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RESEARCH ARTICLE

ANALYSIS OF THE WATER QUALITY CHARACTERISTICS OF INTAWAOGBA RIVER

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ABSTRACT

This study examined the water quality characteristics and self-purification capacity of Intawaogba River. This was done by collecting samples from five (5) sampling points over 300m distance, analysing the physiochemical and heavy metal parameters (pH, Temperature, Salinity, TSS, Turbidity, DO, BOD, Colour, Phosphate, Sulphate, Lead and Iron). The physical parameters were analysed on site while the chemical parameters were analysed carefully in the laboratory. pH, Temperature, Turbidity, TSS, Salinity and Colour had the mean values of 6.10, 26.82^{0}C, 7.22mg/L, 39.60mg/L and 245.20PtCo respectively, while DO, BOD, Phosphate and Sulphate had mean values of 4.35mg/L, 2.39mg/L, 0.78mg/L and 6.67mg/L respectively. Heavy metals Lead and Iron had concentrations of <0.1mg/L and 0.63mg/L. The linear correlation statistics between water values and distances downstream further showed that four parameters (DO, pH, Turbidity and Iron) actually decreased with distances downstream with correlation values of -0.71; -0.71; -0.14 and -0.75 respectively; showing evidences of self-purification. The other parameters (BOD, Salinity, Colour, TSS, Phosphate and Sulphate) increased with distance downstream having correlations values of 0.22; 0.69; 0.65; 0.51; 0.88 and 0.81 respectively; indicating a high correlation values The experimental results indicated that DO and Turbidity in the river actually exceeded the Federal Ministry of Environment (FMEnv) permissible limit for surface water. The researchers call for more stringent law on waste discharge into the Intawaogba river and closer monitoring of its water quality.

INTRODUCTION

Fresh water resource is the most valuable assets of the human civilization. It serves a major role in overall economy of a country due to inevitable demand of water in all sectors of life. It has many economic values including fishing, electricity generation, recreational activities, transport and irrigation, biodiversity; water for domestic and industrial uses. and harbour for discharging wastewater. Surface water quality is influenced by various anthropogenic activities and natural processes. In many developing countries such as Nigeria, wastewater is disposed into the natural water bodies due to their capacity to assimilate and dilute the harmful constituents of the effluents. The water quality degradation is evident as a result of effluents added in a water body (Adekunle and Eniola, 2008). Flowing water is capable of purifying itself with distances through a process known as self-purification; (a natural process whereby a river purifies itself of sewage or impurity). These mechanisms involve dilution of polluted water with influx of surface and groundwater or through certain complex hydrologic, biologic and chemical processes such as sedimentation, coagulation, volatilization, precipitation of colloids and its subsequent settlement at the base of the channel, or biological uptake of pollutants. On the other hand, certain streams are capable of adding-up more materials as they flow downstream from riparian input[2&3]. The degree of self-purification in any river depends on temperature; water volume, velocity; amount of inorganic compound, distribution and types of aquatic weeds along the river channel (Ongley, 1991 and Oyinloye, 2015).

The water quality in tropical Nigeria cities varies depending on the river's hydraulic conditions (Ugbebor *et al.*, 2012). Water bodies have natural capacity to clean up pollutants by dispersion,but when the pollutants level is very high its loses its inherent capacity to clean up (Sulphey, 2013). Quality of water is of paramount importance because of its role to human health, aquatic life, ecological integrity and sustainable economic growth. Without good water quality sustainability, environmentally sound management of water resources will be meaningless. The relevance of this can be justified by a scientific research which stated that on a global scale, water borne disease is estimated to be responsible for about 3 million deaths and also, render sick, a billion people (WHO, 1998).

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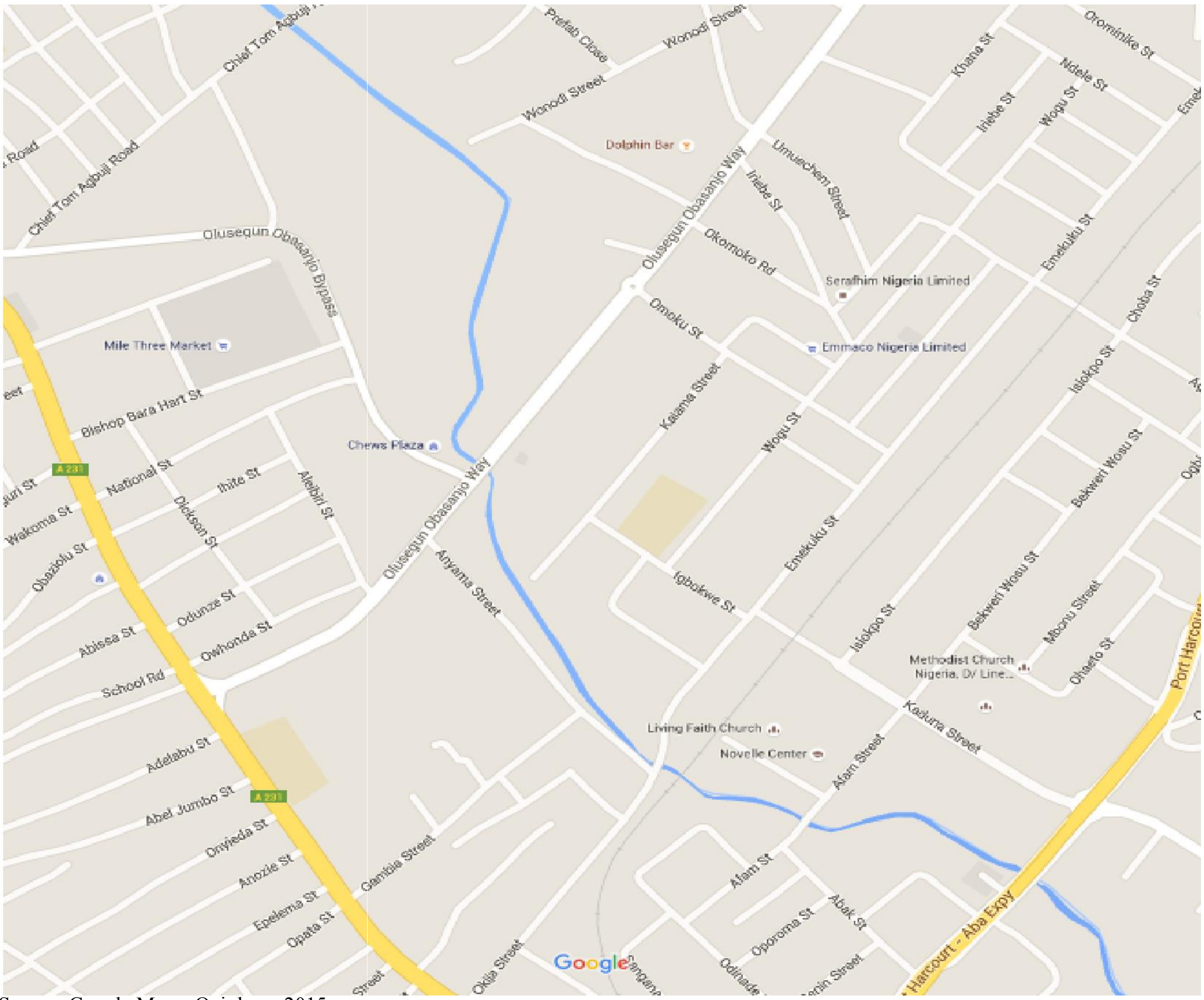
MATERIALS AND METHODS

Area of Study

The Intawaogba River is located in Trans-Amadi, Port Harcourt, Rivers State. A strategic segment of the on Intawaogba River which was selected for the study was 300m stretch. This segment was identified and selected because of the numerous and conflicting water uses taking place there. The Beehive of activities[8&9] (Ugbebor, 2011, WHO, 1996) in the area include refuse dumping by the urban residential area, car washing, mechanic workshops, and food restaurants. The drainage system in the area is channeled into the creek. Factors which contributed to these daily polluting activities and indiscriminate dumping of generated waste along streets, open spaces and river channel include the size of the town, consumption pattern and the people's attitude. These waste impacts on Intawaogba River by running storm water importing wastes from numerous sources into it. Furthermore, residents of this area use the water body as a source of domestic water supply in its untreated state.

The Extech container is used to collect water sample while such parameters as pH, Temperature, Salinity and Turbidity were successfully measured. DO and BOD samples were collected in a two 75ml DO bottle which was filled to the brim with water sample to ensure an air tight condition. This was stored in a cool containment to preserve the quality and protect the credibility and integrity of the results to be obtained. The sample for the other parameters to be tested was collected with 1L white plastic keg. Care was taken during the collection of sample because a little alteration can alter the true chemistry of the water. The sample keg was rinsed about 2-3times. It is then filled with the sample and tightly covered to avoid contamination. This sample was preserved in the cool box with ice packs. Preservation of water samples due to the time elapsed between collection of samples and the laboratory analysis is essential because organisms in water and water have samples have the tendencies to undergo several changes as a result of disturbance to the conditions of the environment hereby affecting the integrity and credibility of the results obtained (Oyinloye, 2015).



Source: Google Maps, Oyinloye, 2015.

Figure 1. Map showing Intawaogba Creek River

Water Sampling: The water sampling materials used include plastic keg, 75ml Do Bottle, odometers masking tape, measuring tape, permanent marker, camera, Cool box and note book.

Water sampling collection and preservation: In-situ measurement was carried out by the use of an Extech meter.

Laboratory Analysis

The standard methods was used to analyze the various water parameters in the Laboratory which include Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Phosphate (PO_4^{3}), Sulfate (SO_4^{2-}), Colour, Lead and Iron. The analysis was however based on the sound knowledge of the in-situ measurement methodologies to obtain the credible results.

RESULTS AND DISCUSSION

Table 1 indicated results obtained from field measurement at different stations along the River stretch. The Table showed the results of physiochemical parameters as determined in samples collected from Intawaogba river. The mean water temperature at the time of sampling was 26.82°C with a saturated DO of the river of 8mg/L.

Dissolved Oxygen

Figure 2 showed the graphical representation of DO value of the river. The control point the value was 4.78mg/L and S1, S2, S3, S4 had DO values of 4.17mg/L, 4.23mg/L, 4.29mg/L and 4.26mg/L respectively. This was below the saturated dissolved oxygen level of 8mg/L of the river.

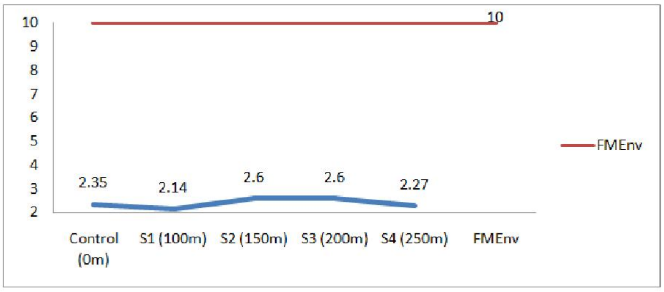


Fig. 3. BOD trend line against sampling stations compared with FMEnv standard

Temperature

Figure 4 indicated the temperature trend along sampling points. The initial temperature at the control point was 26.6°C it increased to 26.9°C at Station 1 while it maintained the same value at Station 2 and further reduced to 26.8°C at Station 3 but increased to 26.9°C at Station 4.

Table 1. Result of analysis

PARAMETERS	CONTROL	POINT 1	POINT 2	POINT 3	POINT 4	FMEnv Standard
pH	6.23	6.15	6.02	6.01	6.11	6.0-9.0
Temperature, (°C)	26.6	26.9	26.9	26.8	26.9	30
Salinity, (mg/L)	36	40	42	40	40	2000
Color, (PtCo)	231	252	249	247	247	NA
Turbidity, (NTU)	7	8	8	7	7	1.0
TSS, (mg/L)	2	11	7	9	7	10
DO, (mg/L)	4.78	4.17	4.23	4.29	4.26	10
$BOD_{5,}$(mg/L)	2.35	2.14	2.60	2.60	2.27	10
Phosphate, mg/L	0.64	0.76	0.82	0.86	0.81	5
Sulphate, mg/L	6.22	6.71	6.76	6.94	6.72	50
Lead, (mg/L)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Iron, (mg/L)	0.78	0.64	0.83	0.51	0.40	20

TSS= Total Suspended Solids; DO= Dissolved Oxygen; BOD= Biochemical Oxygen Demand.

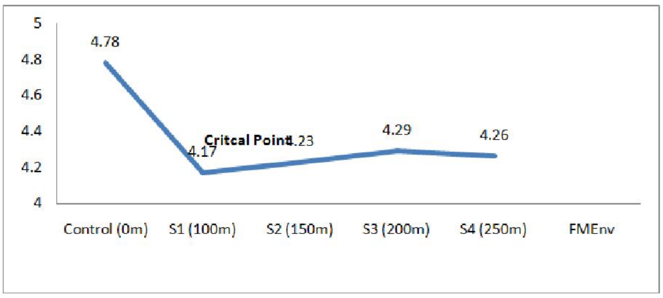


Fig. 1. DO trend line against sampling stations

Biochemical Oxygen Demand (BOD)

Figure 2 indicated the BOD trend along sampling points. The initial BOD at the control point was 2.35mg/L, it reduced to 2.14mg/L at S1, while it increased to 2.6 mg/L at S2 and maintained the same value at S3, while it reduced to 2.27mg/L. The BOD of the creek was below the FMEnv standard permissible limit of 10mg/L.

pH

Figure 3 indicated that the pH ranged from 6.01 to 6.23 for all sampling stations. The pH at the control point initially was 6.23, it reduced to 6.15 at the second sample point and reduced to 6.01 at Station 3, it later increased to 6.11 at the last sampling point, Station 4.It was observed that the pH of the water is below the FMEnv neutrality range of 6.5 – 8.5.

The temperature of the creek was below the FMEnv standard limit of 30°C.

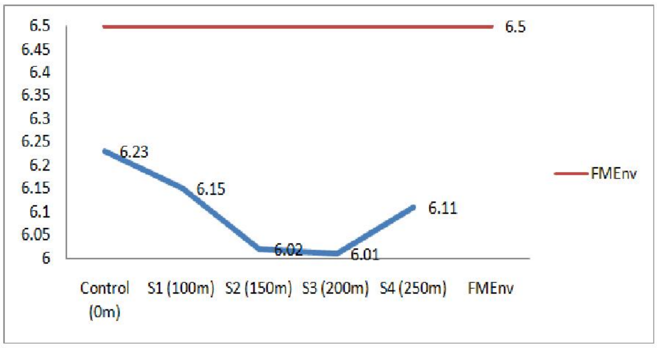


Fig. 3. pH trend line against sampling stations

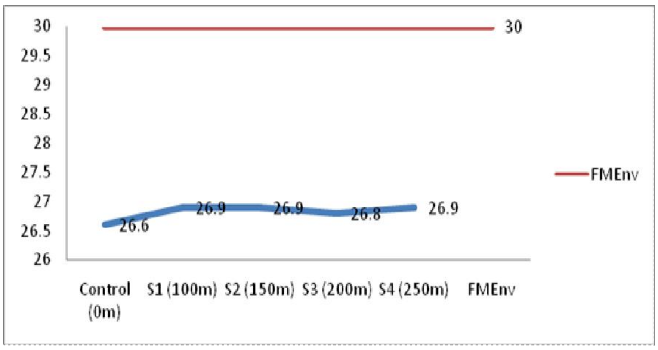


Fig. 4. Temperature trend line against sampling stations

Salinity

Figure 5 indicated that the salinity at the control point was 36 mg/L. It increased to 40 mg/L at Station 1(S1) while it increased further to 42 mg/L at Station 2 (S2) and later reduced to 40 mg/L at Station 3 (S3) and maintained the same value at Station 4 (S4). The salinity of the river was below the FMEnv standard limit of 2000mg/L.

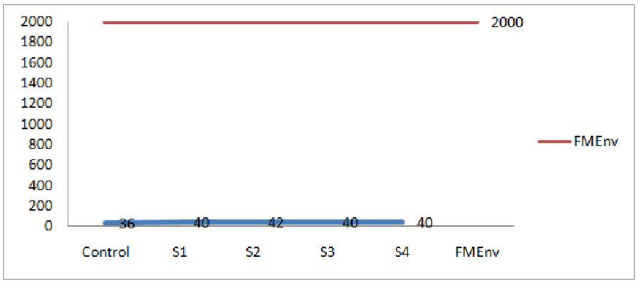


Fig. 5. Salinity trend line against sampling stations

Colour

Figure 6 indicated that the colour initially at the control point was 231 PtCo, it increased to 252 PtCo at Station 1, it reduced a bit to 249 PtCo at Station 2, and it further reduced to 247 PtCo at Station 3 and maintained the same value at Station 4 as shown.

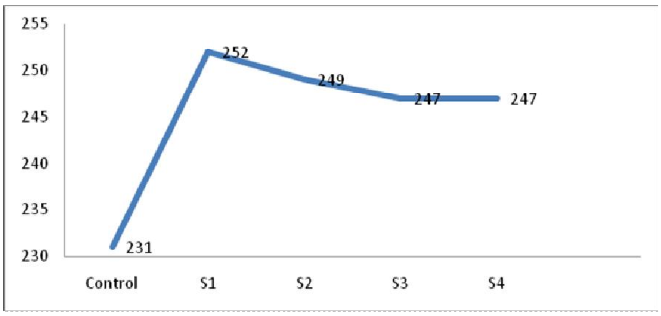


Fig. 6. Colour trend line against sampling stations

Turbidity

Figure 7 indicated that the turbidity initially at the control point was 7 NTU it increased to 8 NTU at Station 1 and Station 2, it later reduced to 7 NTU at Station 3 and it maintained the same value till Station 4. The turbidity of the river exceeded the FMEnv standard permissible limit of 1.0mg/L.

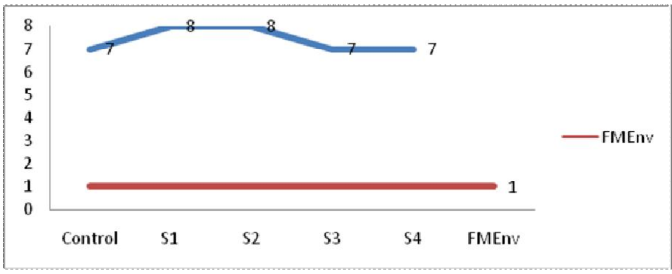


Fig. 7. Turbidity trend line against sampling stations

Total Suspended Solids (TSS)

Figure 8 indicated the TSS trend along sampling points. The TSS at the control point was 2 mg/L it increased to drastically to 11 mg/L at Station 1 which may be due to municipal drain discharge at this point, it started to reduce at Station 2 with a value of 7 mg/L it increased at Station 3 to 9 mg/L and it later reduced back to 7 mg/L at Station 4. The TSS at Station 1 exceeded the Federal Ministry of Environment limit of 10mg/L.

Phosphate

Figure 9 indicated the Phosphate trend along sampling points. The phosphate concentration at the control point was found to be 0.64 mg/L, it later increased to 0.76 mg/L at Station 1, it increased further at Station 2 and Station 3 with values of 0.82 and 0.86 mg/L respectively. It reduced a bit to 0.81 mg/L at Station 4. The Phosphate concentration was within the FMEnv standard permissible limit of 5mg/L.

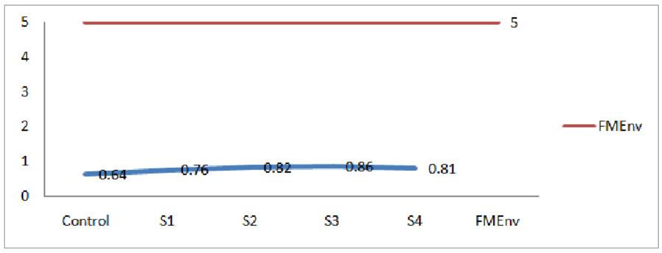


Fig. 9. Phosphate (PO_4^{3-}) trend line against sampling stations

Sulphate

Figure 10 indicated the Sulphate trend along sampling points. The sulphate concentration at the control point was 6.22mg/L, it increased to 6.71mg/L at Station 1. It further increased at Station 2 and Station 3 to 6.76mg/L and 6.94mg/L respectively. But it was observed to reduce to 6.72mg/L at the last point Station 4 as shown in figure 4.10 above. The sulphate concentration was below the Federal Ministry of Environment (FMEnv) standard permissible limit of 50mg/L.

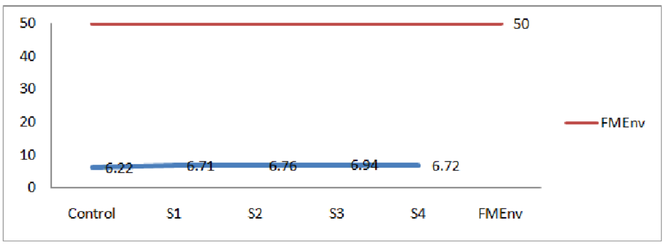


Fig. 10. Sulphate (SO_4^{2-}) trend line against sampling stations

Heavy Metals (Iron and Lead)

Iron: Figure 11 indicated the Iron trend along sampling points. The Iron concentration present in the control point is 0.78mg/L it reduces to 0.64mg/L at Station 1 but increases at Station 2 to 0.83mg/L but the concentration later reduces at Station 3 and the last point Station 4 from 0.51mg/L to 0.40mg/L respectively as shown above in figure 4.11. The iron concentration was below the Federal Ministry of Environment (FMEnv) standard permissible limit of 20mg/L.

Lead: The lead analysed in the various water sample was <0.1 and generally below the maximum permissible limits for Federal Ministry of Environment standard of 0.1mg/L.

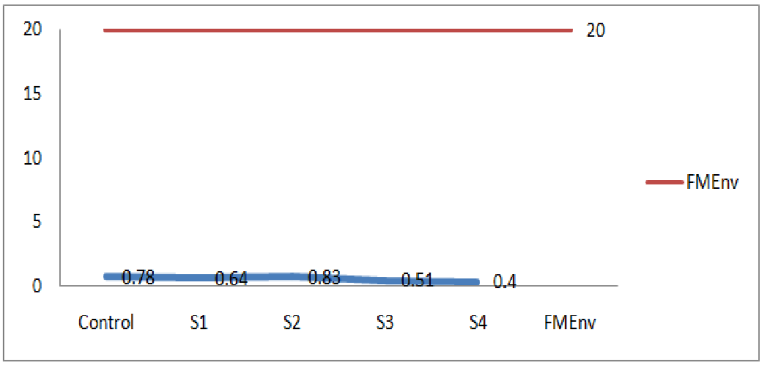


Fig. 11. Iron trend line against sampling stations

Table 2. Self-purification attributes of water samples

Variation	DO mg/L)	BOD (mg/L)	pH	Salinity (mg/L)	Colour (PtCo)	Turbidity (NTU)	TSS (mg/L)	Phosphate (mg/L)	Sulphate (mg/L)	Iron (mg/L)
Mean	4.35	2.39	6.10	39.60	245.20	7.40	7.20	0.78	6.67	0.63
Standard Deviation	0.25	0.20	0.092	2.19	8.20	0.55	3.35	0.085	0.27	0.18
Coefficient of Variation (%)	5.68	8.53	1.51	5.53	3.34	7.4	46.48	10.92	4.02	28.51
Correlation Analysis	-0.71	+0.22	-0.71	+0.69	+0.65	-0.14	+0.51	+0.88	+0.81	-0.75

Self-Purification

The result of the linear correlation (Table 2) between water values and distances downstream showed that four parameters (DO, pH, Turbidity and Iron) actually decreased with distances downstream with correlation values of -0.71; -0.71; -0.14 and -0.75 respectively, while other parameters (BOD, Salinity, Colour, TSS, Phosphate and Sulphate) increased with distances downstream having correlations values of 0.22; 0.69; 0.65; 0.51; 0.88 and 0.81 respectively and therefore indicating a high correlation value.

Conclusions

The results of the study revealed that water physiochemical parameters vary in both relative and absolute terms. DO pH and turbidity in the study segment of the River was found to exceed Federal Ministry of Environment (FMEnv) standard for surface water permissible limit. The study therefore conclude that artificial purification efforts should be directed towards increasing the level of DO and controlling the concentration of BOD, Salinity, Colour, TSS, Phosphate and Sulphate which increased with increases in distance downstream. This was clearly shown in the various descriptive statistics. The extent of variability suggested a need for a close monitoring of the physiochemical parameters for the purpose of water resource management in the study area.

Recommendations

The researchers recommended that since the control of pollution is the responsibility of the Federal and State Ministries of Environment, as Government regulatory bodies, to activate existing environmental laws; enact regulations restricting the dumping of solid waste (especially food waste) directly into water body and ensure proper enforcement of effluent quality standards before disposal.

The study further advised that improving the self-purification capacity of the Intawaogba River can be achieved by dredging which will increase the velocity of water flow, the rate of reparation by atmospheric absorption and invariably, the self purification capacity of the River.

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