 5.063, 0.717, 30mg/L respectively. Remarkably, surface runoffs from municipal drains channelled to stations 1 and 2 contribute significantly to the turbidity with 4.333 and 4.233mg/L respectively, whereupon urbanization and industrialization are seemingly the culprits.

Keywords: pollutants, eigenvalue, heavy metals, turbidity, differential treatment, ichtyofaunal

Nomenclature, Symbols and Notations

Symbols

Y_{ijk}= Response variable
ε= Rrror term
Pb= Lead
β = Block variable
r_{jk}= Correlation coefficient
NO_3= nitrate
α =Treatment variable
X_{ij} ,Y_{jk}= Pair of observations
BOD=Biological Oxygen demand
μ=Mean response
Σ= Summation sign
COD=Chemical Oxygen demand
DO= Dissolved Oxygen
Cu= Copper
Fe= Iron
Cd= Cadmium
PO_4= Phosphate
Turb.=Turbidity
Temp.= Temperature
pH= Hydrogen ion concentration
Feacal col.= Feacal coliform

Notations

SST= Total sum of squares
SSA= Sum of squares for treatment
SSB= Sum of squares for block
SSE= Sum of squares for error
SST=Total sum of squares
SSAB= Sum of squares for interaction
SS= Sum of squares
MS= Mean sum of squares
MSE= Mean sum of squares for error
MSAB= Mean square for interaction between Block and treatment
MSA= Mean sum of squares for treatment
MSB= Mean square for block
df= Degree of freedom
df_B=Degree of freedom for block
df_A= Degree of freedom for treatment

df_{AB}=Degree of freedom for interaction between block and treatment
I= Upper limit number for blocks
J= Upper limit number for treatments
K= Upper limit for number of replications
ups= upstream
dns= downstream

1.0 Introduction

There are noticeable effluents loading into Ikpoba River by certain industries located near the river course. Relatedly, urban sprawl has led to unchecked generation of wastes and attendant disposal challenges. As a result, some of the liquid and other particulate matters are washed into municipal drains and natural rills by flood and eventually into the river. Developments geared towards better water quality of Ikpoba River may result to costly measures and sometimes controversial political decisions. Also, efforts towards remediation of the poor water quality of the river may become a tall order because of laxly enforced environmental protection legislations and the huge financial burden involved.

This field research uses the result of laboratory analysis of samples of water collected from the river to underscore the implications of this loading to the wellbeing of ichtyofaunal and humans in the ecosystem. Although several research work have been carried out on the river concerning effluent loading thereof, however, the balance of literature is deficient on the use of statistical and numerical methods to analyze the sample observations obtained from the river. The researches imputed adopted techniques that are unable to unravel the underlying correlations among the pollution parameters and how the presence of one can affect the others. Again, the approaches are not able to palpably indicate the severity order of the pollutants. On the contrary, the approach advocated in this paper has triumphed over the limitations of the past methods.

The literature on Ikpoba River is substantial. Representative study include[1] which noted that Ikpobariver receives effluents from two breweries, a Teaching Hospital via their drainage system and a Local Government owned abattoir, which is situated along the river bank, discharging cow blood, excreta and diverse abattoir wastes into the river. These wastes pose serious threat to the environment and human health [2]. Ikpoba River is highly disturbed while passing through Benin City where it receives profound effluent loadings from high population that depend on the stream [3].A high population density is always associated with urbanization which is most often an offshoot of industrialization. Industrial activities produce wastes which are discharged uncontrolled and unregulated into rivers and streams in most developing countries of which Nigeria is a typical example. The resultant pollution of fresh water and scarcity of clean water according to [4] have led to a situation in which one-fifth of the urban dwellers in developing countries and three quarters of their rural dwelling population do not have access to reasonably safe water supplies. Hence they resort to contaminated water with its attendant disease burden [5]. This could further reduce life expectancy in the developing countries relative to the developed ones [6].

Relatedly, Ikpoba River is used for domestic, agricultural and other sundry purposes by inhabitants around it. It is therefore observed that any activity which depletes its water quality will pose a critical threat to the human and aquatic lives.

This study seeks to ascertain the level of variability of the water quality parameters along the river while flowing through the city (which is where industrial activities are going on). This will provide evidence about the relative contribution of each of the predetermined point sources. Furthermore, the correlation among the water quality determining parameters will be determined because the combined effect of their inter-relatedness indicate the water quality of the river.

2.0 Materials and Methods

2.1 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-litre 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:* Unicam 919 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 in December, 2011 and in March, 2012 (December is a typical harmattan season while March is a typical dry season in Southern Nigeria). Figure 1 is the map of the study area showing the course of the river studied. Station 1 is the point where the wastewater from the Teaching Hospital is believed to enter the river. Station 2 which is at Ewa Road junction is where runoffs and wastes from the abattoir discharge into the river. Station 3 is the point where the effluents from a brewery were channeled into the river and station 4 is 200m downstream of station 3. Figure 1 depicts the map of relevant portion of Ikpoba River studied.

2.2 Methods

2.2.1 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.

2.2.2 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 (0-100^0 C) to the nearest 0.05^{0}C. An HACH pH meter was used for hydrogen-ion concentration (pH) determination. Dissolved oxygen (DO) and biochemical oxygen demand (BOD_5) 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[7]. The turbidity was measured on site using a micro processor turbidimeter[8]. The bacteriological parameter monitored was fecal coliform according to the method of [9]. Also, the isolation and identification of bacterial isolates were carried out in accordance with Bergey's Manual of Determinative Bacteriology [10].

2.2.3 Statistical Analysis

The obtained data were subjected to statistical analysis. Two-way analysis of variance was used for the analysis of the water quality determining parameters in order to ascertain whether there is a differential treatment of the parameters with respect to the various stations, and also to ascertain, on the other hand, the relative contribution of each of the point sources to the river (block effect). Correlation matrix (lower triangle matrix) was obtained from the data matrix to determine the cross correlation between parameters. In keeping with standard procedures [11], a systematic study of correlation coefficients of the water quality parameters was undertaken in order to assess the overall water quality and also to quantify relative concentration of various pollutants in water so as to provide necessary cue for implementation of rapid water quality management programme.The resulting correlation matrix was treated as an eigenvalue problem and eigenvectors were extracted with the aid of MATLAB version 7.5.0.342 (R2007b) software and necessary interpretations made.

2.2.4 Theoretical Brief

The theories underpinning the ANOVA and the correlation matrix as applied in this study are briefly presented in this section.

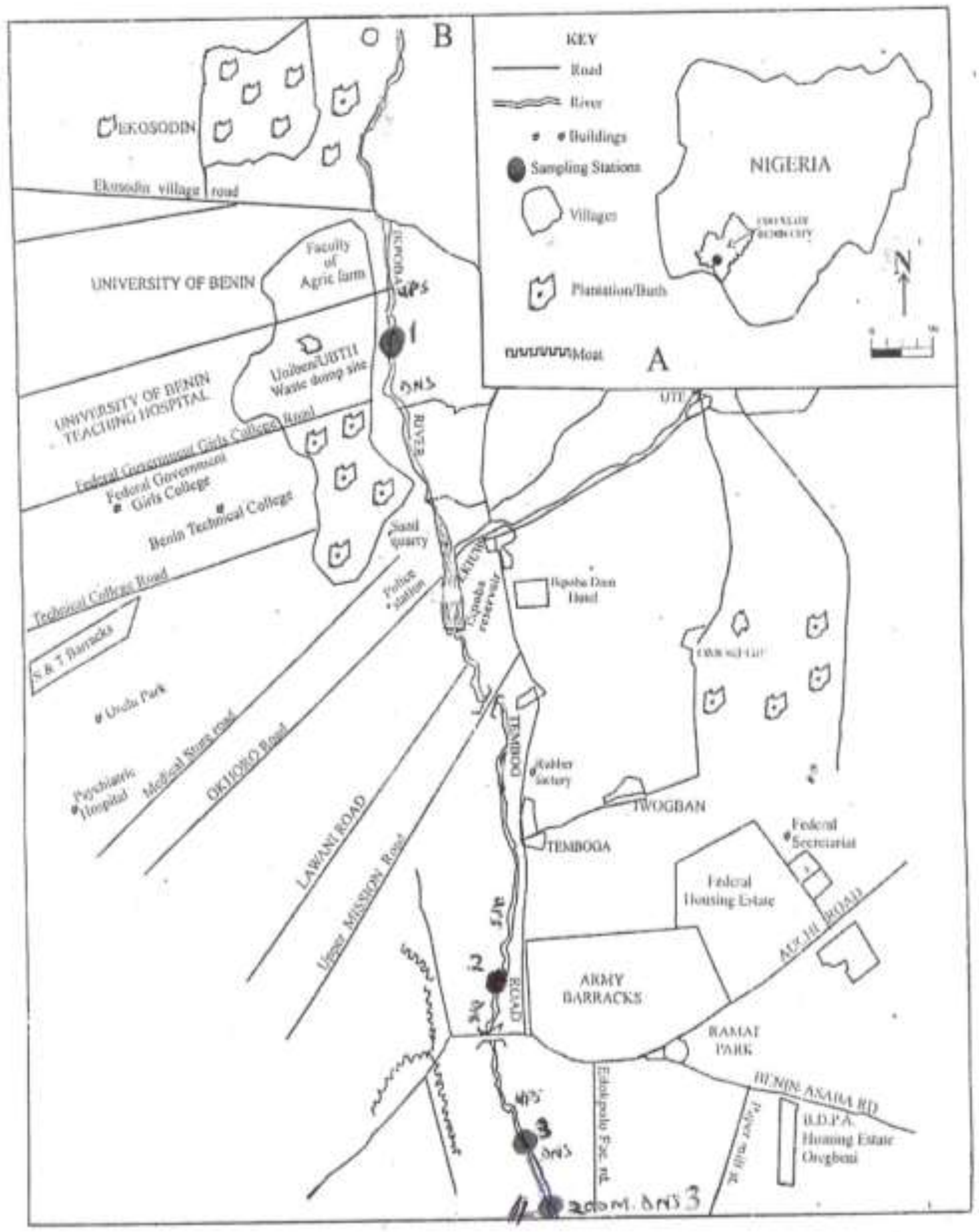

Fig. 1: The study area: (A) Map of Nigeria showing Edo State, (B) Map of Ikpoba River showing Sampling Stations

2.2.4.1. Two-Way ANOVA

$$\gamma_{ijk} = \mu + \alpha_j + \beta_i + (\alpha\beta)_{ij} + \varepsilon_{ijk} \quad (1)$$

where $\gamma_{ij} = observation$
where $\beta_i = block\ effect$
$(\alpha\beta)_{ijk}$ = interaction effect
ε_{ijk} = erro term
$\mu_x = \mu$ = overall mean (true mean)
μ_j = treatment mean

$$\gamma_{ijk} = \mu + \alpha_j + \beta_i + (\alpha\beta)_{ij} + \varepsilon_{ijk} \quad (2)$$

γ_{ijk} = response variable
μ = overall mean and it is associated with SST = $\sum\sum\sum X_{ijk} - C$
α_j = treatment component and its associated with SSA = $\sum_i \sum_k \frac{X_{.j.}}{JK} - C$
βi = block effect and it is associated with SSB = $\sum_j \sum_k \frac{X_{i..}}{JK} - C$
$(\alpha\beta)_{ik}$ = interaction effect and it is associated with SSAB
$= \sum_k X_{ij.} - \sum_j \sum_k \frac{X_{i..}}{JK} - \sum_i \sum_k \frac{X_{.j.}}{JK} + C$
ε_{ijk} = error term (SSE)

2.2.4.2 Computation of Correlation Coefficient

The Correlation Coefficients were computed using the following formula:

$$R_{jk} = \frac{\Sigma xy}{\sqrt{(\Sigma x^2).(\Sigma y^2)}}, i = 1,2,3, \ldots \quad (3)$$

Where $x = X_{ij} - X_{.j}, y = Y_{ij} - Y_{.j}$

It is noted here that (X,Y) is a pair of water quality parameters. Then a collation of the set of computed r_{ij} according to the upper bounds of i and j comprise the lower triangular correlation matrix.

2.2.4.3 Hypothesis Statement

(a) Treatment

H_0 : all $\alpha_j = 0$, $\alpha_j = \mu_j - \mu_x$

i.e. treatment (column) means are not significantly different from the overall mean. In other words there is no differential treatment.

H_1 : some $\alpha_j \neq 0$

i.e. there is differential treatment .

(b) Block

H'_0 : all $\beta_i = 0 \ \forall_i$

i.e. there is no block effect. In order words no variation of pollution concentration before and after each station studied

H'_1 : some $\beta_i \neq 0$

i.e. there are variations before and after each station (block effect)

(c) Interaction

H''_0 : all $(\alpha\beta)_{ij} = 0$

i.e. there is no interaction between treatment and block H''_1 : some $(\alpha\beta)_{ij} \neq 0$

i.e. there is interaction between treatment and block

3. Results and Discussion

The result of this study are presented below:

3.1 Data Presentation

Data for the study is represented as 7x13 matrix, illustrating observations of water quality parameters according to the various stations delineated. Table 2 shows the ANOVA results

Table 1: Data Matrix of Ikpoba River Quality Parameters

	PO4	NO3	Cd	Cu	Fe	Pb	Turbidity	Temp.	Feacal col.	Ph	DO	BOD	COD
station1 (ups)	0.317	0.491	0.346	0.259	1.552	0.194	2.5	26.467	16.333	7.443	8	3.267	25
station1 (dns)	0.489	0.724	0.316	0.191	1.425	0.137	4.333	25.066	26.667	7.827	7.567	5.767	39.667
station2 (ups)	0.246	0.629	0.641	0.245	1.467	0.155	2.367	27.033	20.667	7.457	6.8	0.7	28.4
station2 (dns)	0.334	0.707	0.732	0.267	2.737	0.126	4.233	27.467	25	7.27	6.433	4.1	28.133
station3 (ups)	0.432	0.499	0.4	0.137	2.097	0.135	2.633	27.8	12	7.41	7	1.267	27.933
station3 (dns)	0.868	0.933	0.77	0.503	5.062	0.717	30	27.433	126.33	6.16	0.267	16.467	277.633
200M dns	0.133	0.487	0.399	0.049	1.108	0.039	2.933	26.7	13.333	7.52	6.667	1.733	12.933

Table 2: ANOVA Result Table

Source of variability	(df)	SS	MS	$F_{calculated}$	F_{table}	Decision
Treatment	J –1 = df_A 7 – 1 = 6	SSA = 30805.1236874	$\frac{SSA}{J-1} = MSA$ =5134.18	$\frac{MSA}{MSE}$ =97.465969	$F_{J-1,IJ(K-1),\alpha}$ 6,182,0.05 = 2.10	$F_{calculated}$> F_{tab} reject H_O
Block	df_B = I – 1 = 13-1 =12	SSB = 93600.53944	$\frac{SSB}{I-1} = MSB$ = 7800.04495	$\frac{MSB}{MSE}$ = 148.073862	$F_{(I-J)IJ(k-1),\propto}$ $F_{12,182,0.05}$ =1.75	$F_{calculated}$> f_{tab} Reject H_O
Interaction	df_{AB} (I-1) (J-1) = 12 x 6 = 72	SSAB =155978.555	$\frac{SSAB}{(I-1)(J-1)} = MSAB$ =2166.3688	$\frac{MSAB}{MSE}$ = 41.1257372	$F_{(I-1)(J-1)IJ(K-I)\alpha}$ 12,6,182,0.05 = 4.0	$F_{ratio} > F_{tab}$ Reject H_O
Error	IJ (K-I) 13 x 7 (3-10) = 182	SSE = 9587.162537	$MSE = \frac{SSE}{IJ(K-1)}$ = 52.676717			
Total	IJK -1 =(13 x 7 x 3)-1 = 272	SST 289971.381367	SST/IJK-1 = 1066.071255			

Table 2 shows that the three null hypothesis H_O, H'_O, H''_O are respectively rejected at a p-value of 0.05, suggesting that there appears to be differential treatment and block effects. Also interaction appears to exist between treatment and various point sources studied.

3.1.1 Examination of Treatment Effect

Since F_{cal} = 97 > F_{tab} = 2.10, the F_{cal} is way beyond the F_{tab} in the statistical table, the experimental data therefore do not furnish enough proof for us to accept the null hypothesis H_O of lack of differential treatment at a p-value of 0.05. Our conclusion therefore is that the listed water quality parameter contribute significantly to river pollution.

3.1.2 Examination of Block Effect

Reference to Table 4, again, F_{cal}=148 >F_{tab}=1.75; F_{cal} is way beyond the F tabular value suggesting that our experimental data furnishes paucity of evidence for us to accept the null hypothesis of lack of block effect. The implication therefore is that the point source contribute significantly to the perceived river pollution.

3.1.3 Examination of Interaction Effect

Further, we note that F_{cal}=41.13> F_{tab}=4.0; once more, the calculated Fisher's ratio is far away to the right of the tabular value which gives a positive indication that there is certainly interaction between the set of water quality parameters on the one hand and the point source on the other. In effect, point sources are where pollutants are injected into water body thereby intensifying the pollutant concentration. Overall, it is quite evident from the foregoing analysis that Ikpoba River is loaded with effluents of various kinds from several point sources.

The Two- way analysis of variance (ANOVA) carried out on the samples of the river water collected revealed differential treatment. In other words the results depicted in Table 2 reveal significant variations in the levels of the water quality determining parameters. The import is that the experimental data do not provide sufficient evidence for the acceptance of the null hypothesis (H_O)

3.2 Correlation Matrix

Sample Computation:

r_{14} = correlation between the following columns

X_1 = [0.317, 0.489, 0.246, …, 0.133]^T for PO_4

X_1 = [0.259, 0.191, 0.245, …, 0.049]^T for Cu

$$\therefore r_{14} = \frac{\sum xy}{\sqrt{\sum x^2 \sum y}} = 0.8124$$

Excel software was used for the determination

Other correlation coefficients were computed with MATLAB software and the entire values summarized in a table of lower triangular correlation matrix (see Table 3). The upper triangular correlation matrix is obtained by reflectance.

Table 3 shows the numerical values of correlation coefficient, r_{jk} for thirteen (13) water quality parameters studied.

The correlation coefficient ascertains the extent of relationship among chosen variables.. The closer the correlation coefficient is to $\pm 1$the more perfect relationship between the variables. With a few exceptions, Table 3 indicates that water pollution parameters studied correlate substantially among themselves. For instance, feacal coliform correlates meritoriously with pH, DO, BOD, and COD.

3.3 Eigenvalue and Eigenvector Analysis

Figure 2 depicts the eigenvalue plot

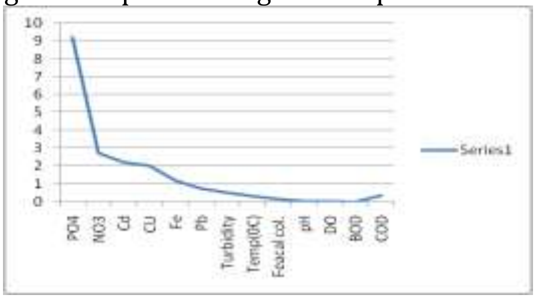

Figure 2: Eigenvalue plot by water quality parameter

The eigenvalue analysis presents the results in four observable modes. The first mode comprises the radicals i.e PO_4 and NO_3 with the highest magnitude of λ_1= 9.2151 and λ_2 =2.7476 respectively as shown in Figure 2. This result is corroborated by [12] which asserted that the presence of high amount of phosphates and nitrates is a main cause of the destruction of fresh water and lake ecosystems around the world. Additionally, [13] noted that scientists have studied mineral levels in different bodies of water, and have found that levels of phosphates and nitrates heavily impact the overall health of the water and its inhabitants.

Further, nitrate and phosphate pollution are man-made influences such as the effluents from sewage and improperly treated wastewater from factories, as well as runoffs from farms and urban centres. From our results however, it is obvious that the major contributory point sources of phosphate and nitrate pollution are stations 1 and 3 downstream (where two major industries along the course of the studied river discharge their untreated effluents directly into the river).

Moreover, brewery plants produce varied pollutants from individual process steps. Generally, however, it contains organic materials such as spent grains, waste yeast, spent hops and grit. Nitrate which has the second highest eigenvalue is the end product of aerobic decomposition of these organic nitrogenous matters from the brewery [12]. Hence the results of the samples collected from station 3 downstream, where brewery effluents are discharged into the river show very high level of nitrate composition. This indicates that this point source contribute to the high pollution stress in the river studied. The paper [14] reported a very high concentration of nitrate in hospital wastes.

Table 3: Correlation coefficient among various water quality parameters of Ikpoba River Quality Parameters

	PO4	NO3	Cd	Cu	Fe	Pb	Turb.	Temp	Feacal col.	pH	DO	BOD	COD
PO4	1												
NO3	0.816	1											
Cd	0.399	0.683	1										
Cu	0.813	0.371	0.699	1									
Fe	0.793	0.809	0.731	0.998	1								
Pb	0.864	0.788	0.572	0.912	0.918	1							
Turb.	0.757	0.823	0.590	0.862	0.928	0.972	1						
Temp.	0.223	0.006	0.599	0.235	0.341	0.268	0.247	1					
Feacal col.	0.792	0.892	0.618	0.871	0.925	0.976	0.995	0.213	1				
pH	-0.70	-0.69	-0.76	-0.8	-0.95	-0.20	-0.93	-0.54	-0.85	1			
DO	-0.66	-0.81	-0.69	-0.7	-0.93	-0.93	-0.97	-0.39	-0.96	-0.959	1		
BOD	0.54	0.60	0.369	0.84	0.892	0.931	0.963	0.053	0.9694	-0.84	-0.90	1	
COD	0.57	0.56	0.49	0.6	0.91	0.97	0.99	0.24	0.99	0.93	0.97	0.9552	1

Furthermore, [15] observed that phosphates indicate the effects of industrial pollution.

The second mode comprises of the heavy metals, Cadmium, Copper, Iron, and Lead of 2.2183, 2.0063, 1.1975 and 0.7371 mg/L respectively. Although the eigenvalue tool applied ranked heavy metals as middling, however, the effect on human health is deleterious. The tool placed Cadmium and Lead as the first and last respectively among the heavy metals while Copper and Iron are intermediate. Lead has been traced to be the leading cause of heart dysfunction and kidney damage. In Zamfara state of Nigeria for example, lead contaminated water killed 111 children between March and June 2010 [16]. More important when humans consume fish that has heavy metal, the metal remain in human system , a situation that has been described as absorbing state. It hardly leaves the system. This aspect of health implication tends to underpin the significance of this study.

Heavy metals find their way into fresh water bodies by industrial and consumer waste, or even from acidic rain breaking down soils and releasing heavy metals into streams , lakes and rivers. The study [17] noted that point sources of heavy metals into the rivers include wastewater effluent containing metals from metabolic waste sludge which may substantially contribute to metal loading.

The third mode includes turbidity, temperature, faecal coliform and COD with eigenvalues of 0.5053, 0.3213, 0.1679, and 0.3662 respectively. Turbidity is a measure of opaqueness, translucence, unclearness, and murkiness in appearance of running water. It is majorly caused by undissolved, suspended matters in rivers. COD is the amount of Oxygen consumed during the chemical oxidation of organic matter. Industrial effluents are characterized by abnormal turbidity and chemical Oxygen demand (COD). The presence of faecal coliform in running water is attributed to faecal pollution of the water bodies by human activities [18].The study [19]observed that high temperature is usually associated with bottle washing plants (which is one of the major processes in the brewery industry).

The eigenvalue indicates that pH , DO and BOD which make up the fourth mode are not pollutants in themselves and by themselves, but rather as indicators of pollution, hence the low eigenvalues they wield. These correlations clearly depict behaviour of these water quality determining variables in the effluents going into the river. The results obtained, as can be seen from Table1, suggests that most of the measured parameters have immediate effects and they get weakened as they flow downstream.

The results of the water quality determining parameters obtained from samples at different points, as shown in Table 1, evidently reveal that there are variations in the values of PO_4 obtained from the various sample points in this study. However, the ones that are outstandingly significant are those obtained from station 1 downstream, that is the one obtained from the downstream of the government owned hospitals well as the one obtained from a brewery downstream which are 0.489 and 0.868 mg/l respectively. This implies that the government-owned Hospital and the brewery contribute more to the addition of PO_4 in the river. The NO_3 profile of the water samples varies significantly and ranged from 0.487 to 0.933 mg/l .

It is important to note that nitrate is the most highly oxidized form of nitrogen compounds commonly present in surface and groundwater because it is the end product of aerobic decomposition of organic nitrogenous matter [20]. Usually unpolluted natural water contains very insignificant amount of nitrate [21]. Again, the brewery (station 3) downstream was found to have the highest contribution to the nitrate profile of the section of the river studied with 0.933mg/l, followed by the hospital (station 1) downstream) with 0.487mg/l.

The Cadmium (Cd) regime of the samples ranged from 0.316- 0.770mg/l with the highest value of 0.77mg/l obtained from the brewery (station 3) downstream followed by the government owned hospital station 1 (downstream) with a value of 0.732mg/l.

The values of water quality determining parameters obtained from stations 3 and 1 are consistently higher than values obtained from the other stations studied as can be seen in Table 1. It can therefore be inferred that effluents from these two stations contribute more to the degradation of the water quality of the section of the river studied.

4.0 Conclusion

This study sought to analyze the influence of effluent discharge and runoffs into Ikpoba River on its water quality. The results show that each point source has its own relative contribution to the overall degradation of the water quality of the river with station 3 contributing most, followed by station 1 and then finally followed by station 2. The study also reveals that significant differences exist among the mean quality parameters. By implication we can state categorically that the differences in means are not as a result of chance error but due to deliberate input of such pollutants at various points in the river.

The eigenvalue clearly depicted the pollutants in the order of the severity of their effects on the water quality of the river studied, with nitrate and phosphate being most troublesome. This study therefore shows that these industries contribute significantly to the increasing degradation of Ikpoba River. Furthermore, the high turbidity recorded at stations 1 and 2 also suggests that urban sprawl with its attendant huge waste generation results to liquid and other particulate matters being washed into the river through the drains and natural rills.There is therefore the need for all concerned, especially the environmental regulatory agencies in Nigeria, to check the uncontrolled discharge of effluents into the river to forestall the unpleasant incident of epidemic which is likely to occur if the trend continues unchecked. This could be done by strictly enforcing the abounding relevant laws in the country on lotic system pollution.

Finally, the study has revealed that industrialization and urbanization have negatively impacted on the water quality of Ikpoba River as a result of the discharge of untreated and unchecked effluent discharges from industries into the rivers from the industries under reference.

References

[1] Igboanugo A.C., Chiejine, C.M. A Mathematical Analysis of Brewery Effluent Distribution in Ikpoba River in BeninCity, Nigeria. *ARPN Journal of Engineering and Applied Science* Vol. 6, Number 9 September 2011

[2] Rahman, A; Lee, H.K and Khan, M.A. Domestic Water Contamination in Rapidly Growing Megacities of Asia: Case of Karachi, *Pakista Environment Monitor,*1997

[3] Victor, R and Dickson, D.T. MacrobenthicInvertebrate of a Perturbed Stream in Southern Nigeria. *Environmental Pollution*(series A) 38: 1985,pp99 – 10

[4]Lloyd, B; Helmer, R.*Surveillance of Drinking Water Quality in Rural Area.* Longman Scientific and Technical Publication. New York, Wiley 1992

[5] Okoh, A.I; Odjadjare, E.E; Igbinosa, E.O; Osode, A.N.Wastewater Treatment Plants as a Source of Microbial Pathogens in the receiving watershed. *African Journal of Biotechnoloy*, 6(25) 2007 pp2932-2944.

[6] WHO.Water and Health in Europe: A Joint Report from the European Environment Agency and the WHO Regional office for Europe. *World Health Organization, WHO Regional Publications, European* series No. 93, 2002

[7] APHA.*Standard Method for Examination of Water and Wastewater*. American Public Health Association, 17th Ed. Port city Press, Baltimore. 1992, pp1391

[8] HATCH. *Digital TitratorHandbook*. HATCH company USA. 1991, pp121

[9] Gerhardt P, Murray EGR, Wood A.W, Krieg R.N (1984). *Methods for General and Molecular Bacteriology*.ASM.Press. Washington, DC. pp791.

[10] Buchanan and Gibbon. *Bergey's Manual of Determinative Bacteriology* 8thedn. Williams and Wilken Co. Baltimore. 1998, pp3100

[11] Jothivenkatachalam, K., Nithya, A., and Chandra Mohan, S. Correlation Analysis of Drinking Water Quality in and around Perur block of Coimbatore District, Tamil Nadu, India. *Rasayan Journal of Chemistry*, 3(4), 2010, pp649-654.

[12] Igbinosa E.O. and Okoh, A.I.Impact of Discharge Wastewatereffluents on the Physico-chemical qualities of a receiving Watershed in a Typical Rural community.

International Journal of Environmental Science and Technology 6 (2), 2009,pp175 – 182.

[13] Jaji, M.O; Bamgbose, O; Odukoya, O.O; Arowolo, T.A. Water quality assessment of Ogu River, South West Nigeria.*Environmental Monitor.Assess,* 133 (1-3), 2007,pp447 – 482.

[14] Ansar, A; and Khad, F. Eutrophication: An Ecological Vision. *The Botanical Review*, 71(4), 2005, pp449-482.

[15] Yanamadala, V. Calcium Carbonate Phosphate Binding Ion Exchange Filtration and Accelerated Denitrification to Improve Public Health Standards and Combact Eutrophication in Aquatic Ecosystems. *Water Environment Research,* 77(7), 2005, pp. 3003-3012

[16] BBC News. Nigeria-Lead Poisoning Kills 100 children in North 4 June 2010

[17] Ekhaise F.O and Omavwoya. The Influence of Hospital Wastewater Discharged from the University of Benin Teaching Hospital (UBTH), Benin city on its receiving Environment. *American-Eurasia Journal of Agriculturre and Environmental Science* 4(4), 2008,pp484-488

[18] Rishi and Rishi. Ecological Effect of Urbanization on Swan River Watershed District Una, Himachal Pradsh. *International Journal of Pharmacy and Life Sciences* 2(5) May, 2011, pp723-729

[19]Aaron, A and Gabriel, H. Heavy Metal Pollution and *Agricultural. TSM 424 Public Information Bulletin Fal,l* 2006, pp1-8

[20]Aluyi, A.S.A; Ekhaise, O.F; Adelusi, M.D. Effect of Human Activities andoil Pollution on the Microbiological and Physiological Qualities of Udu River, Warri, Nigeria. *Journal of Applied sciences* 6(5), 2006,1214-1219

[21] Kosaric.*Treatment of Industrial Wastewater by Anaerobic process-newdevelopments in Recent Advances in Biotechnology*. Vardar-Sukan, F and Sukan, S.S (eds). Kluwer Academic Publishers, Netherlands, 1992.