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EFFECT OF WASTE DISCHARGES ON THE WATER QUALITY OF ASA RIVER IN ILORIN, NIGERIA.

S.A ADEBAYO AND G.O ADEDIRAN
Department of Chemistry, University of Ilorin,
P.M.B. 1515, Ilorin, Nigeria.

ABSTRACT.

Sections of Asa river along its course in Ilorin Kwara State Nigeria, were studied over a period of 12 months (covering the raining and dry seasons) to determine the effect of various municipal and industrial waste discharges on the water quality of the river. Water samples were collected from four different points along the course. Sampling and analysis were carried out at monthly intervals between July 2003 and June 2004. The following parameters were monitored at each point in order to assess the water quality of Asa river: pH, alkalinity, colour, turbidity, conductance, dissolved and suspended solids, total hardness, levels of magnesium, sodium, potassium, calcium, total Iron, manganese, lead, copper, nitrate, sulphate, chloride, ammonia, Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD_5) and carbon dioxide (CO_2).

The results showed that the level of pollution varied depending on the season and that the water quality was acceptable before entering the town and becomes unacceptable as it flows across the heart of the town indicating significant pollution from both industrial and municipal waste discharges.

INTRODUCTION

River pollution according to Goulden (1) is the presence in concentration higher than normal in natural waters of dissolved or suspended foreign materials such as silt, chemicals or metallic elements.

Pollutants are generally introduced into the aquatic environment in significant amounts as waste, accidental discharges or as bye-products of manufacturing processes or other human activities.

The problem of river pollution in acute form came up in the industrialized countries as a result of growth in both population and economic activities following the Industrial revolution when the rate of discharge of crude domestic and trade sewage into streams and rivers out-stepped the self-purification capabilities of the rivers resulting in severe deterioration of river water quality (2).

Although the potential pollution index of Nigerian rivers was on the average considered by Zoeteman to be low (3), as the planned modernization of Nigerian economy matures, the use of rivers for waste disposal will increase and except a control programme is initiated early enough, Nigeria will find herself battling with problems which are better avoided.

Asa river lies between lat. 8°36' and 8°24' North and between longitude 4°36' and 4°10' East. The river catchment basin is about 1040km^2 in area, stradding two states of Nigeria (Osun and Kwara). Only about 309km^2 lies in Osun state (4). The river is very significant to the socio-economic growth of Ilorin. It is being used for agricultural activities such as irrigation of farmland and fishing. It provides over 50% of fresh fish supply to the town. Apart from these, it provides water source for both industrial and domestic uses. More than ¾ of domestic and Industrial water requirements of the town and its environ is supplied from Asa river. Major Industries in the town are sited along its bank or its tributaries. The river is also being used for recreational purposes serving as a tourist attraction centre (particularly the Asa Dam). Because of the importance of the river to the town, it deserves constant monitoring for quality criteria. Hence, this study was designed to assess the impact of both domestic and industrial discharges on the quality of the River water.

MATERIALS AND METHODS.

Sampling Sites: In this study, four sampling points were identified as follows:

i. Point I (Asa Dam) – at this point, the river is dammed with a large volume of water. It is before the river enters the town.

ii. Point II (Unity Bridge) – This is about 2km from the sampling point I. The river at this point receives significant run-off waters from farmland and some Industrial effluents.

iii. Point III (station Bridge) – This is less than 1 km from the sampling point II. Significant human activities such as farming, dumping of refuse and dungs occur between point II and III. The river also receives run-off from streams and drainages from heavily residential area.

iv. Point IV (Amilengbe Bridge) – It is a distance of about 1.5km from the Station Bridge. A lot of run-off into the river from drainages and refuse dumps occurs at this point.

Sampling: sampling was carried out at approximately monthly intervals from July 2003 to June 2004 (12 months) covering both the rainy and dry season and took place between 08.00 hours and 12.00 hours. Samples were collected in polythene bottles, which were previously soaked in nitric acid and washed with distilled water before sampling. Standard sampling method for river water was used (5). Samples for the determination of dissolved Oxygen were collected in pre-cleaned dark glass

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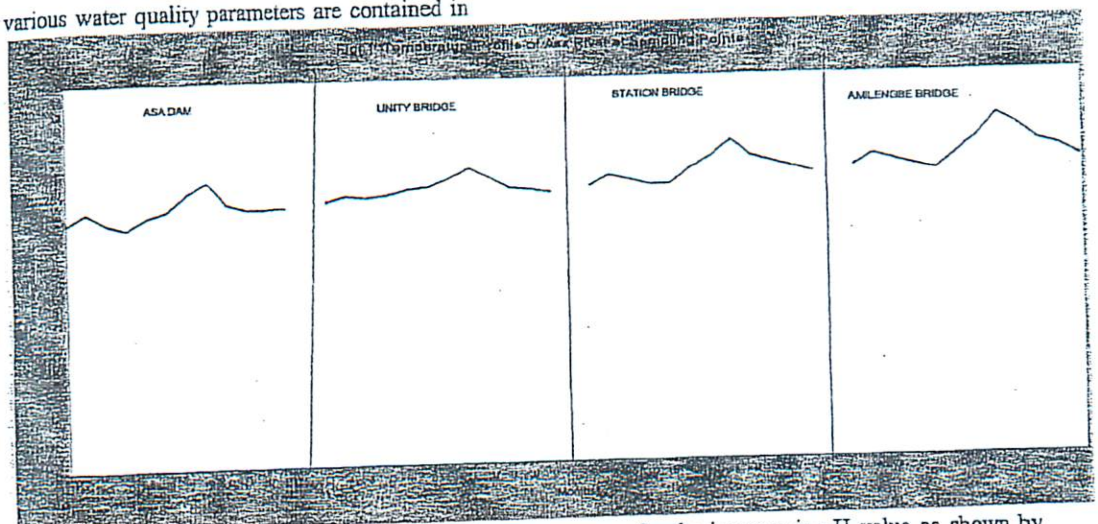
containers and fixed on the spot with Winkler reagent, while those for the determination of metal ions were preserved with HCl.

Methodology: Standard methods recommended for the analysis of river water were used for the determination of all parameters (6). Storage and treatment of water samples were done according to Fresenius et al (7) and APHA (8). Analyses of the samples usually commenced within 2 hours of collection and were usually completed within 48 hours.

RESULTS AND DISCUSSION

The result of the determination of various water quality parameters are contained in Table 1. Each figure is an average of three measurements.

Temperature: The temperatures of waters are in the range of 22-31°C with the highest recorded for the last sampling (Amilengbe Bridge). The temperature was also found to be dependent on the season. Highest temperature was recorded in the month of February (for each point) which corresponded to the peak of the dry season. Significant increase in temperature was observed at all the points except point 1(Asa Dam), suggesting thermal pollution at these points.

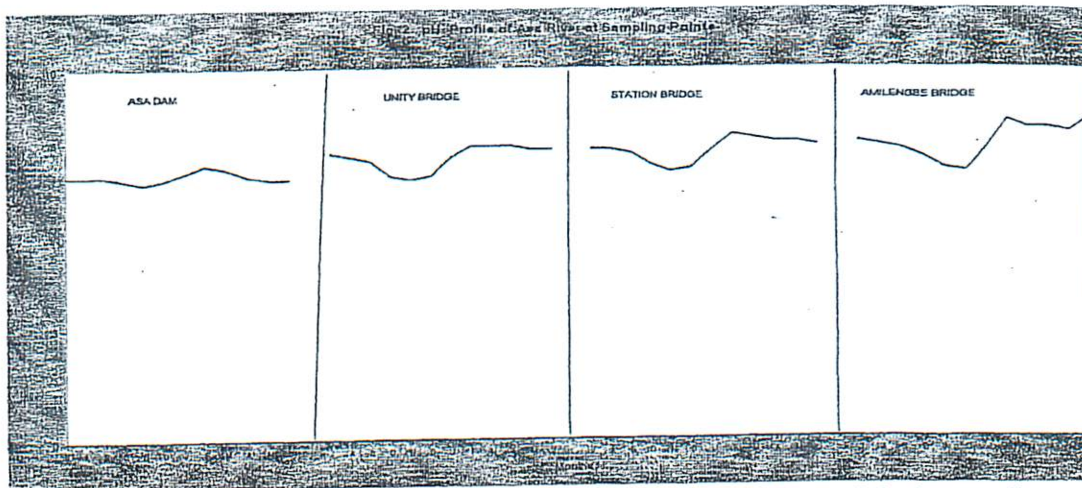


Hydrogen ion concentration (pH): A look at pH data shows that the variation in the pH of point 1 is relatively small (0.5) compared to other points i.e. the pH is fairly constant. Lower pH values were recorded for the rainy season with the lowest figure of 6.9 recorded for point 1. The influx of alkaline effluents from industrial sites between point 1 and point 11 could be the reason for the increase in pH value as shown by the average of 7.6 from 7.1. An all time high value of 8.6 recorded for point IV (Amilengbe Bridge) in the month of February could be due to eutrophication (9). The water at this point was characterized by massive growth of green algae with the consequent

TABLE 1: Result of Analysis

nmeter.	Asa Dam	Unity Bridge	Station Bridge	Amilengbe Bridge
	6.9-7.4(7.1)	7.0-7.9(7.6)	7.0-8.2 (7.7)	7.1 –8.6 (7.9)
perature (°c)	22-26.0 (23.5)	25-27 (25)	25 –29 (26)	26- 32 (29)
our (Hu)	25-160 (62)	35-200 (97.3)	35 –200(97.9)	50- 225(121.3)
bidity (Ntu)	3.3-51.5 (15.9)	7.5 – 57(22.2)	7.5- 55.8 (21.2)	8.2 –59(27.9)
rical conductivity (uscm^{-1})	49.2- 80.8(66.4)	95.1-410 (288.3)	162.4 –405.9 (319.2)	187.3-533 (407.8)
olved solids (mg/l)	48-150 (112.8)	80-262 (187.5)	102 –340 (227)	121- 352 (252.8)
ended solids (mg/l)	12- 60 (34.8)	46 –86.8(70.9)	43-150 (87.0)	62-204 (120.0)
linity (mg caco$_3$/l)	35-65 (48.3)	45 – 170 (114.7)	45 –190 (130.9)	50-240 (157)
l hardness (mg caco$_3$/l)	26-48 (34.7)	24-116 (79)	24 – 132 (85.9)	24- 144 (100.3)
ium(mg/l)	4.1 –11.2 (6.7)	6.4 – 30.7 (21.3)	6.4 –40.1 (22.7)	6.4 –35.3 (25.1)
nesium (mg/l)	3.1 –5.8 (4.5)	2.1 –8.7 (6.0)	2.1 – 12.6 (6.9)	2.9 –14.6 (8.8)
ium (mg/l)	6.5 –12.9 (9.9)	14.5 –18.3 (16.8)	15.2 – 22.0 (18.7)	17.3 –22.1 (20.3)
sium (mg/l)	3.0- 6.6(5.4)	8.5 –14.4 (11.9)	9.5- 15.1 (12.5)	11.2- 16.2 (13.9)
l Iron (mg/l)	0.1 – 0.9 (0.4)	0.6 –1.8 (0.8)	0.8 –1.5 (0.6)	1.0 –2.8 (1.2)
ganese (mg/l)	ND.	0.4 –0.9 (0.6)	0.5 –1.4 (0.8)	0.6- 1.6 (1.0)

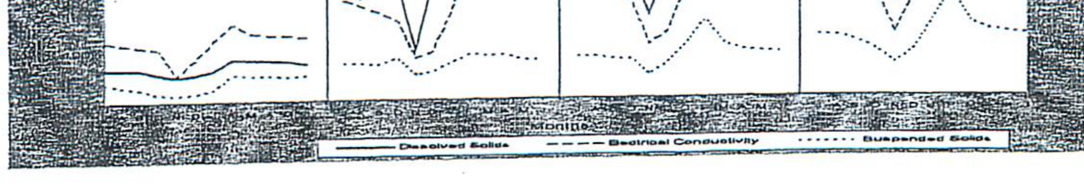
Nitrate (mg/l)	0.2 - 0.9 (0.6)	0.4–1.6 (1.1)	0.5–1.9 (1.2)	0.6– 2.2 (1.5)
Sulphate (mg/l)	7.6 –40 (19.2)	20 –91 (47.2)	15 –54 (37.6)	20.0 – 47.0 (29.6)
Chloride (mg/l)	8.0 – 20 (16.0)	20 –45 (35.2)	– 60 (42.7)	21 –98 (66.5)
Ammonia (mg/l)	4.0 – 7.3 (6.3)	10.0- 14.0 (12.3)	10.5 –15.6 (13.5)	12.1- 16.8 (14.6)
DO (mgO_2/l)	15.9 –23.8 (18.6)	10.8 –16.6 (14.3)	9.8 – 14.9 (10.4)	8.5 –13.8 (11.7)
BOD_5 (mgO_2/l)	2.2 –4.8 (3.9)	3.4 – 6.9 (5.6)	3.9 – 7.8 (6.0)	4.2 –8.4 (7.1)
CO_2 (mg/l)	2.6 – 3.2 (2.9)	2.0 –3.0 (2.4)	1.8 –3.0 (2.3)	1.2- 2.9 (2.1)
SiO_2 (mg/l)	64 – 88 (77)	84 – 140 (123)	65 – 144 (125.1)	80 – 198 (172.7)
Pb (mg/l)	ND	0.5- 1.2 (0.6)	0.6 –1.4 (0.9)	1.0 – 1.8 (1.4)
Cu (mg/l)	ND	0.3 –1.0 (0.5)	0.4 –1.2 (0.8)	0.8 –1.6 (1.2)



Colour, Turbidity, Solids and Conductivity: Highest figures for Colour were recorded at point IV reaching a peak value of 225 (Hu) in the month of February. This could be as a result of eutrophication process and also low self-purification capacity of the river as a result of low volume of water in the river at this time. The constant addition of waste (mostly organic) could also be responsible. The increase in the value of solids in the river could be attributed to the deposition of waste from the residential areas into drainages and streams which then empty into the river. This increase in solids increases the level of conducting ions and thus electrical conductivities also increases as can be seen in Fig 3. Expectedly, the increase in solids also increases the turbidity as well as the colour unit of the river water.

Dissolved solids at all the four sampling points varied widely with the lowest value being recorded in the month of November, the last month of the rainy season marked by large volume of water in the river.

Maximum figure of 352 mg/ l was recorded for point IV, the last sampling point in the month of February, the peak of the dry season. Wide variations in conductivities were observed at points11, 111&1V. Variation in point 1 was fairly wide. The wide variations suggest that considerable amount of dissolved ionic substance enter the river due to indiscriminate dumping of waste at these three locations. Lower values recorded in the month of November could be due to dilution as a result of large volume of water in the river.



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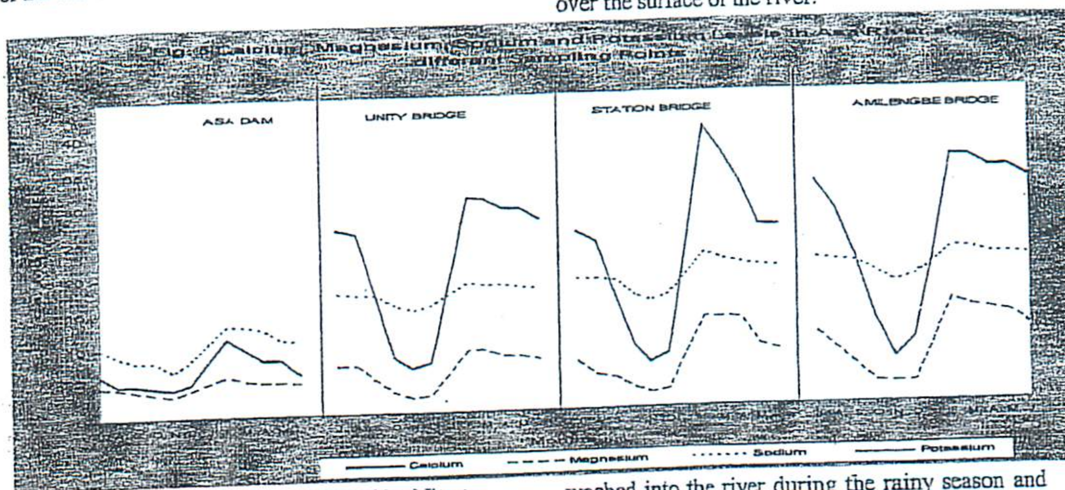
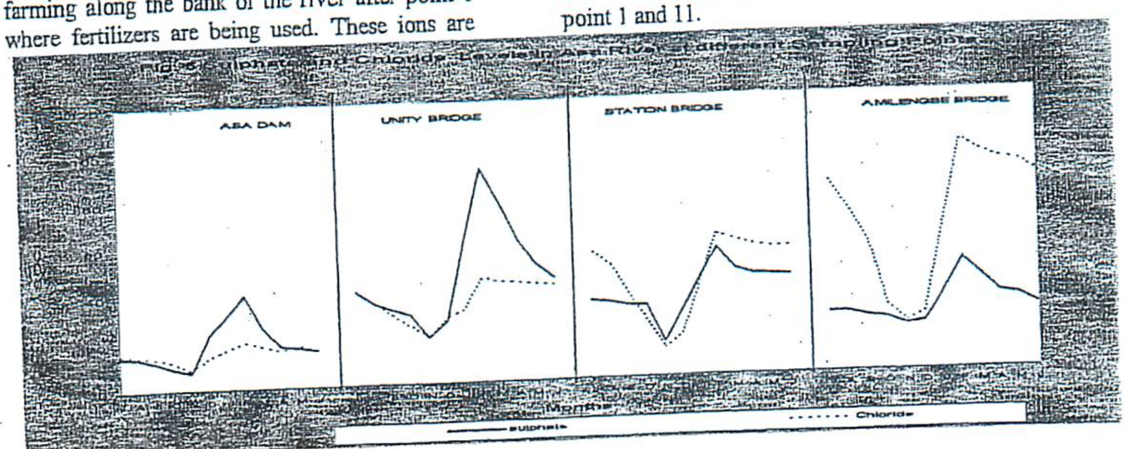
Alkalinity and Total hardness: Wide variations were observed in the figures of alkalinity and total hardness for all the sampling points except for point 1. Point 1V recorded the widest variation. This shows continuous and cumulative effect of high alkaline content of the waste being discharged into the river. The decomposition and release of some inorganic compounds by sediments increase the dissolved salts concentration. The alkalinity of the river water is essentially due to the presence of bicarbonates. This trend of the alkalinity is reflected in the pH of the water.

Calcium, Magnesium, Sodium and Potassium: Lowest values for each of these ions were recorded for point 1 and highest values recorded for point 1V which indicates continuous addition and accumulation of these ions to the river as it flows across the town. High values of sodium or potassium could be ascribed to domestic activities such as washing (usually due to sodium or potassium soap being used domestically). This is evident along one of the tributaries where clothes and vehicles are being washed. The high values of these important nutrient ions enhance the growth of aquatic plants over the surface of the river.



Nitrate, Sulphate and Chloride: Nitrate concentrations estimated as $N\text{-}NO_3^-$ were in the range of 0.2mg/l to 2.2mg/l with the highest figure recorded for point 1V. No appreciable increase in nitrate was observed for point 1. The high values recorded for point 1V could be attributed to domestic waste. A similar trend is observed for Sulphate and chloride. The high values of Sulphate and Nitrate observed could be due to agricultural wastes as a result of intensive farming along the bank of the river after point 1 where fertilizers are being used. These ions are washed into the river during the rainy season and continue to accumulate to reach its peak during the dry season when farming activities along the riverbank is usually reduced to the minimum. Significant amount of Sulphate and Chloride are introduced into the rivers as a result of industrial and domestic activities. The increase in SO_4 and Cl ion concentration as shown in the figure after point 1 could be attributed to discharge of effluents from a soap and detergent industry and soft drink bottling industries located between point 1 and 11.



Ammonia-Nitrogen, Dissolved oxygen (DO), Biochemical oxygen Demand (BOD_5) and Carbon Dioxide (CO_2): One of the most important indicators of organic pollution is the development of an 'oxygen-sag' along the course of a river (10). The 'oxygen-sag' along the course of the river as indicated in figure 7 shows that there was constant addition of pollution to the river down stream. This was confirmed by the increase in Biochemical Oxygen Demand determined after five days of incubation at 20°C (BOD_5) as well as the increase in NH_3-N (as

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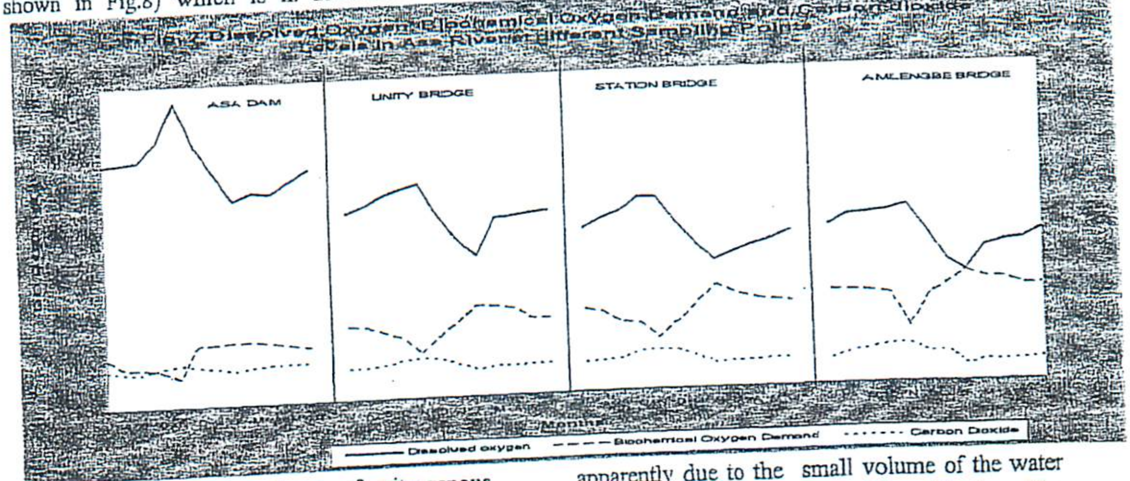
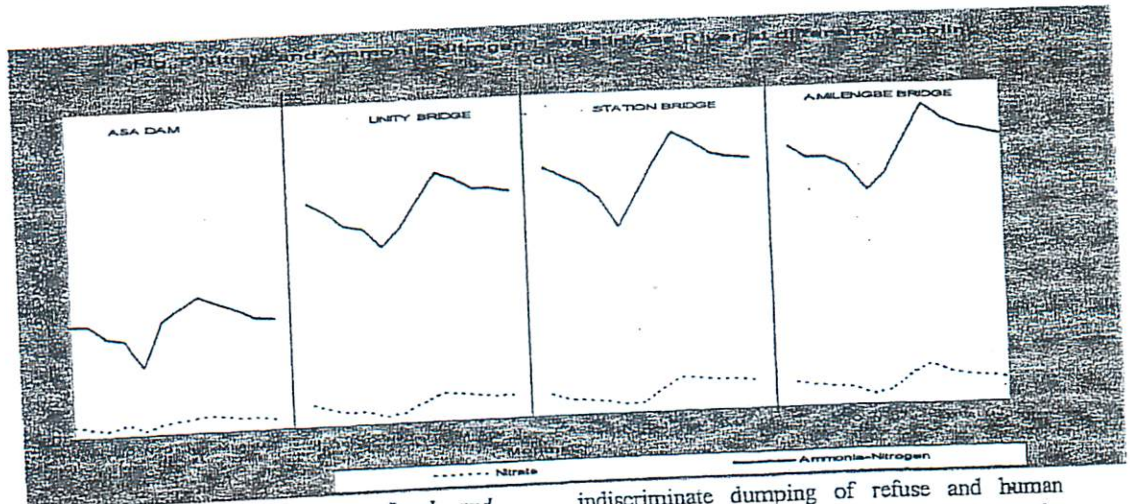
shown in Fig.8) which is in accordance with Manahan (11) that ammonia is the



initial product of the decay of nitrogenous organic waste and its presence frequently is indicative of such waste, and a decrease in the CO_2 down stream due to increase in the deposition of domestic wastes particularly human waste into the river. The lowest values of DO for each point was recorded in the month of February apparently due to the small volume of the water at these points with little self–purification. The growth of aquatic plants on the surface of the water at points 11, 111&1V during the drying season and decrease in the number of fish is a further confirmation of pollution of the river by domestic wastes.



Total iron, Manganese, Lead and Copper: The concentrations of these metals were generally high at point 1V. On the overall basis, there was substantial variation in the metal concentrations over the sampling periods. The high concentration of these metals could be attributed to the discharge of industrial effluents rich in these metals as well as dumping of wastes from various motor mechanic and metal welding workshops into the river. Vehicular emission over the sampling points (11, 111&1V) also be a source of these metals especially lead (12). A trend observed in these data was the increase in the values of the pollutants during the dry season. This could be due to the low volume of water in the river which consequently affected the 'self-purification' capability of the river. Also the indiscriminate dumping of refuse and human waste reached the peak at this period because the river banks were cleared and could easily be reached by the people unlike during the rainy season where the banks were over grown with bush. As the rains began to come, the value of the pollutants decreased as a result of increase in the volume of water and 'self-purification' of the river and reaching the minimum in the month of November which coincided with the last month in the rainy season and usually characterised by heavy down pour.

On the basis of water quality classifications adopted in a number of countries, Prati et al (13) established the classification of surface water quality shown in part in Table 2.

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Table 2: Water Quality Criteria

Parameter	Excellent	Acceptable	Slightly Polluted	Polluted	Heavily Polluted
PH	6.5-8.0	6.0-8.4	5.0-9.0	3.9-10.1	3.9-10.1
DO	88-112	25-125	50-150	20-200	20-200
BOD_5 (mgO_2/l)	1.5	3.0	6.0	12.0	12.0
NH_3(mg/l)	0.1	0.3	0.9	2.7	2.7
Cl^-(mg/l)	50	150	300	620	620
Total Fe (mg/l)	0.1	0.9	2.7	2.7	2.7

Comparing Table 2 above with Table 1, it was found that the quality of Asa River was barely acceptable in term of their pH values. On the basis of the average BOD_5 recorded for the river, it shows that the water quality at Asa Dam was acceptable while that of unity and station were slightly polluted and that of Amilengbe was polluted.

In term of Ammonia (NH_3-N), the river was heavily polluted with average ammonia values at 6.3mg/l, 12.3mg/l, 13.5mg/l and 14.6mg/l for Asa Dam, unity, station and Amilengbe respectively. This cannot be unconnected with the dumping of refuse and human domestic wastes into the river particularly at station and Amilengbe.

In term of total iron concentration, the water quality at Asa Dam was acceptable while that of unity and station were slightly polluted and that Amilengbe was polluted. Form the table, the average value of total iron at the unity bridge was greater than that of station. This could be ascribed to the activities of iron welders and motor mechanics close to the sampling point and partly due to washing of vehicles at a stream (along the new Yidi road) which empties into the Asa river at about this point.

The results obtained in this work followed a similar trend as the result of Ajayi et al (14) and Salau (15) as well as that of Jonnalagadda et al (16,17).

CONCLUSION

It could to seen from this result that water of river Asa was polluted and the level of pollution increased down stream as it transverse the heart of Ilorin town. Also, the level of pollution was high during the dry season and low during the rainy season.

The effects of pollutants from sewage and sewage effluent apart from making the river unsightly, evil-smelling and rendering the water useless for domestic usage, they are known to be directly or indirectly toxic to fish and other aquatic animals and produce undesirable biological effects on them. For example, level of DO, pH, Hardness, suspended solids are known to affect the survival of fishes in river.

The presence and types of fishes in a river have been used as 'indicator' of the river water quality (18). Absence of fish indicates gross pollution; presence of some fishes only indicates some pollution while a river which supports a wide variety of fishes may be considered clean. No fishing activities was observed in the section of the river studied from unity bridge to Amilengbe indicating pollution in the river but before the Asa Dam, at Egbejila, Odore in Asa LGA intensive fishing was observed indicating no serious or any pollution at this point.

It can also be concluded that water from the river (after the Dam) is unfit for drinking by man as a result of high values of BOD_5 (19) and total iron content which must not exceed 100 µg/l.

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