



ASSESSMENT BY PARAMETER QUALITY FUNCTION OF MU RIVER, MAKURDI, NIGERIA

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ABSTRACT

A survey of the Mu River was carried out between February and July, 2004. Samples of water from three stations (stations 1, 2 and 3) were analysed for physico-chemical parameters. The results of the study shows that, dissolved oxygen ranged between 4.0 – 7.0 mg/l and 61 – 90 % saturation, temperature 26.8 – 30.9°C, hydrogen ion concentration 5.0 – 7.2, secchi – disc transparency 0.85 – 0.20M, alkalinity 43 – 90 CaCO₃ mg/l, free carbon (IV) oxide 2.2 – 15.4 mg/l and biochemical oxygen demand 1.0 – 3.9 mg/l in all the stations during the sampling period. The analyses of the physico-chemical features using parameter quality function indicate quality appraisals of good grades. This finding was further confirmed by the dominance of macro-invertebrates, not known to have much tolerance to pollution. This also reveals that domestic sewage released into Mu River affected the quality of the water but not to an extent to cause pollution.

Keywords: water, environment, hazard, indicator

INTRODUCTION

Before there could be any meaningful management of a river system, there is need to have background information on the quality of a river as well as its viability under a variety of a natural conditions. The knowledge about the river quality will require both chemical and biological examination of the system. This is obtained through regular surveys of a river system. Inland and marine water area coverage in Nigeria was known to be 125,470.82 km² and 46,300 km² respectively, sustaining an average of over 6 million artisanal fishermen. Their activity has been attributed to about 85% of local fish utilization in Nigeria (Fish for All Summit, 2005).

The water cycle is synonymous with inland water especially as it serves as a means of transport of materials around the world (Dalai *et al.*, 2004). This transport of water brings about the mixing of plants and animals across their habitats. The individual pores within substrates are the most significant for water mix and therefore, identified with high volume of aquatic biome (Gilbert *et al.*, 1994).

Increases in biodiversity of invertebrate in inland water is determined by the nature of its substrates (Downes *et al.*, 1995), macro-invertebrates are sensitive to range of depth, water current and under-layer texture (Brooks *et al.*, 2005). Organism

from the river surroundings when received serves as ration for fish making up to about 50% of feed for some species (Nakano *et al.*, 1999).

Aquatic system can be divided into three spatial compartments within which different trophic levels are located. The pelagic community of the water mass, the benthic community living in and on the underlying sediments or rocks, and in shallows regions, and the fringing communities dominated by emergent or submerged plants. Abundance of organism at any lower trophic level is dependent on the activity of its predators (Rudstam *et al.*, 1993), this may have spill interaction amongst trophic levels (Rudstam *et al.*, 1993; Menge 1995; Deegan *et al.*, 1997; Heck *et al.*, 2000).

For descriptive purposes, the pelagic compartment can be divided into the planktonic community suspended in the water, and the nektonic assemblage of larger more mobile organisms which can swim through it.

Benue State has a tropical savanna climate with two clearly marked seasons of wet (May – October) and dry (January – April). The dry cold harmattan wind is experienced between November and January when the hot season starts and lasts until the rain begins. The highest water levels are between Augusts – September and the lowest are between Marchs – April. Extremes of temperatures are rare. The average air temperatures for Makurdi are 44°C

and 20 °C respectively, (FMA, 2003). Mu River has a lot of beneficial role in that, it is used broadly for fishing, and it is also used for drinking, industrial and other domestic activities. The above role can be hindered by some factors such as pollution. The effect of pollution can be due to its large catchment area on the aquatic life, and the composition of Mu River has received little scientific focus as evidenced by the scanty information available on the river. Most health hazards are attributed to use of contaminated water by organism in environment identified with both domestic and industrial discharges (Dan'azumi and Bichi, 2010).

Nevertheless, there are some problems inherent; many of the rivers in this country have therefore remained largely unpolluted. Increase nutrients in inland water bodies may result in an increase in total biodiversity and its productivity (Power 1992; Deegan *et al.*, 1997), the pollution stress is low and is easily accommodated by the natural self – purification capacity of rivers. However, as a result of the oil boom, the situation has changed significantly; since independence and specifically during the 1970s increased industrial activities led to urbanization and pollution stress on the environment both from industrial and domestic sources. The major streams in the industrial estates of big cities like Lagos, Kano, and Kaduna are already seriously polluted by wastes from industrial sources (Jegede, 1977; Martins, 1978). The turn of events is already causing concern in governmental quarters (Ojikutu, 1997).

Some scientific works had been carried out on the physico – chemical and bio – limnology of rivers in Nigeria. Notable among these are the effect of Abattoir loads in form of contaminant on inland water bodies, this cannot be over emphasized in terms of health and environmental degradation (Osibajo and Adie, 2007; Coker *et al.*, 2001; World Bank, 1995; Nafarnda *et al.*, 2006). But none of these

studies made an attempt to appraise the quality of the Mu River. Inadequate information on Mu River makes it almost impossible to determine the exact state of the water productivity, ability to sustain fish production, non-fish resources, occurrence per season and limnological characteristics. The objective of this study is to provide some limnological information on Mu River. This objective can be pursued through one of the most acceptable methods of water quality survey that is by the use of physico-chemical parameters; however, this method has cost implications on achieving its objective (Raburu *et al.*, 2009; Njiru *et al.*, 2008).

MATERIALS AND METHODS

Study Area

The study site, Mu River is a tributary of River Benue. Mu River joins the Benue River behind Kilometer Five, Gboko Road that is Benue Breweries in Fiidi Ward and moves from Gwer passing through Ikpayoungu, through Ugondu (Apir) before entering Makurdi after Air Force Base. It then moves down to Kilometer Five Gboko Road, then discharge into the River Benue. The Mu River is situated at Latitude 7°45'' N – 7°44'' N and Longitude 8° 26'' E and 8° 45'' E.

Mu River usually flows into River Benue during high flood but recede during dry period. It usually dries up during the dry season leaving only pools of water at points where deeper ditches are found.

The study was restricted to sampling stations located along Mu River. The sampling stations were designated with station1 to station 3 comprising of areas receiving domestic wastes and run off during rains. The three sampling stations were: Station 1 located at 150 meters after the old bridge, Station 2 located at 1.2 kilometers away from the new bridge and Station 3 located at 1.6 kilometers before the old bridge.

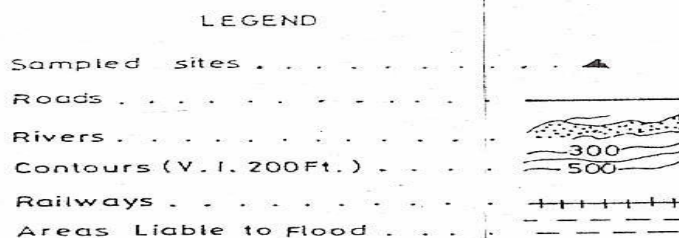
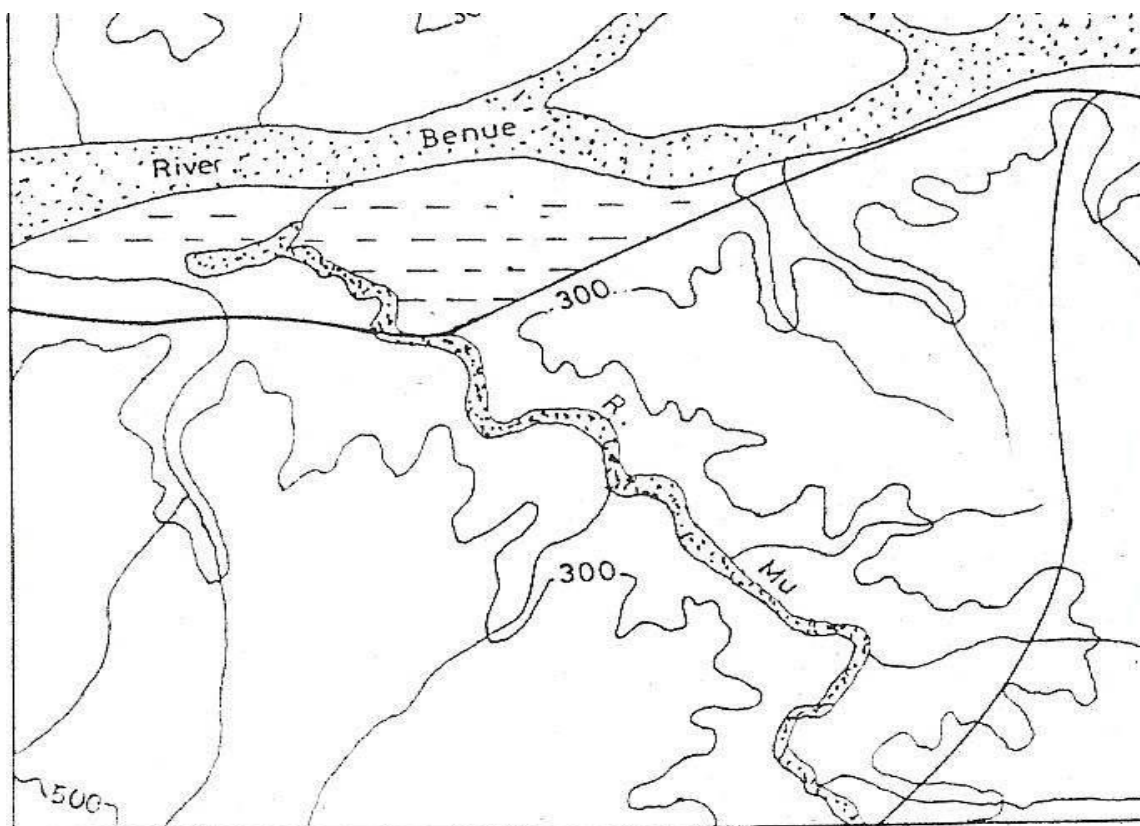


Fig I: Topographical Map Showing Mu River

Sampling

Samples for the characterization of different physico-chemical parameters were collected at monthly intervals from three (3) experimental stations between February and July, 2004. Water samples from different stations were collected by means of shallow water sampler using a 250 ml reagent bottles and one litre white plastic bottles. Some physico-chemical parameters like water temperature, and Secchi disc transparency were analyzed and recorded on the spot immediately after collection of the water samples. Analysis for the

remaining physico-chemical parameters were carried out in the laboratory. The methods used for the estimation of the variables were standard methods of APHA, (1998) and Trivedy and Goel, (1986).

The Parameter Quality Function

The values obtained for all the physico-chemical parameters were used to determine the parameter quality functions, which was in turn used to rate the water quality (Deininger, 1980) as shown in Table 1, with values ranging from 0-100 as indicated below.

Parameter Quality Function	Assessment
90 – 100	Excellent
70 – 89	Good
50 – 69	Medium
25 – 49	Bad
0 – 24	Very Bad

Table 1: Data used for assessment of water pollution (modified from –Deininger, 1980)

	UNPOLLUTED			POLLUTED		REMARK
	EXCELLENT	GOOD	MEDIUM	BAD	VERY BAD	
Water Temperature (°C)		32 – 25		Below 25		(for tropical fish culture)
Secchi – Disc Transparency (cm)	Above 30 to		Above 60	30 to 0		(when plankton bloom accounts for the turbidity)
Dissolved Oxygen (mg/l)		12 to 15		Below 5.0		
Dissolved Oxygen (%)	Above 80 to 120	Above 67 to 80	Above 54 to 57	Above 33 to 54	Below 33	
Biochemical Oxygen Demand (mg/l)	0 to 1.5	Above 1.5 to 3.5	Above 3.5 to 6.0	Above 6.0 to 12.5	Above 12.5	
Hydrogen Ion Concentration (pH)	Above 6.8 to 7.5	Above 6.4 to 6.8	Above 5.8 to 6.4	Above 5.0 to 5.8	Below 5.0 and above 7.5	

Macro-Invertebrate Sampling

A preliminary survey was carried out to determine the dominant macro-invertebrates collected from the different stations using plankton nets, they were pooled, and separated under a Kena-vision (Model; 15-2424) microscope. The macro-invertebrates were identified using an identification key (Elliot, 1977) and were then grouped into pollution indicators and unpolluted water species. Samples were preserved in formalin. The plankton net has a conical-shaped net (25 mesh/cm) 42 cm long, and with a circular opening 28 cm in diameter. The net was dragged along the sides of the river, and dragged back through the same depth.

RESULTS

The physico-chemical parameters are presented in Table 2; while mean values recorded on some physico-chemical parameters including their

parameter quality function and water quality index are presented in Table 3.

The mean values of dissolved oxygen (mg/l) were above 5.0 mg/l in stations 1, 2 and 3 with Q value of above 60. The temperature (°C) values in stations 1, 2 and 3 were slightly above 29.0 °C and had a Q value of above 80.

The hydrogen ion concentration (pH) values for station 3 had the lowest of 6.0 which increased above 6.0 in station 1 and 2 respectively. Their Q values ranged from 80 to higher value of 95 in station 2.

The Secchi disc transparency (M) values for stations 1, 2 and 3 were above 0.50 M. Q value of 85 for station 3 while station 1, and 2 had values of Q above 90.

The alkalinity (CaCO₃ mg /l) and free Carbon (IV) oxide (mg/l) may not have parameter quality

function, as these results were insignificant and thus excluded as seen in Table 1.

The biochemical oxygen demand Q values for stations 1, 2 and 3 were above 80. The Q values for some of the physico-chemical parameters were analysed using the water quality index, in which stations 1, 2 and 3 had values above 80.

The check-list of dominant macro-invertebrates in Mu River are represented in Table 4. The results showed that worms, molluscs, crustaceans and insects were dominant in all the three sampling stations.

Table 2: Monthly variations for some physico-chemical parameters along Mu river

Parameters		Dissolved Oxygen (mg/l)	Temperature (°C)	Hydrogen Ion conc. (pH)	Secchi-disc Transparency (M)	Alkalinity (CaCO ₃ mg/l ⁻¹)	Free carbon oxide (iv) (mg/l)	Biochemical oxygen demand (mg/l)
MONTHS								
FEBRUARY	ST1	6.3	28.0	7.0	0.80	49	4.3	2.1
	ST2	6.0	30.1	7.0	0.83	75	4.4	1.4
	ST3	6.0	30.7	6.3	0.74	71	4.5	1.5
MARCH	ST1	6.4	30.3	7.1	0.85	55	2.3	2.3
	ST2	6.3	30.2	7.2	0.80	64	2.2	2.0
	ST3	6.2	30.5	6.3	0.75	65	2.2	2.1
APRIL	ST1	7.0	30.6	6.6	0.53	81	13.0	2.1
	ST2	6.9	30.8	6.8	0.73	50	15.4	1.9
	ST3	5.9	28.9	6.5	0.52	90	8.9	2.3
MAY	ST1	6.7	30.8	5.5	0.42	45	2.2	2.4
	ST2	6.0	30.9	6.5	0.35	43	4.3	3.9
	ST3	6.5	30.5	5.0	0.33	46	4.4	1.0
JUNE	ST1	5.5	28.0	6.6	0.38	50	6.5	1.5
	ST2	4.0	28.1	6.5	0.30	46	6.6	2.2
	ST3	4.3	27.7	5.8	0.35	50	6.5	1.9
JULY	ST1	5.8	26.8	6.2	0.20	69	8.7	2.5
	ST2	6.4	26.9	6.5	0.23	51	15.3	2.0
	ST3	6.7	27.3	6.1	0.66	55	15.0	2.4

Table 3: Mean values obtained on some physico-chemical water quality parameters in Mu river including their *Q and **W.Q.I.

Parameters	Sampling Stations		
	Station 1	Station 2	Station 3
Dissolved Oxygen (mg / l)	6.3	5.9	5.9
Q	69	68	68
Dissolved Oxygen (% sat)	72.5	74.5	71.8
Q	82	85	80
Temperature (°C)	29.1	29.5	29.3
Q	85	87	86
Hydrogen Ion Concentration (pH)	6.5	6.8	6.0
Q	89	95	80
Secchi Disc Transparency (M)	0.53	0.54	0.56
Q	95	92	85
Alkalinity (CaCO ₃ mg / l)	58	55	63
Q	-	-	-
Free Carbon (IV) Oxide (mg / l)	6.17	8.03	6.92
Q	-	-	-
Biochemical Oxygen Demand (mg / l)	2.2	2.2	1.9
Q	85	85	88
Water Quality Index W.Q.I	84.2	85.3	81.2
Assessment	GOOD	GOOD	GOOD

*Q = Parameter Quality Functions **W.Q.I = Water Quality Index

Table 4: Check-list of dominant macro-invertebrates in Mu river

Phylum	Order/Taxonomic Group
Annelida	Hirudinea (Leech)
Mollusca	Gastropoda (Gill Breathing Snails) Pelecypoda (Clams)
Crustacea	Decapoda (Astacidae) Amphipoda (Scuds) Copepoda Cladodera
Insecta	Coleoptera (Riffle beetle) Trichoptera (Caddisfly larvae) Ephemeroptera (Mayfly) Odonata / Dragon Flies and Damsel Flies Diptera (Crane fly) Chironomids

DISCUSSION

The range of dissolved oxygen (DO) was between 4.0 – 7.0 mg/l. Scanty rainfall, with attendant low volume of water in March may result to higher dissolved oxygen content in stations 1, 2 and 3; also there was oxygen diffusion from the atmosphere into the water body. The low values in June could be from domestic sewage washed into the river from the settlement. Comparable findings were also credited to Gupta *et al.* (1996) that DO level in the river water may be higher in monsoon as compared to summer seasons.

Aquatic organism possess morphological and physiological features for adaptability in low oxygen concentrated water. For instance, the accessory respiratory organs in catfish *C. gariepinus* and *C. batrachus* comprise (I) Suprabranchial chambers; (II) Fans (gill – plates) borne on each gill arch, and (III) The respiratory dendritic organs borne by the second and fourth gill arches. Minimum oxygen concentration for fish is species dependent, which has to do with genetic factor, water temperature and level of activity. Above the concentration at which basic metabolic needs are just satisfied, there is a range of concentration in which the organism can survive but cannot be as active as desirable.

The range of temperature was between 26.8 – 30.9 °C in all the stations. Temperature determines many factors in the aquatic ecosystem, such as rate of dissolved oxygen, and metabolic activities, however, the temperature recorded in the study area appears optimal for most organisms. Most effluent discharge does not seem to affect the temperature fluctuation and so temperature may not be a useful finding to assess pollution in fresh water. However, temperature remains a singular significant determinant of different metabolic process of organisms in the ecosystem as observed in the work of Munawar, (1970).

pH is expected to be neutral but becomes acidic where there is domestic sewage, which on break down produces ammonia. The ammonia formed is toxic to most fish. pH range for the study was from 5.0 – 7.2. However, fluctuation in pH is also attributed to input loads of pollutants in the river system. (Sahu *et al.*, 1995). The pH of inland water fluctuates in the day due to the process of photosynthesis. Reservoir known for badly buffering capacity of water will have a situation of pH as low as 7 in the dawn with a sharp increase to 9 and above after the mid day (Boyd, 1990).

According to Chowdhury and Khan, (1994) high value turbidity during rainy period may be due to heavy load of silt into the river water from the catchment area. The range for this parameter in the

study varies between 0.85 – 0.20 m. The study shows that as the rain increases the transparency reduces and also during the dry season when there is less inflow into the river the transparency increases. Therefore, the range obtained is adequate for all aquatic activities.

Alkalinity is usually due to the presence of carbonate; bicarbonate and hydroxide in natural waters. It can be defined as the capacity of water to accept protons (Standard Methods, 1992). There was fluctuation in alkalinity during the sampling period, which may be due to deposit on the bank from clay. Other reasons not obvious. It ranged between 43 – 90 CaCO₃ mg/l.

In this study, free carbon (IV) oxide ranged between 2.2 – 15.4 mg / l. The source of carbon (IV) oxide could be activities of aquatic organism such as respiration and decomposition of organic materials in the aquatic system. Since these processes consume oxygen, aquatic system is usually monitored for oxygen depletion rather than for high carbon (IV) oxide levels as a means of determining their suitability for aquatic organisms. It is possible to have both high concentration of carbon (IV) oxide and oxygen levels in an aquatic system, but this occurs so rarely that is not considered a problem when using the oxygen monitoring for determining water quality.

The biochemical oxygen demand is an indirect measure of the bio-degradation of organic matter and the level of organic pollution. According to Akpata *et al.* (1993), microbial oxidation of “organic sub-surface leads to the increase in level of biochemical oxygen demand in water bodies”. In this study the BOD values were high, this indicates that organic load coming from the watershed may not be of any consequence to the aquatic life. Its values ranged from 1.0 – 3.9mg / l during the study. The oxygen content and the BOD level confirm the finding that Mu River may not be polluted, because as the oxygen decrease, the BOD increases.

Parameter quality function and water quality index was used in the appraisal of the physico-chemical parameters. The study revealed the quality appraisals of good grades which show that most of the field values for parameters obtained at each of the sampling stations may not be polluting.

The dominant micro-invertebrates are not known to have much tolerance to pollution. However, the chironomids show that some levels of pollutants are going into the river. Best and Boss, (1977) showed that species of *Tubifex* (Oligochaeta) and *Chironomus* (Chironomidae) seems to prosper in

polluted waters. This does not indicate that Mu River may be polluted.

CONCLUSION

This study showed tentative appraisals of good grades, which means Mu River may not be polluted. Nevertheless, more studies need to be carried out on its macro-invertebrates composition and physico-chemical parameters. It is pertinent to note that, there was exchange of medium and aquatic life between Mu River and River Benue.

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