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Water quality assessment of river ngadda, northeastern Nigeria

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ABSTRACT
Water is arguably one of the most priceless gift of nature that is regarded as the life line on earth, both aquatic and terrestrial organisms depends on it. The general desire to protect fresh water fisheries has led to an expansion of research into their water quality requirements, in terms of their physicochemical parameters such pH, temperature, dissolve oxygen, transparency, total alkalinity, total hardness, electrical conductivity, total dissolved matter, e.t.c. (Ibrahim et. al., 2009). The limnochemical status of River Ngadda was investigated within a twelve month period at three different sampling stations (Monday market bridge, Lagos bridge and Gwange bridge) which has varying degree of anthropogenic activities. All data gotten were compared with World Health Organization (WHO) standards. The comparison of estimated values of different parameters with W.H.O. standards indicated that the river water is polluted with reference to most parameters studied with Monday Market Bridge being most culpable, followed by Gwange and Lagos Bridges respectively, however some parameters such as temperature, pH, and TSS still within allowable permit. There is therefore an urgent need for improved water quality management within the study area with emphasis on the Monday market area more so because of the use of this water body by some inhabitants around it for household activities like cooking, washing and even drinking for both human and livestock.

Introduction

Water also known as blue gold, one of the most priceless gifts of nature is also regarded as the life line on earth, both aquatic and terrestrial organisms depends on it. The general desire to protect fresh water fisheries has led to an expansion of research into their water quality requirements, in terms of their physicochemical parameters such pH, temperature, dissolve oxygen, transparency, total alkalinity, total hardness, electrical conductivity, total dissolved matter, e.t.c. (Ibrahim et. al., 2009). The status of these factors gives a pointer to the biological productivity richness or otherwise of any aquatic environment.

Rivers are important water resources that provide several services like drinking, irrigation and recreation to terrestrial organisms and abode for aquatic ones where all of their physiological needs are met. Rapidly increase in population; urbanization and rapid industrialization along the rivers have put tremendous pressure on water resources and their quality (Biswas 2000, Khan 2004). Occurrence of contaminants in water bodies are either of natural origin (eroded minerals within sediments, leaching of ore deposits and volcanism-extruded products) or of anthropogenic origin (solid waste disposal, industrial or domestic effluents, harbour channel dredging e.t.c.) (Marcovecchio *et. al.*, 2007).

In view of growing concern over the use of River Ngadda by resident along the river banks and the fauna and flora of the ecosystem, this work is aimed at assessing the extent to which anthropogenic contaminant has affected productivity of the river by measuring its physicochemical parameters and comparing them with standards set World Health Organization (WHO).

Materials and methods

Study area

River Ngadda, located at latitude 11° 50'N and longitude 13° 09'E is found in Maiduguri, the capital city of Borno state in the north eastern geo-political zone of Nigeria which shares international boundaries with republic of Niger and Chad in the north and Cameroon in the east. It has a population of 4,171,104 (NPC, 2006) and a total area of 70,898km^2 (27,374m^2). The area is semi-arid, with a long summer and short winter and a mean temperature of 25° C to 37° C. The mean total rainfall is 150 to 300mm per year with 80 to 85% of the river annual discharge in the wet season.

The river is used for various human activities including fishing, vegetables irrigation, brick making and by residences along the river banks for bathing, washing and as drinking water by animals. The river originates from Rivers Yedzram and Gombole which meet at a confluent at Sambisa both in Nigeria and flows as River Ngadda into Alau Dam and stretches down across Maiduguri Metropolis then empties into Lake Chad. The river receives copious amounts of wastes from residential houses and abattoirs sited along its course. (Akan *et. al.*, 2011).

Three sites on River Ngada were selected as sampling points i.e. Lagos Street, Monday Market and Gwange bridges respectively; sampling frequency was monthly for a year (April 2012 to March, 2013). The first site has little or no commercial activities around it while the other two sampling sites are located about 2 km upstream between each other, with Gwange Bridge has a thriving timber market, upholstery and metal waste factories around it while the Monday market site has the biggest market in the state adjacent to it. As such, this made the areas suitable point for collecting the representative sample for this

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study to determine the impact of anthropogenic contaminant on the river, and the implication on the productivity.

Figure 1. Ngada River shown on the map of Lake-Chad shaded green.

Surface water samples for physico-chemical analyses were collected mid-stream at depth 20-30cm directly into clean 1-litre plastic bottles. Temperature, Electrical Conductivity, pH, Dissolved Oxygen (DO), Total Suspended Solids (TSS), Total Dissolved Solid, Turbidity, were measured *in situ*, using an electronic multiparameter probe. The phosphate was determined using the UV/VIS spectrometer (Lind, 1978) and APHA (1985), while the Nitrate- nitrogen was determined by phenoldisulphonic acid method as described by Mackereth (1963). Sulphate and ammonium using a DR 2000 Spectrometer; chloride by argentometric titration; and ammonium by direct nesslerisation and spectrophotometric determination at 410 nm. Total and faecal coliforms were determined by membrane filtration method using M-Endo-Agar Les (Difco) at 37 ^{o}C and on MFC Agar at 44 ^{o}C, respectively. Water quality standards were obtained were compared with World Health Organization standard limits.

Statistical analysis

Results obtained were analyzed using Analysis of Variance (ANOVA) software to get the mean and Least Significant difference (LSD) to ascertain if there is significant differences in the various parameters among the three sampling stations.

Results

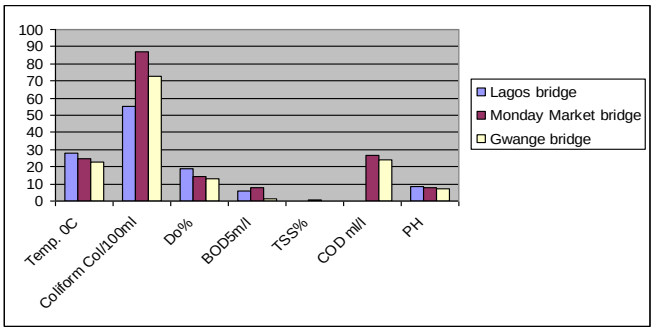

Figure 2: Selected physico - chemical parameters of Ngadda River at the 3 selected locations

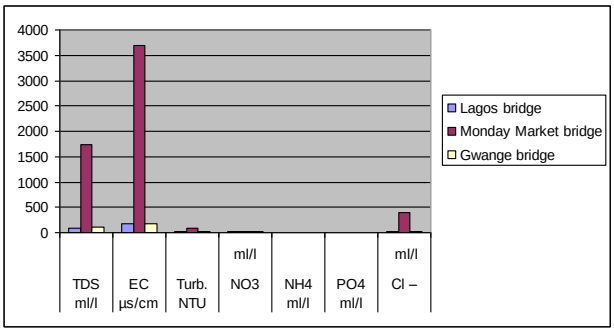

Figure 3: Selected parameters of Ngadda River at the 3 selected locations

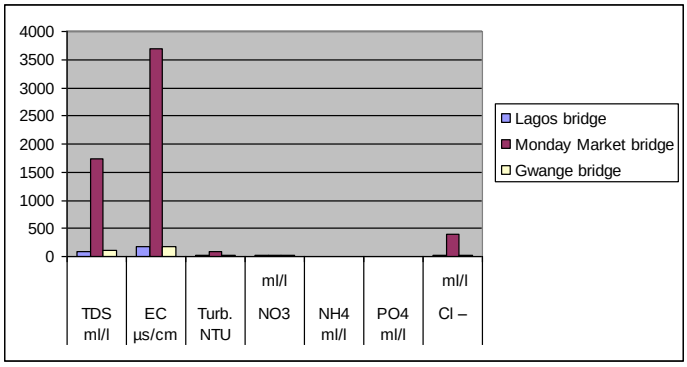

Figure 4: Selected parameters of Ngadda River at the 3 selected locations

Discussions

The results for the various physico-chemical parameters determined in the water samples from each sampling site along River Ngadda are presented in Tables 1 and 2. Temperature of water sampled ranged from 23.03 – 27.90 ^{0}C, with slight variations between sites, but still within the maximum allowable permits of WHO (1971) standards. Coliform was significantly high ranging from 55.00 – 87.00 which is far above the allowable permits of <1 – 10 by both FEPA and WHO, this is an indication of the presence of pathogenic bacteria. High levels of fecal coliform in the water may cause typhoid fever, hepatitis, gastroenteritis, and dysentery. Dissolved Oxygen (DO) however ranged from 13.00 - 19.00mg/l. The DO values obtained at all sites were generally above the acceptable limit of 5.0 – 9.0 set by WHO (1971). DO measurements can be used to indicate the degree of pollution by organic matter, destruction of organic substance and level of self-purification of the water.

Biological Oxygen Demand (BOD) ranges from 1.25 – 7.75 which is still within the allowable permit of WHO. Unpolluted waters typically have BOD values of 2 mgl^{-1} O_3 or less, whereas those receiving wastewaters may have values up to 10 mg l^{-1} O_2 or more, indicating that Ngadda River is productive in this regard. Chemical Oxygen Demand (COD) ranges from 23.75 – 26.80 ml/l, which is also above the recommended limits. In unpolluted water, concentration of COD in surface waters ranges from 20 mg l^{-1} O_2 or less, this indicates that the river is polluted. COD is widely used as a measure of the susceptibility to oxidation of the organic and inorganic materials present in water bodies and in the effluents from sewage and industrial plant. Total Suspended Solid (TSS) results obtained ranges from 88.50 – 1736.00 with Lagos and Gwange bridges within WHO standard of 500mg/l, but Monday Market Bridge way above the set standard, indicating that the water in this area is less productive and more polluted, this could be attributed to the high human activities in that area. Turbidity values ranged from 14.97 – 85.10 NTU. The turbidity values obtained at all sites is within allowable standards except for Monday Market Bridge with 85.10 higher than WHO standard of 85 NTU (FEPA, 1991 World Health Organization, 1984). The high turbidity value at the Monday market area could be due the increased human activities around the market in the form of surface runoff and erosion carrying soil/silt and partially dissolved or undissolved organic matters into the water body.

Generally, the pH values fall within the WHO standard of 6.5–8.5 (World Health Organization, 1984). The pH can also affect fish health, for most freshwater species, a pH range between 6.5 - 9.0 is ideal, but most marine animals typically cannot tolerate as wide range pH as freshwater animals, thus the optimum pH is usually between pH 7.5 and 8.5 (Boyd, 1990).

Table 1: Showing the Least Significance Difference (LSD) all-pairwise comparison test of physico-chemical parameters

Sample Points	Temp. ^{0}C	Coliform Col/100ml	Do%	BOD5m/l	TSS%	COD ml/l	PH
Lagos bridge	27.90	55.00	19.10	5.75	0.14	20/70	8.14
Monday Market bridge	24.50	87.00	14.00	7.50	0.93	26.80	7.70
Gwange bridge	23.03	73.00	13.00	1.25	0.11	23.75	6.95
LSD	0.947	5.882	1.934	0.707	0.740	1.868	0.493

If x > LSD then there is significant difference,
If x ≤ LSD then there is no significant difference.

Table 2: Showing the Least Significant Different (LSD) all-Pairwise comparison test of physio-chemical parameters

Sample points	TDS ml/l	EC µs/cm	Turb. NTU	NO_3 ml/l	NH_4 ml/l	PO_4 ml/l	Cl^- ml/l
LB*	88.50	173.50	14.97	19.50	2.25	3.06	11.00
MM*	1736.00	3696.50	85.10	15.10	2.76	7.41	389.00
GB*	100.50	185.00	16.85	31.77	5.10	4.17	15.00
LSD	364.710	667.550	1.602	3.288	0.799	1.153	76.148

LB – Lagos bridge, MM – Monday Market bridge, GB- Gwange bridge
If x > LSD then there is significant different,
If x ≤ LSD then there is no significant different.

Table 3: Site-wise mean values of physicochemical parameters of River Ngadda with their respective W.H.O. standards

Sampling stations	LB (A)	MM(B)	GB(C)	WHO LIMITS *
Parameters	**Mean**	**Mean**	**Mean**	
Temp. (^{o}C)	27.9	24.5	23.03	≤ 40
DO (mg/l)	19.10	14.00	13.00	5.0 – 9.0
BOD^5 (mg/l)	5.75	7.50	1.25	6.0
TSS (%)	0.14	0.93	0.11	25
pH	8.41	7.70	6.95	6.5 – 8.5
TDS (mg/l)	88.50	1736	100.50	500
Condty (µs/cm^3)	173.5	369.5	185.0	1000
Turbidity NTU	14.9	85.10	16.85	5 - 25
NO_3 ml/l	19.50	15.10	31.77	10.0
NH_4 ml/l	2.25	2.76	5.10	0.04-1.0
PO_4 ml/l	3.06	7.41	4.17	5.0
Coli (Col / 100ml)	55.0	87.0	73.0	<1-10
Cl^- ml/l	11.0	389.0	15.0	250
COD (ml/l)	20.73	26.80	23.75	10.0

LB – Lagos bridge, MM – Monday Market bridge, GB- Gwange bridge
*Sources for WHO limits: WHO 1971, 1984, 1993 and Gray, 1994.

This shows that the river still within the optimum range for fishes to thrive. In addition, Electrical Conductivity (EC) values ranges from 173.50 – 3696.50 all within standards of WHO of 1000, except for Monday Market Bridge which was way above the sets standards. Conductivity is a measure of the ability of water to conduct an electric current. It is sensitive to variations in dissolved solid most mineral salt. It is higher for waters containing high concentrations of sulphate, the conductivity for fresh water normally is 1000 us/cm, but polluted water exceeds this, indicative that Monday Market Bridge is polluted which can be attributed to the commercial activities around it.

Nitrate (NO_3), the most highly oxidized form of nitrogen compounds is commonly present in surface and groundwater; because it is the by-product of the aerobic decomposition of organic nitrogenous matter. Unpolluted natural waters usually contain negligible quantum of nitrate. In this study, the nitrate concentration of Ngadda River is high ranging from 15.10 – 31.77 indicating that it is polluted. The nitrate values obtained in all sites were above the WHO standard of 10 mg/l. Concentrations in excess of 5 mg l^{-1} NO_3-N usually indicate pollution by human or animal waste. High levels can affect osmoregulation, oxygen transport, eutrophication and algal bloom (Lawson, 1995).

The study reveals that Chloride (Cl^-), which is the chloride ion content ranged from 11.00 – 398.00 mg/l. The chloride values obtained from all sites during the research are within the WHO standard of 250mg/l except for Monday Market, with 398.00 ml/l. Phosphate (PO_4) content on the other hand ranged from 3.06 – 7.41mg/l, with all sampling points within standard with the exception of Monday market which recorded 7.41ml/l above the 5.0ml/l WHO standard. Generally, the high phosphate values obtained from the investigation at Monday Market Bridge could be attributed to the phosphorus in runoff from domestic, municipal and agricultural wastes (non-point source) flowing into the river as well as washing along the riverside with detergent (Correl, 1998).

Finally, Ammonium (NH_4) values ranged from 2.25 – 5.10 mg/l way above the set standard for fresh water indicating the polluted nature of the river. Ammonia occur naturally in water bodies arising from the breakdown of nitrogenous organic matter and inorganic matter in soil and water, excretion by biota, reduction of the nitrogen gas in water by microorganisms and from gas exchange with the atmosphere.

Conclusion

Site-wise mean values of physicochemical parameters of River Ngadda with their respective W.H.O. standards are presented in Table 2 (W.H.O. 1984). The comparison of estimated values of different parameters with W.H.O. standards indicated that the river water is polluted with reference to most parameters studied with Monday Market Bridge being most culpable, followed by Gwange and Lagos Bridges respectively, however some parameters such as temperature, pH, and TSS still within allowable permit. There is therefore an urgent need for improved water quality management within the study area

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