International Journal of Management, Modern Sciences and Technologies
ISSN: 2305-199X || WWW.IJMMST.ORG
Open-Access || pp-30-36

Quality Status of a Stretch of IMABOLO River in ANKPA, KOGI State, Nigeria Using Physicochemical Parameters and MACROBENTHIC Fauna

Salifu, M.
Department of biology, Kogi State College of Education, Ankpa

Abstract: The study was carried out to determine the level of pollution of a stretch of Imabolo River in Ankpa, Kogi State using macrobenthic fauna. Five sampling stations were selected. Sampling was done monthly for twelve months. The physico-chemical and biological parameters were analyzed according to standard methods. Most physico-chemical parameters fall below the international maximum permissible limits. Macrobenthic samples were collected using Ekman Grab (model 923). At each station, triplicate samples were taken and the dredged materials washed through a standard sieve number 40 with 0.41mm mesh size. The organisms were picked from the residue by means of forceps and preserved in plastic storage jars with 4% formalin prior to identification. Compound microscope was used to identify the specimens with the aid of IOWATER Advanced Benthic Key. A total of 134 individuals of 13 families grouped into six orders were identified. Chironomidae larvae had the highest occurrence of 108 individuals (80.6%) and 1350 individuals/m^2. The population was more in the dry season than in the rainy season. ANOVA shows highly significant values between months and stations. Shannon-Weiner's diversity index shows low diversity in community structure.

Keywords- Ankpa; fauna; Imabolo River; Macrobenthic; Paraneters; Physicochemical; Quality status

INTRODUCTION

Availability of safe and reliable sources of water is an essential prerequisite for sustained development (Adakole *et al.*, 2008). This availability of safe and reliable sources of water has in recent times, been affected by climate change. Climate change directly affects the water cycle. It also affects the quantity and quality of water resources available to meet human and environmental demands. Even where water is available, it is frequently useless due to the damaging effects of elements in it. In many areas of the world, the same water is used for washing, bathing and drinking. This makes the water to be at high risk of pollution.

Nigerian freshwater bodies have been subjected to various forms of degradation due to pollution from industrial effluents, domestic wastes, agricultural run-offs, oil spillage and obnoxious fishing methods (Njoku and Keke, 2003; Chia *et al*., 2011). This pollution is likely to cause water related diseases (Ayeni *et al*., 2009)..This makes it imperative to monitor the quality status of every water source to control the pollution of such water sources and also to avert the consequences of consuming polluted water.
Traditionally, water quality monitoring actions have focused on physical and chemical measurements. It is widely recognized that the use of other indicators, in addition to traditional chemical and physical water quality monitoring techniques, can greatly enhance the assessment and management of aquatic ecosystems (Ramachandra and Malvikaa, 2007). In this regard, biological monitoring or biomonitoring has proved to be an important tool in assessing the condition of aquatic ecosystems. Biological methods used for assessing the water quality include qualitative and quantitative analysis of different groups of aquatic organisms (Ramachandra and Malvikaa, 2007). Bio - indicators of pollutants are useful in predicting the level and degree of pollution before the effects of the pollutants start (Pai, 2002).

The macrobenthic fauna community structure represents an integral measure of autotrophic and heterotrophic process in rivers, and reflects disturbances in these processes. As benthic macroinvertebrates tend to remain in their original habitat, they are affected by local changes in water quality. Some are capable of tolerating higher loads of pollution than others. Thus if the pollution is severe, or is moderate but sustained over time, the whole community structure may be simplified in favor of tolerant species. By assessing indicator species, diversity, and functional groups of the benthic macroinvertebrate community, it is possible to determine water quality (Ramachandra and Malvikaa, 2007). Aquatic invertebrates live in the bottom parts of water bodies.. Macro-invertebrates convert and transport nutrients from one part of the water body to another, influencing nutrient cycling. They ingest organic matter such as leaf litter and detritus and in turn become food for higher aquatic organisms such as fish, forming a basic link between organic matter and higher aquatic animals in the food web. They are sensitive to changes in habitat and pollution, especially to organic pollution (Ramachandra *et al*., 2005)
Benthos are preferred indicators of watershed health because they live in the water for all or most of their life, are easy to collect, differ in their tolerance to amount and types of pollution, are easy to identify in a laboratory. They also have limited mobility and are integrators of environmental condition (Ramachandra and Malvikaa, 2007).

Imabolo River is the largest river in Ankpa L.G.A of Kogi state which is used majorly to supply water to Ankpa, the local government headquarters, and the surrounding villages for domestic and agricultural uses. There is dirt of published work on the macro benthic composition of Imabolo River. Hence, this research work was undertaken to fill this gap.

Study Area
Imabolo river is the largest river in Ankpa L.G.A of Kogi state which is used majorly to supply water to Ankpa, the local government headquarters, and the surrounding villages. Ankpa is located within latitude $7^0$24'16"N and longitude $7^0$37'50.6"E at the eastern part of Kogi State (Fig. 3.1). The town has an area of approximately 1200km^{2}and a population of 267,353 in the 2006 population census (National Population Commission).

Most of the town's landscape slopes to the river so that run–off from the town finally ends in the river. Commercial and agricultural activities predominate in the area.

Imabolo River passes through Ankpa in Ankpa L.G.A. to Olamaboro L.G.A. before joining Ofu river in Ofu L.G.A to form Anambra river that flows to river Niger. The river flows throughout the year. The river is used mostly for domestic purposes-washing, bathing, cooking and drinking. There is also little fishing activities.

Sampling Stations
Five sampling stations were selected based on a preliminary survey of the river. The first station (Station I) is located at the point of entrance of the river to the town with no visible evidence of surface run-off from the town. It has an elevation of 304.49 m above the sea level and a coordinate of 07^{0}24′40.3"N007^{0}38′47.0"E (GPS). Station II is located immediately after Saint Charle's college, where the first major drainage channel that brings run-off from the town into the river is located. It has an elevation of 295.96 m above the sea level and a coordinate of 07^{0}24′17.9"N007^{0}38′28.0"E (GPS). Station III is located at the bridge along Otukpo road and receives effluents from mechanical and vehicular washers. It has an elevation of 298.40 m above the sea level and a coordinate of 07^{0}24′08.6"N007^{0}38′19.6"E (GPS). Station IV is located at Owelle – Ankpa where the last major drainage channel that carries domestic and commercial effluents into the river is found. It has an elevation of 265.48 m above the sea level and a coordinate of 07^{0}22′20.7"N007^{0}37′59.3"E (GPS). Station V is located at the bridge along Enugu road where the river finally leaves the town. It has an elevation of 311.81 m above the sea level and a coordinate of 07^{0}21′04.4"N007^{0}07′41.9"E (fig.1).

Sampling Procedure
Sampling was done from October 2012 to September 2013 (1 year). The physico-chemical and biological parameters were analyzed according to standard methods. Water temperature, pH, electrical conductivity (EC) and total dissolved solids (TDS) were measured using the portable Combo HANNA instrument water check (model HI 98129). Water transparency was determined by the use of Sec chi disc. Velocity was determined using a measuring tape, a stop watch and a floating object. A measuring rope with weight at one end was used to measure the water depth at each station. The width of the river was determined at each sampling station using a measuring tape. Total suspended solids (TSS) and total solids (TS) were determined according to APHA, 2002. Nitrate –nitrogen (NO_3-N), phosphate-phosphorus (PO_4O), total alkalinity dissolved oxygen (DO) and biological oxygen demands (BOD) were measured according to APHA1998.

Sampling of benthos was done using Ekman Grab model 923 to collect the benthic fauna from the stations. The Grab measures 19cm by14cm with an area of 0.0266m^2. At each station, 3 grabs were taken and the dredged materials washed through a standard sieve number 40 with 0.41mm mesh size. The organisms were picked from the residue by means of forceps and preserved in plastic storage jars with 4% formalin prior to identification. Compound microscope was used to identify the specimens with the aid of IOWATER Advanced Benthic Key (2005).

Statistical Analyses
Analysis of variance was performed on the data set to determine the effects of stations and seasons. Shannon-Weiner's diversity index was performed on the parameter to determine the diversity of the organisms.
Analysis of variance was done using Statistica 8.0 for windows; DCA, CCA and Monte Carlo permutation tests was done using Canoco 4.5. All analyses were done at 95% confidence interval ($p<0.05$).

RESULTS & DISCUSSION

The study showed that temperature ranged between 23.24±0.39 and 28.36±0.19^{0}C, transparency between 39.80±9.16 and 59.30±9.41cm, TSS between 100.00±68.24 and 300.00±0.00 mg/l, TDS between 40.00±24.49 and 820.00±335.26 mg/l, velocity between 0.17±0.05 and 0.17±0.05 m/s. pH ranges between 5.75±0.11 and 6.19±0.17, EC between 17.80±3.54 and 34.60±10.27 µS/cm, DO between 2.96±0.17 and 4.62±0.45 mg/l, total hardness between 18.40±2.40 and 48.00±8.10 mg/l, alkalinity between 4.75±0.95 and 13.20±3.18 mg/l, NO_3-N between 7.200±73 and 24.80±1.39 mg/l and PO_4-P between 1.00±0.07 and 2.34±0.04 mg/l (table 1). The study revealed that the physico-chemical parameters vary significantly between stations and months of study at $p>0.05$ (table 2).

Table 3 shows a checklist of macrobenthic fauna identified during the period of study. A total of 134 individuals of 13 families grouped into six orders were identified. Chironomidae larvae had the highest occurrence of 108 individuals (80.6%) and 1350 individuals/m^2 (Table 1). The relative abundance of other families ranges between 13 – 100 individuals/m^2. The highest number of occurrence was found at station 3 in the month of April while no occurrence was recorded at all stations in July, August and September (Fig. 2). The occurrence of macrobenthic fauna was higher in the dry season (1075 individuals/m^2) than in the rainy season (600 individuals/m^2) (Table 5). The analysis of variance of macrobenthic fauna means between months, stations and

ISSN: 2305-199X || WWW.IJMMST.ORG

months/stations showed a highly significant value (Table 6). Shannon-Weiner's species diversity index showed that June sample at station 2 had the highest species diversity of H' 1.10 (Table 4). The correlation that exists between the physicochemical quality of a water body and the population of macrobenthic invertebrates indicates that the physicochemical quality tends to have regulated the distribution of the organisms (Adakole *et al*., 2008). The biotic component of an aquatic environment is affected in various ways by the physicochemical parameters (Adeogun *et al*., 2004). Thus the macrobenthic invertebrates encountered and enumerated represent the summation of the prevailing water condition of Imabolo river water during the period of study. The one hundred and thirty four (134) species identified during the study period is grossly below the number reported by Adakole et al., (2008), Adakole and Annune (2003) for tropical streams. The low number encountered during the study period could be attributed to frequent disturbance of the river by cattle and humans. The comparably lower number of macrobenthic fauna encountered in the rainy season and none at all in June, July August and December could be the result of sediments brought by flood which buried the organisms deeper beyond the reach of Eckman grab. The dominance of Chironomidae and Oligocheate worms was an indication of moderately polluted water (Debbie, 2012).

CONCLUSION

Imabolo River water though having most physicochemical parameters falling below maximum permissible limits by international bodies showed evidence of pollution as suggested by low DO values reinforced by the dominance of Chironomidae larvae and presence of oligocheaate worms Table 1: Comparison of physico-chemical parameters of Imabolo river between months of the study period.

Means with the same letter along rows are not significant at p>0.05 level of significance

Note: DO= Dissolved Oxygen, BOD= Biological Oxygen Demand, TSS= Total Suspended Solids, TDS= Total Dissolved Solids, TS= Total Solids, NO_3-N= Nitrate-nitrogen, PO_4-P= Phosphate-phosphorus, EC= Electrical Conductivity n.d= Not Determined.
Table 2: Some physico-chemical parameters of a stretch of Imabolo river.

Parameters	Station 1	Station 2	Station 3	Station 4	Station 5
Temperature (^{0}C)	25.94±0.44c	26.97±0.43a	26.95±0.38a	26.30±0.43b	26.44±0.42b
Transparency (cm)	61.88±2.98a	59.79±5.48a	35.71±2.98b	48.25±2.11a	53.29±3.14a
TSS (mg/l)	125.00±37.18b	133.33±37.10a	133.33±37.10a	141.67±35.80a	133.33±33.33a
TDS(mg/l)	100.00±40.82b	191.67±112.45a	176.00±104.54a	200.00±112.14a	100.00±30.15b
TS (mg/l)	225.00±59.19b	325.00±135.33a	308.33±126.85a	341.67±134.53a	233.33±55.50b
Depth (cm)	61.88±2.98b	94.00±6.23a	40.54±1.97d	48.25±2.11cd	53.29±3.14c
Width(m)	10.54±0.98b	17.29±1.69a	8.29±1.17c	6.32±0.58d	6.22±0.77d
Velocity (m/s)	0.02±0.01b	0.02±0.01b	0.51±0.08a	0.40±0.04a	0.39±0.05a
pH	5.57±0.03c	5.59±0.03c	5.73±0.06b	6.22±0.06a	6.15±0.06a
EC (µS/cm)	12.50±0.80c	15.58±2.30c	22.25±2.00b	37.25±1.90a	34.25±3.21a
DO (mg/l)	4.06±0.31a	3.70±0.18a	3.07±1.8a	4.02±0.20a	3.78±0.29a
BOD (mg/l)	1.11±0.17a	1.60±0.23a	1.03±0.22a	1.61±0.35a	1.32±0.28a
Total Hardness $CaCO_3$ (mg/l)	29.27±3.17a	33.50±4.89a	30.67±3.36a	34.17±3.42a	37.00±3.35a
Toall Alkalinity $CaCO_3$ (mg/l)	6.78±1.24c	6.00±0.99c	9.58±0.95ab	11.67±1.57a	10.33±1.18a
NO_3-N (mg/l)	11.42±2.07a	14.29±2.42a	14.38±1.45a	16.00±1.56a	15.46±a
PO_4-P (mg/l)	1.64±0.13a	1.69±0.13a	1.78±0.11a	1.63±0.13a	1.75±0.13a

Note:
Means with the same letter are not significant at p>0.05 level of significance
EC= Electrical Conductivity
DO= Dissolved Oxygen
BOD= Biological Oxygen Demand

ISSN: 2305-199X || WWW.IJMMST.ORG

TSS= Total Suspended Solids
TDS= Total Dissolved Solids
TS= Total Solids
NO_3-N= Nitrate-nitrogen
PO_4-P= Phosphate-phosphorus.

Table3: Macrobenthic fauna of a stretch of Imabolo River.

Order	Family	No. per Station					Total No. Identified	% Occurrence	Individual/m^2
		1	2	3	4	5			
Coleoptera	Dystiscidae	-	-	-	1	-	1	0.75	13
	Hydrophilidae	-	1	-	-	-	1	0.75	13
Diptera	Anthericidae	-	-	-	1	1	2	1.5	25
	Chironomidae	7	39	58	3	1	108	80.6	1350
	Empididae	-	1	-	-	-	1	0.75	13
	Simulidae	-	1	-	-	-	1	0.75	13
	Syriphidae	-	-	-	1	-	1	0.75	13
	Tupilidae	-	-	-	-	3	3	2.2	38
Hemiptera	Nepidae	-	-	-	2	2	4	3	50
Megaloptera	Sialidae	-	1	-	1	1	3	2.2	38
Odonata	Coenagrionidae	-	-	-	1	-	1	0.75	13
Lumbricina	Encliytraeidae	-	-	8	-	-	8	6	100

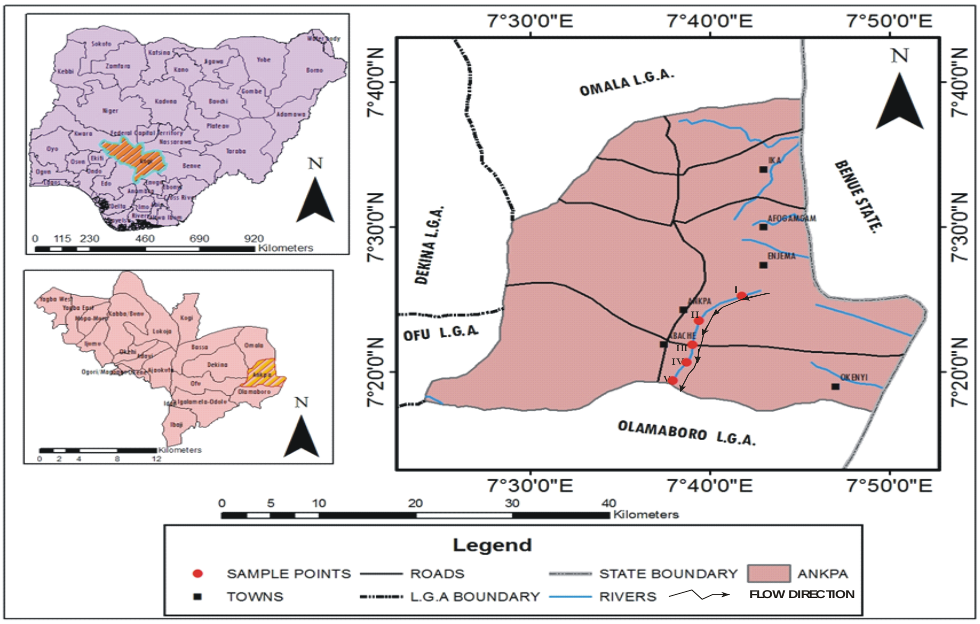

Figure 1: Map of Ankpa showing Imabolo River

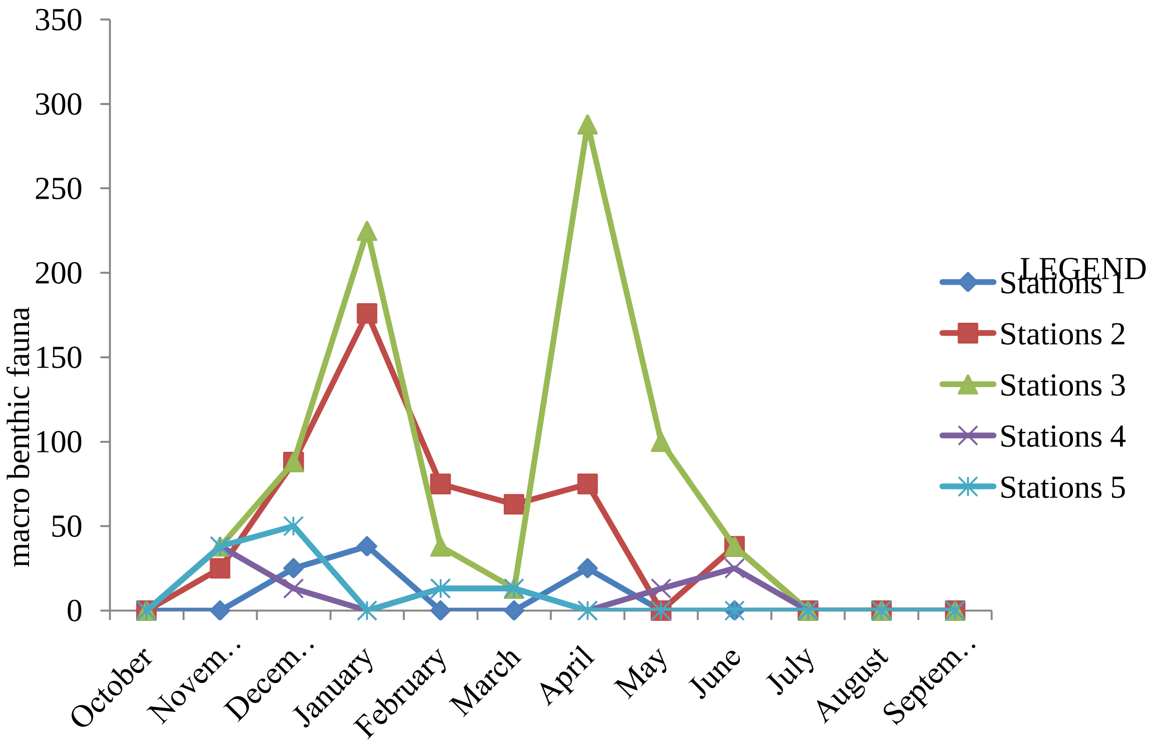

Figure 2: Mean monthly variations in macrobenthic fauna of a stretch of Imabolo River

Table 4 :Shannon-Weiner's diversity index for macrobenthic community of a stretch of Imabolo River.

Months	Stations 1	2	3	4	5
October	0.00	0.00	0.00	0.00	0.00
November	0.00	0.00	0.64	0.69	0.64
December	0.00	0.00	0.00	0.00	0.56
January	0.00	0.00	0.53	0.00	0.00
February	0.00	0.00	0.00	0.00	0.00
March	0.00	0.00	0.00	0.00	0.00

ISSN: 2305-199X || WWW.IJMMST.ORG

April	0.00	0.00	0.30	0.00	0.00
May	0.00	0.00	0.38	0.00	0.00
June	0.00	1.10	0.00	0.69	0.00
July	0.00	0.00	0.00	0.00	0.00
August	0.00	0.00	0.00	0.00	0.00
September	0.00	0.00	0.00	0.00	0.00

Key:
0.00-0.4 = 1 Species
0.5-0.9 = 2 Species
1.0-1.2 = 3 Species
Source: Exponential table.

Table 5 : Comparison of macrobenthic fauna between seasons

Season	Month	Benthos	Individual/m^2
Dry	November	11	138
	December	21	263
	January	35	438
	February	11	138
	March	8	100
Sub-total		**86**	**1075**
Wet	April	31	388
	May	9	113
	June	8	100
	July	0	0
	August	0	0
	September	0	0
	October	0	0
Sub-total		**48**	**600**
Grand Total		**134**	

Table 6: ANOVA of Biological Parameters per Month, Station and Station/month

Source	Variable	Mean	df	Mean square	F	Sig.
Month	Benthos	5.170	10	26.729	2.285E28	.000
Station	Benthos	6.718	4	45.137	3.858E28	.000
Month/station	Benthos	3.225	39	10.401	8.890E27	.000

Alpha = .05.

REFERENCES

- *Adakole, J.A. and Annune, P.A. (2003). Benthic macroinvertebrates as indicators of environmental quality of an urban stream, Zaria. Nigerian Journal of Aquatic Sciences, 18 (2):85-92.*
- *Adakole, J.A., Abolude, D.S. and Balarabe, M.L. (2008). Assessment of water quality of a man-made lake in Zaria, Nigeria. In Sengupta, M. and Dalwani, R. (Eds), Proceedings of Taal 2007. The 12th World Lake Conference, 342 – 346.*
- *Adeogun, O.A., Fafioye, O.O., Olaleye, B.A. and Ngobili, G.O. (2004).The relationship between some physicochemical parameters and plankton composition on fish production in ponds. Proceedings of the 19th Fisheries Society of Nigeria (FISON), Lagos-Nigeria, 424-428.*
- *Chia, A. M., Oniye, S. J., Ladan, Z., Lado, Z., Pila, A. E., Inekwe, V. U. and Mmerole, J. U. (2009). A survey for the presence of microcystins in aquaculture ponds in Zaria, Northern-Nigeria: Possible public health implication. African Journal of Biotechnology, 8 (22): 6282-6289*
- *IOWATER (2005). Benthic macroinvertebraate key.*
- *Njoku, D.C. and Keke, I.R. (2003). A Comparative Study On Water Quality Criteria Of Delimit River In Jos, Plateau State of Nigeria. ASSET Series A 3(4). 143 – 153.*
- *Pai, I.K. (2002).In Kumar, A. (Ed). Ecology of polluted water. Shodhganga.inffilbnet.ac.in.8080/jsp…*
- *Ramachandra T.V. Ahalya N., and Rajashekara Murthy C. (2005) Aquatic Ecosystems: Conservation, Restoration and Management, Capital Publishing Company, New Delhi., p 31.*
- *Ramachandra, T. V. and Malvikaa, S. (2007). Ecological Assessment of Lentic Water Bodies of Bangalore. ENVIS Tecnnical Report: 25.*

