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POLLUTION STATUS OF URBAN SECTION OF RIVER DELIMI JOS PLATEAU, NIGERIA

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Abstract
River pollution in the urban areas is a common problem in many parts of Nigeria. This study examines the physico-chemical and biological parameters of the river Delimi within the Jos urban area. The specific objectives were to identify the dominant activities that constitute factors of pollution, and assess the pollution levels at different activity positions and different times of the year. Eight water samples were collected at eight locations on the river stretching from the entry point of the river to the outlet point. The results of the water analyses were compared with the WHO and National /NAFDAC water quality standards for drinking and irrigation. The results show that the concentration of pH, electrical conductivity, total dissolve solid, hydrocarbon, lead iron and BOD exceed the WHO and NAFDAC standards. Cobalt, chromium, nickel, potassium, sodium and manganese values are below the contaminant level for all the eight sample points. E. coli Drancuculum larvae, hydra-organisms, small fishes, small snails' Paramecium and Spirogyra were significantly present in the water samples. In order to improve the quality of the water, there is need for control or prevention of pollution activities along the river course

Key Words: *Pollution, Condition, Municipal, Segment, Waterway*

Introduction

Pollution of river bodies has become a main and global problem that is becoming serious in developing nations of the world because of inadequacy or non-existence of surface water quality protection measures and sanitation Lagoons, rivers and streams are sinks for wastes, and wastes are most often discharged into the receiving water bodies with little or no esteem to their assimilative volumes. However, releases of raw sewage, garbage, as well as oil spills are threats to the diluting capacities of the oceans, lagoons and rivers in major cities while most coastal waters are wholly polluted (Longe and Omole, 2008). Pollution of surface and ground water is largely a problem due to rapid urbanization and industrialization. The large-scale urban growth due to increase

in population or migration of people from rural areas to urban areas has increased domestic effluents while industrial development manifested either due to the setting up of new industries or expansion of the existing industrial establishments resulting in generation copious volume of industrial effluents. The point sources like the domestic waste and sewage are the first order contamination sources of waste. Also unplanned and indiscriminate disposal of municipal waste cause pollution of water bodies (Verma and Saksena, 2010). This in effect makes pollution of river bodies a global issue that has no respect for national or international boundaries. The degree of pollution and natural purification are measurable, physically, biologically and chemically (Longe and Omole, 2008). Water pollution has a wider ecological impact than just being unsuitable for consumption or passing health hazards. Most of the water withdrawn from rivers is used for consumption or household use. Water is the major conduit in direct transmission of toxic agents, trace elements and persistent hazardous organic chemicals and infections agents and vector for several diseases (Narayanan, 2007). So, the adverse effect of water pollution on ecological systems at local, regional, continental and global level would become more and more serious.

Water as an enviable resource is greatly needed by man for virtually all his activities, whereas, the quality for various uses cannot be over emphasized. Suffice to say that domestic water more especially for drinking purpose should be water of highest quality, while water meant for other forms of uses can be of good quality. To this effect, water in the study area is generally believed to be polluted. It is in view of these that this research intends to determine the pollution status of a section of river Delimi.

Study Area

The study covered the urban section of Delimi River starting a point close to from its source at lamingo dam and two tributaries from millionaire quarters and ray field Jos metropolis to behind university of Jos student village Russau. The research considers only two seasons that is end of rainy season and dry season (harmattan) due to time constraint and also physical, chemical and biological water quality were investigated.

The study area, Jos lies within the Plateau located in the central part of Nigeria. The Jos metropolis is bounded by Latitudes 10° 60′ and 9° 50′ and longitudes 90° 60′ and 80°55′, which covers an area of about 340km^2 extending for about 18mk from the North to South and 18.5km from East to West. The area bounded by Bauchi plains to the North-East, Bassa Local Government Area to the west and North-west, Bukuru (Jos South) to the South and Jos East LGA to the East. Jos North LGA is divided into 20 political wards inhabited by various ethnic groups/tribes namely: the Berom, Anaguta, Afizere, Yoruba, Igbo, Hausa Fulani among other Much of the river Delimi basin is underlain by rocks of the crystalline basement complex of Nigeria. According to (Buchnan *et al*., 1971), the present section has relied on this account. The major rock types in the basin are the younger granite complex. The oldest recognized of this complex include the granolithic gneisses in small widely scattered outcrop and a few small bodies of dioritic rocks. Granite gneisses and Allo – pegmatatite granite – gneisses cover the greatest proportion of the basin.

In places may be found banded and porphyroblastic gneisses, some schists and amphibolites. The part of the basin near Jos is composed of the Jos biotite – granite and Neil's valley granite – porphyry. The author has recognized the following younger granites complexes, the Kwandon-Kaya complex, the Junguru complex and the Tongolo complex. The Jos – Bukuru complex lies at the focal point of the younger granite magmatic activity. Together with the associated satellite ring – structures it covers a large area of the central Jos Plateau. The major rock types here are biotite – granite and granite porphyry, the Kwandon-kaya complex is situated about 25 miles (40km) North East of Jos, forming a prominent hill mass with an area of 74 square miles 189km^2. The hills lie between the Delimi and Jarawa River basin which feed the Chad and Gongola triangle systems respectively. The major rock types recognized within the complex are boilite – granite and quartz feldspar porphyry. The Junguru complex lies about 45 miles (72 km) North East of Jos, where it gives rise to a group of dissected rocky hills rising about 500 feet (152.4km) above the surrounding plains. The associated rock type includes quartz – feldspar porphyry riebeckite and biotite – granite. The Tongolo complex lies about 35 miles (56km) North of Jos – the major rock types are rhyolites and agglomerates, quartz – feldspar – porphyry and biotite – granite. The Tongolo hills are predominantly granitic (Eziashi, 1980).

Hydrology and Drainage

Two aquifers exist in the study area according to (Shoenich and Mbonu, 1991). The fractured crystalline aquifer and the soft over burden aquifer. The two aquifers are interconnected and form one hydraulic system with unconfined water table .These is fractured crystalline aquifer and soft over burden aquifer (Badamasi, 2010). According to Shoeniech *et al*. (1994), this aquifer comprises of fresh ,fractured and joint granites and gneisses, depth to water table range from 10-100m.It has highly fluctuating seasonality, high permeability, low storage; water occurrence is peachy and limited to tectonically fractured zones . However, the aquifer contains water in amounts on which open wells and sometimes boreholes can be sited in tectonically fractured zones. The major fractured zones generally have high yielding boreholes usually from 10m^3/hr and above. Transitivity value of this aquifer is between 0.58 to 1.08/hours and hydraulic conductivity values ranges from 0.13 to 0.023/hr (Badamasi, 2010). This consists predominantly of clay materials and *in situ* chemically weathered rocks. Litho logically it is highly variable. The most common constituents are sand and gritty clays formed as a result of borrowing activities of temiters. This makes the soft overburden aquifer lack natural purification processes and makes it susceptible to biological contamination, rendering the quality of water low (Shoeniech and Mbonu, 1991). The average yield is 10m^3/hr and transivity value range between 0.08 and 0.0055m/hr. On the general, the study area has a radial drainage pattern but some of the rivers in the study area are developing denderetic pattern on a smaller scale. According to Eziashi (1995), the Jos plateau is consciously drained by streams which are largely-water and tributaries of large river systems (Badamasi, 2010). Some of these river systems include the Wase, Shemankar, Dep-Ankwe, Mada, Lere-

Gongola and the Delimi-Bunga.The Delimi- Bunga river system is captured mostly in the study area. The Delimi river take its source some 13km south-east of Jos and flows North-east towards Lake Chad. Its major tributary, the Tilde Fulani rises from the Shere hills and flows through the Neil's valley before joining it at about 20km beyond the plateau edge. North-west of the study area is the Rukuba a tributary of river Kaduna. It flows over the Aplo-pegmatic rock through the Ngell. Figure 3 show the drainage characteristic of the study area.

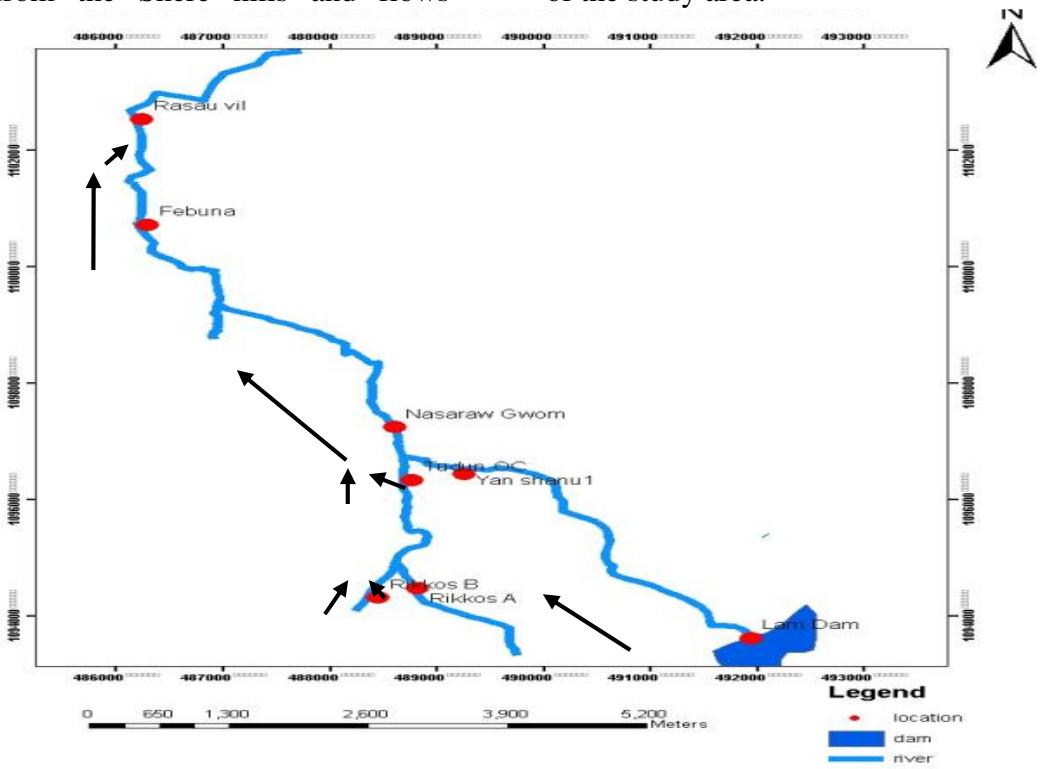

Fig. 1: Locations of the Water Sample Point

Methodology

A reconnaissance survey was conducted in August 14th, 2014. This involves going through Lamingo dam, Sele bridge, British American bridge, Tudun o.c , Yan shanu bridges and also Tsogai, through Bauchi road to Febuna and to behind student village, Russau in the river channel . A total of eight (8) water samples were collected in the study area during the rainy and dry seasons around August and December 2019 respectively. Using a specific strategic point sampling method, by considering the concentration of settlement and human activities identified along the both side of the river channel. From low, medium and high, settlement areas and the latitude and longitude positions of each location was taken using hand held global positioning system (GPS) model 60 Garmin.

The samples for each one location were connoted, A. Lamingo dam, B. Rikkos (A), C. Rikkos (B), D. Tudun-O.C. F . Yanshanu, F. Nassarawa Gwom, G. Febuna, H. behind Russan student village. At each location, water samples were collected in polyethylene bottles for

determination of, Total Dissolved Solid (TDS), Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD), Conductivity, Turbidity, PH values and heavy metals concentration at each location collected.

All bottles were washed with non-ionic detergent and raised with de-ionized water prior to usage. Before the final water sampling will be done the bottles are raised three times with the river water at the point of collection. The sample bottles ware labeled according to the sampling location. All samples are well preserved and taken to the laboratory. Global positioning system (GPS) readings were taken at all the locations of all the sample points as shown in figure 4. The water samples collected was analyzed at Abubakar Tafawa Balewa University Water Laboratory Bauchi (ATBU). USEPA method of water analysis was used to test for biological chemical and physical parameters of water pollution.

The following instruments were used for the test;

i. TDS/conductivity meter (HACH) model 446000.00
ii. The HANA PH meter, model IH 98129
iii. Atomic Absorption Spectrometer (AAS) model VGB 210 system; Buck scientific.
iv. Microscope James Swift and Sons ltd, Basingstoke England model M.P 120.
v. Turbidity Uv-ultraviolent Spectrophotometer.

Result and Discussion

The physico-chemical characteristics of Delimi River were analyzed using Range, Mean and Standard deviation of the tested parameters as shown in Tables 1 and 2 below.

Table 1: Mean, Range, and Standard Deviation of Water Quality Parameters for Rainy Season

S/No	Parameters	Range	Mean	Standard deviation
1.	PH values	5.7- 9.0	8.07	0.997
2.	Turbidity (NTU)	0.101 – 0.806	0.55	0.382
3.	Electrical conductively µs/cm	0.268 – 0.622	0.40	0.105
4.	Total dissolve solid mg/l	0.0038 – 0.036	0.02	0.014
5.	Hydrocarbon mg/l	0.0056 – 0.028	22.53	67.451
6.	Lead (Pb), mg/l	0.008 – 0.072	0.02	0.021
7.	Zinc(Zn) mg/l	0.010 – 0.034	0.02	0.009
8.	Iron(Fe) mg/l	0.019 – 0.045	0.31	0.085
9.	Magnesium(mg)mg/l	0.019 – 0.045	0.03	0.008
10.	Chromium(Cr) mg/l	0.019 – 0.045	0.03	0.008
11.	Cobalt(Co) mg/l	0.000 – 0.572	0.14	0.202
12.	Nickel(Ni) mg/l	0.018 – 0.043	0.07	0.109
13.	Potassium(K) mg/l	0.009 – 0.064	0.03	0.017
14.	Sodium(Na) mg/l	0.009 – 0.51	0.02	0.011
15.	Manganese (Mn) mg/l	0.0014 – 0.643	0.63	0.16
16.	BOD_5 mg/l	267.6 – 206.4	313.00	33.756
17.	COD_5 mg/l	120.4 – 206.4	180.80	27.10

During the rainy season there is significant difference in the point of hydrogen (pH) in all the sample locations with a range of 5.7-9.0, mean value of 8.07 and also standard deviation of 0.997 which could be as a result of flow of water from upstream to downstream of the river channel. The water in the study area is turbid as a result human activities during the rainy season such as, construction, mining and rain fed Agriculture. The water from A is colourless that is around Lamingo dam while coming down to location B around Sele bridge the water from millennium quarters Rikkos B is cloudy. Water sample collected from location C a river tributary from ray-field is slightly cloudy not turbid while along location D, E and F the water is very Turbid likewise G and H respectively which result to Range value of 0.101 – 0.806mg/l and standard deviation of 0.997. The electrical conductivity within the sample locations in the study area have the range value of 0.268 – 0.622µs/cm average mean of all the samples is 0.55µs/cm with a standard deviation of 0.382µs/cm which could be as a result of movement of water in the river during the rainy season, which result to low conductivity of the river water. Total dissolve solid range were 0.0038 – 0.036mg/l in all the eight locations and the mean of 0.02mg/l in all the location with a standard deviation of 0.014mg/l in all the locations which could be as a result of maximum movement of water across the river which make the solids suspended in the water to be less through a natural process of water movement which enable the solid particles to settle down. Hydrocarbon is any of class of organic chemical compound composed only of the elements carbon and hydrogen; hydrocarbon is the principal constituents of petroleum and natural gas. They serve as fuel and lubricants as well as raw material for the production of plastics fibres, rubbers, solvents, explosives and industrial chemicals. Hydrocarbon concentration ranges from 0.0056 – 0.028 mg/l between the samples could be as a result of runoff from residential, commercial and industrial areas to the water body. The ranges of all the heavy metals in the water samples collected are 0.000 – 0.643mg/l in the samples. Biological oxygen demand have the range concentration of 267.6 – 372.4mg/l this values shows high level of BOD recorded in all the samples which shows high level of pollution. The high concentration of chemical oxygen demand in all the eight samples is as the result of waster waters or of a natural waters contained by domestic and industrial wastes from the major land uses along the river which are Agriculture, Residential, industrials, sewage and solid waste disposal.

Table 2: Mean, Range, and Standard Deviation of Water Quality Parameters for Dry Season

S/NO	Parameters	Range	Mean	Standard deviation
1.	pH values	4.96 – 10.0	8.06	1.44
2.	Turbidity (NTU)	0.254 – 0.966	0.52	0.237
3.	Electrical conductivity µs/cm	0.265 - 0.5260	0.38	0.098
4.	Total dissolve solid mg/l	0.0085 – 0.0420	0.02	0.2
5.	Hydrocarbon mg/l	0.0035 – 0.4200	0.07	142
6.	Lead (mg/l)	0.0003 – 0.1420	0.09	0.043
7.	Zinc (mg/l)	0.0013 – 0.0402	0.0	0.011
8.	Iron (mg/l)	0.1320 – 0.3360	0.27	0.065
9.	Magnesium (mg/l)	0.0200 – 0.6306	0.03	0.008
10.	Chromium (mg/l)	0.1850 – 0.4200	0.27	0.069
11.	Cobalt (mg/l)	0.0205 – 0.4662	0.14	0.190
12.	Nickel (mg/l)	0.0220 – 0.0364	0.04	0.018
13.	Potassium (mg/l)	0.0265 – 0.6565	0.118	0.221
14.	Sodium (mg/l)	0.0120 – 0.0650	0.03	0.014
15.	Manganese (mg/l)	0.0025 – 0.0460	0.04	0.017
16.	BOD_5 (mg/l)	250.5 – 420.6	338.24	55.155
17.	COD_5 (mg/l)	165.8 – 205.5	200.6	22.86

The pH range in the dry season is higher than that of the rainy season with a range value of 4.96 – 10 .0 with the mean value of 8.06 with a higher dispersion between the samples of 1.44 which shows there is significant variation between the sample locations as a result of activities carried out at specific points of the river channel which result to slight variation in pH at different locations. In location A the dominant activity is farming during the dry season the land near the water body is uncultivated. The pH gets elevated as a result of net consumption of carbon dioxide during the day.

Turbidity of all the samples ranges from 0.254 – 0.96mg/l with the standard deviation of 0.237mg/l which could be as a result of slow rate of flow of water and too much activity along the river during the dry season, some of the activities that results to the high turbidity are, mineral extraction and sewage disposal at locating C and D and irrigation activities at location G. There is no significant difference between all the samples, in terms of total dissolve solid, hydrocarbon due to low run off from residential, commercial and industrial areas at dry season of the year, likewise, the heavy metals (lead, zinc, Iron magnesium, chromium, cobalt Nickel, Sodium) Ranges from 0.000 – 0.643mg/l had a very low standard deviation and mean value. Potassium in all the sample locations has the range value of 0.0265 – 0.6565mg/l in all the locations which increases as a result of high Evaporation during the dry season. During the dry seasons the range of BOD is at 250.5 – 420mg/l and average mean of 338.24mg/l and dispersion between the samples of 55.155mg/l recorded in all the samples which actually indicated that the water is highly polluted during the dry seasons. The high level of chemical Oxygen demand in all the eight samples could be as the result of waste water contamination by domestic and irrigation activities along the river channel during the dry season.

Biological Characteristics and Quality of Water Samples

This study indicates that River Delimi with all its Ecological stresses still supports aquatic life to maintain the natural food chain. Table 3 and 4 shows biological characteristics of River Delimi at rainy and dry season.

Table 3: Macros copy and Microscopy of the Sample Points at Rainy Season

Sample Points	Macroscopy	Microscopy
A	Clear water sample without sediments No fishes present No frogs present.	No larva of any parasite had seen fecal material present.
B	Cloudy water, with few dust like sediments	Few larvae of paramecium faecal material present.
C	Slight cloudy water, turbid with few small fishes, small frogs	Hydra organism present.
D	The water is cloudy Turbid with black floating particles floating.	Spirogyra, larvae of Drancuculum present. E. Coli present
E	Slight cloudy water with sediment floating	Paramecium seen
F	Very Turbid water with small organism present fishes, small fogs, black sediments floating	Faecal material paramecium and E. Coli present
G	Turbid water brown sediment with green flouting materials	- Hydra organisms present - Paramecium present - Traces of spirogyra, present
H	Cloudy water with greenish sediments, small living organism present small frogs, fishes present.	- Hydra organism seen - Faecal material - Present - Traces of paramecium and spirogyra present.

At the rainy season it was discovered that at sample point A water from Lamingo dam, the water were not turbid but no presence of living organisms seen and the microscopic investigations reveals that no larva of any living organism seen. At point B few larvae of paramecium were seen, at C *Hydra* organism seen with small fishes. At D the water was Turbid with blackish floating materials, *Spirogyra*, and *Drancuculum* was seen. At F small fishes, frogs are present, paramecium with faecal materials present in the water at sample point G and H the water is turbid brown and greenish sediment floating on the water body.

This result indicated that at all the sample points except A is evident that disease causing organism is present at all the sample points. Organisms such as *Paramecium, Hydra* organism, *Drancuculum*, *Spirogyra* and *E. coli.*

Table: 4 Macroscopic and Microscopic Investigation of the Sample Points at Dry Seasons

Sample Points	Macroscopy	Microscopy
A	Clear water sample with greenish brown sediments	Larva of *Paramecium* seen
B	The water sample is cloudy with greenish dust-like sediments with light flower-live particles floating	Larvae of *Paramecium* faecal, material seen
C	The water is clear with a small fish with greenish particle	*Hydra* organism *Paramecium* seen
D	The water is blackish – green with black sediments with black floating particles.	*Hydra* organism *Spirogyra* larvae of *Drancuculum* seen.
E	Clear turbid water with brownish sediments with cloudy floating particles.	*Paramecium* and *Hydra* organism seen, *E. coli* present
F	Clear water with small fishes and brownish sediments	*Hydra* organism *Spirogyra Paramecium* faecal material seen.
G	Greenish cloudy water with greenish brown sediment	*Spirogyra Paramecium Hydra* organism seen. *E. coli* present.
	Cloudy water with greenish sediments	*Paramecium Spirogyra*, *Hydra* organism faecal material present.

At dry season it was discovered that all the sample points disease causing organisms are present, such as paramecium larvae, *Hydra*, organisms, *Drancuculum* Levee, *Spirogyra E. coli* and also few living organisms are presents, and small number of aquatic animals. This evident that the water is highly polluted with disease causing organism during the dry season higher than the dry season, this is because the flow of water is low which limits the natural purification of the river water.

Conclusion and Recommendations

The results show that the concentration of pH, electrical conductivity, total dissolve solid, hydrocarbon, lead, iron and BOD exceed the WHO standards. Cobalt, chromium, nickel, potassium, sodium and manganese values. *E. coli, Drancuculum* larvae, hydra-organisms, small fishes, small snails' paramecium and spirogyra were significantly present in the water samples. In order to improve the quality of the water, there is need for control or prevention of pollution activities along the river course. The water in the study area should be used for other purposes due to the low concentration of some parameters.

Water quality laboratories should be established independently in conjunction with Nigerian Universities for the analysis of essential parameters of the surface water as a routine exercise.

There should be increased public participation in water pollution control. When people are educated and sensitized about the effects of pollution, they will be more readily disposed in safeguarding the pollution of rivers. Increased public participation ensures best practice and occurrences that lead to the pollution of surface water. For example, indiscriminate dumping of waste and poor agricultural practices will decline the water quality of the study area.

Government should embark on resource inventory of water pollution data that will ensure more effective monitoring, quick feedback to the authorities in the event of any contamination, and short response time by the relevant authorities. It will help to improve and safeguard the quality of the urban section of Delimi river.

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