An Assessment Of Some Anion Levels Of River Benue In Adamawa State, Nigeria

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Abstract: The assessment of anion levels of River Benue in Adamawa state was carried in ten sampling stations. The sampling was done in the months of February, March, and April 2007, representing dry season, while the months of August, September, and October 2007, represent the wet season. The water samples collected were analysed using standard procedures. The mean concentrations of chloride, total sulphate, and total nitrate ranged from 55.27±13.37 to 110.23±21.41mg/l for dry season and 30.00±5.00 to 59.17±8.83mg/l for wet season, sulphate is between 18.0±2.05 and 35.0±6.05mg/l for dry season and 34.69±11.2 and 72.33±11.21mg/l for wet season, and total nitrate was between 2.44±0.23 and 4.23±0.22 for dry season and 14.00±0.22 and 22.33±1.34mg/l for wet season. Mean seasonal variation of NH_3-N, NH_4^+, NH_3, NO_3-N, NO_3^- ranged between 1.31±0.05 and 2.02±0.10mg/l in dry season for NH_3-N and 1.14±0.13 and 1.85±0.55mg/l for wet season, NH_4^+ was between 1.62±0.11 and 2.46±0.14mg/l for dry season and 1.50±0.19 and 2.43±0.43mg/l for wet season, $NH_3$was between 1.53±0.10 and 2.11±0.09mg/l for dry season and 1.33±0.10 and 2.15±0.31mg/l for wet season, NO_3-N were between 0.50±0.08 and 0.98±0.21mg/l for dry season and 0.51±0.16 and 0.91±0.04mg/l for wet season and that of NO_3^- was between 2.71±0.91 and 4.32±1.40 mg/l for dry season and 1.10±0.02 and 2.10±0.41mg/l for wet season. The values of the parameters were generally high in dry season than wet season; this may be due to low volume of water in the river at that time or as a result of washout from rocks or fertilizers/herbicides application from farms. The anion concentrations were found to be within the permissible limits of current WHO and NAFDAC standards.
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Key words: Assessment; Anions; River Benue; Parameter; Pollution.

1. Introduction

The presence of nitrate ion in surface water is due to processes in the water body itself such as nitrification. It is the oxidation of ammonium ions to nitrate by bacteria species:

$NO_3^- + 0.5O_2 = NO_3^-$. Agriculture is a major source of nitrate pollution due to nitrogen fertilizers and run-off from animal feedlots. Nitrate content of drinking water is rising at an alarming rate in both developed and developing countries owing to lack of proper sewage treatment (Radojevic and Bashkin, 1999). The current WHO drinking water guideline is 50 mg/l. No adverse health effects have been observed with nitrate concentrations less than 20- 30 mg/l except for methaemoglobenemia in infants.

The sources of water pollution vary and involve almost every significant human activity. These include mostly the dumping of domestic wastes, sewage, agricultural wastes and industrial effluents into water bodies (Collocott and Dabson, 1974). The wastes dumped on land are also eventually washed into water e.g animal dung, litters, wind deposited pollutants. Also disturbances of the soil mantle by ploughing during cultivation, road making, stream irrigation/channelization, and mining break the protective vegetation cover and encourage soil washout by storm water during rainfall. In some areas, air pollutants like oxides of nitrogen and sulphur become acidic contaminants during rainfall (Ademoroti, 1996). Increase in industrialization as a result of modern and sophisticated technology has introduced many synthetic materials into our environment. Some may be toxic or carcinogenic. The wastes arising from them find their way into water bodies, and hence they become contaminated. Aquatic biota is sensitive to pH. They cannot live in a medium having a salinity to which they are not adapted, also high temperatures encourages growth of bacteria and causes depletion in oxygen content of water (Bhatia, 200).

The infiltration of rainfall into landfill, together with the biochemical; and chemical breakdown of the waste, produces a leachate, which is high in suspended solids and of varying organic and inorganic content. If the leachate enters surface or ground water before sufficient dilution has occurred, serious pollution incidents can occur. In surface water leachate high in organic material and reduced metals will cause severe oxygen depletion and result in death of fish. Leachate high in non-biodegradable synthetic organic compounds is a particular threat, through bioaccumulation. Concentration of these substances may increase to toxic levels and thus endanger animal and human life.

Pollution may thus be defined as the introduction by man into the environment of substance or energy, liable to cause hazards to

human health, harm to living resources and ecological systems, damage to structure or amenities or interference with legitimate uses of the environment (Holdgate, 1979).

2. The Study Area

Adamawa State was administratively created in 1991 from the northeastern half of former Gongola state. Adamawa is bordered on the north and northwest by Borno and Bauchi states respectively, on the west and southwest by Taraba state, and on the southeast and east by the republic of Cameroon. Adamawa State is located within latitude 9°11'N to 9°20'N and longitude 12°23'E (Ishaku, 1995). The Mandara Mountains lie in the northeastern part of the state along the Cameroon border, and the Shebshi Mountains rise to Mount Dimlang (2,042 m) in the state's southeastern portion. Adamawa State is largely covered by short-grass savanna and is drained westward by the Benue River and its tributaries, including the Gongola, Taraba, and Pai rivers.

Adamawa State is multi-ethnic; few among the tribes are Fulani, Bachama, Mbula, Mumuye, Higi, Chamba, Margi (Marghi), Hausa, Kilba, Gude, Lunguda, Yungur, Kanakuru, and Bata peoples. All these groups except the trader Hausa population are primarily engaged in crop farming and livestock herding (cattle, goats, sheep), but fishing is also important along the riverbanks. Peanuts (groundnuts), cotton, sorghum, millet, rice, and corn (maize) are the main crops. Peanuts and cotton are exported, as are cattle, dyed skins, and gum arabic.

2.1 River Benue

River Benue is the longest tributary of River Niger; being about 1,083 km in length. It rises in northern Cameroon as the Bénoué at about 1,340 m and, in its first 240 km, descends more than 600 m over many falls and rapids, the rest of its course being largely uninterrupted. During flood periods its waters are linked via the Mayo-Kebbi tributary with the Logone, which flows into Lake Chad. Below the Mayo-Kebbi the river is navigable all year by boats drawing less than 0.75 m and by larger boats for more restricted periods (Encyclopedia Britanica, 2004). A considerable volume of imports (particularly petroleum) is transported by river, and cotton and peanuts (groundnuts) are exported in the same way from the Chad region. Between Yola and Makurdi the Benue is joined by the Gongola, and it then flows east and south for about 480 km. The Cameroun government built a Dam on the river near Lagdo town about 250Km away from Yola (Figure 1a).

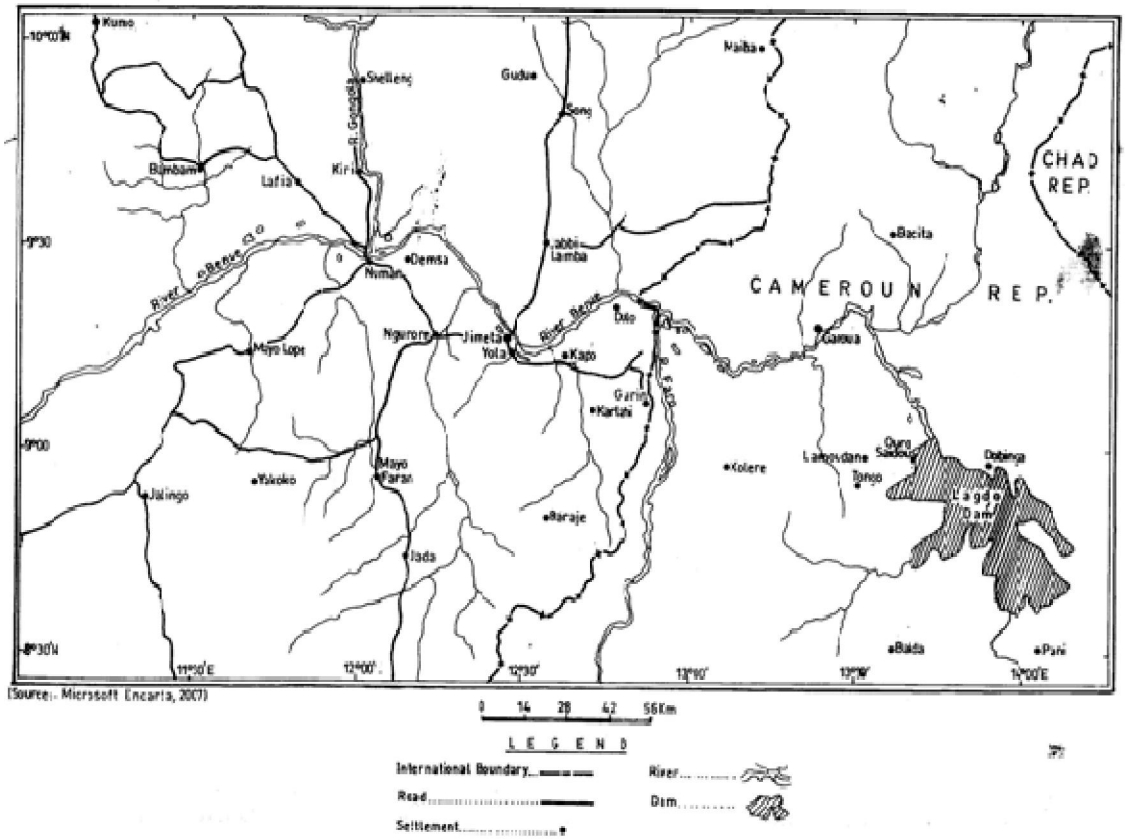

Figure 1a: Map of Study Area Indicating the Lagdo Dam

3. Materials and Methods

The assessment of the anion levels of surface water samples in river Benue in Adamawa State is the focus of this research. It is meant to assess and evaluate the water environment. This is aimed at ascertaining the quality, quantity and the causes of physical and chemical pollutants in the water bodies and their effects on human, animal and aquatic organisms.

3.1 Study Areas

The study areas include:

(a) River Benue: Boronji, Jimeta Water treatment Plant, Jimeta Bridge, Jambutu, Vinikilang, behind Jimeta Bridge, Fisheries, Bajabure I, Bajabure II and Jimeta car wash areas.

(b) All the areas mentioned above are in Adamawa State, Nigeria (Figure 1b). As stated earlier these bodies of water are the main source of water for irrigation, fishing, domestic and industrial purposes in the state. The sediments and water samples were collected from the above-mentioned locations. The sample locations and codes are presented in Table 1.

3.2 Water Sampling

Samples which are representatives of the water bodies were collected and examined. These samples were collected at designated areas as shown in figure 1b. Water samples were collected by lowering pre-cleaned plastic bottles into the bottom of the water body, 30cm deep, and allowed to over flow before withdrawing. Forty three sampling points were used and the sampling points are approximately 100m away from each other. A total of 200 samples were analyzed. Samples were collected in the months of February, March, April (dry season) and August, September, October (wet season) in the year 2007.

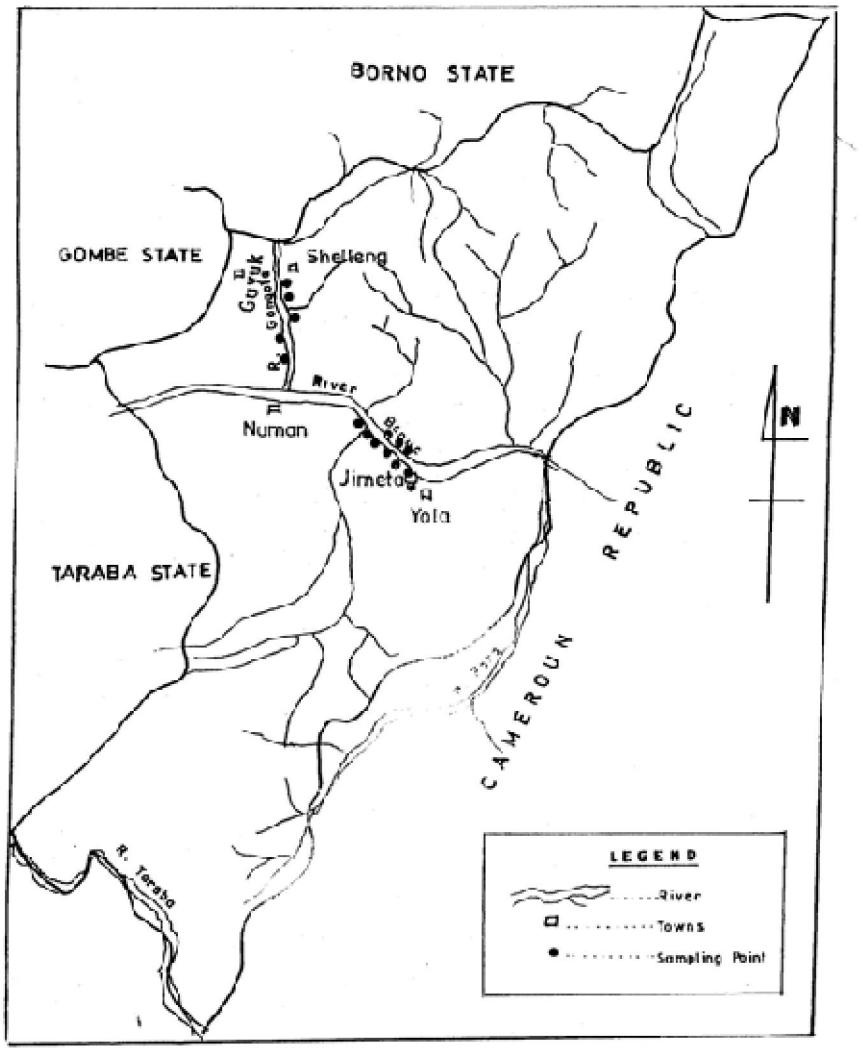

Figure 1b: Map of Adamawa State Showing Study Areas and Sampling Points

Table 1. Sample location and codes for Rivers Benue.

S/N	LOCAITON	CODE
1	River Benue Boronji Water	RBBW
3	River Benue Treatment Plant Water	RBTW
4	River Benue Treatment Plant Sediment	RBTS
5	River Benue Bridge Water	RBB_dW
7	River Benue Jambutu Water	RBJW
9	River Benue Vinikilang Water	RBVW
10	River Benue Behind Bridge Water	RBB_bW
11	River Benue Fisheries Water	RBFW
12	River Benue Bajabore I Water	RBB_IW
13	River Benue Bajabore II Water	$RBB_{II}W$
14	River Benue Car Wash Water	RBC_wW

3.3 Storage and Preservation

Since changes occur frequently in water samples, analysis was done immediately after collection. Where analysis could not commence immediately, samples were stored at 4^oC or relevant preservatives were added depending on the parameter to be determined and duration of the preservation as described by APHA (1985).

3.4 Methods of Analysis

The water samples collected were analysed by determining the amounts of nitrates, sulphates, and total hardness using DR/2010 spectrophotometer (LaMotte Co. 2000).

Standard procedures of analysis as described by Radojevic and Bashkin, (1999), Ademoroti (1996) and APHA (1985) were used for the determination 0f NH_3-N, NH_4^+, NH_3, NO_3-N, NO_3^-

3.5 Data Analysis

Results were presented as mean ± SD. The Pearson's correlation analysis, Analysis of Variance (ANOVA) with Scheffe post hoc test and the student t-test were used for the statistical analyses of results obtained at 95% confidence level using Microsoft Excel 2007 package.

4. Results

Figure 2 shows the histogram of mean concentrations of chloride, total sulphate, and total nitrate for River Benue. Table 2 is mean concentrations and the values for the chlorides ranged from 55.27±13.37 to 110.23±21.41 mg/l for dry season and 30.00±5.00 to 59.17±8.83 mg/l for wet season, sulphate is between 18.0±2.05 and 35.0±6.05 mg/l for dry season and 34.69±11.2 and 72.33±11.21 mg/l for wet season, and total nitrate was between 2.44±0.23 mg/l and 4.23±0.22 mg/l for dry season and 14.00±0.22 mg/land 22.33±1.34 mg/l for wet season.

Figure 3 is the histogram of mean seasonal variation of NH_3-N, NH_4^+, NH_3, NO_3-N, NO_3^- for River Benue. The values ranged between 1.31±0.05 mg/l and 2.02±0.10 mg/l in dry season for NH_3-N and 1.14±0.13 mg/l and 1.85±0.55 mg/l for wet season, NH_4^+ was between 1.62±0.11 mg/l and 2.46±0.14mg/l for dry season and 1.50±0.19 mg/l and 2.43±0.43 mg/l for wet season, NH_3 was between 1.53±0.10 mg/l and 2.11±0.09 mg/l for dry season and 1.33±0.10 mg/l and 2.15±0.31mg/l for wet season, NO_3-N were between 0.50±0.08 and 0.98±0.21mg/l for dry season and 0.51±0.16 and 0.91±0.04mg/l for wet season and that of NO_3^- was between 2.71±0.91 mg/l and 4.32±1.40 mg/l for dry season and 1.10±0.02 mg/l and 2.10±0.41mg/l for wet season.

4.1 Discussion:

The chloride values for the river were generally high except for some few locations like RBJW, where the total sulphate was higher. This may be as a result of less laundry activity in the location which is down stream. The values for all the parameters were higher in dry season than wet season because of low volume of water in dry season and laundry activities taking place at this time. The values for the total sulphate are high than those of total nitrate and these values were higher in wet season than dry season. This may be as a result of wash out from rocks or it may be from fertilizer/herbicide application from farms.

The NH_3^-N values were higher compared to other parameters and these values were higher during the wet season than dry season as can be seen in table II. This may be as a result of run-off from farms due to rains .Among all these parameters; NO_3-N was the lowest. The phosphate and phosphorus values for were high in wet season than dry season, this may be as a result of run-off from farms as a result of fertilizers such as superphosphate. The concentrations of ions were all within the permissible limits of the WHO (2006) and NAFDAC (2001). The seasonal variation showed higher concentrations in the wet season than the dry season, which agrees with Maimuna, (2006). It may be due to washout of salts into the water bodies because of rains.

Table1: Mean ± SD Variations of Ions in River Benue

Season	Code	Total Sulphate (mg/l)	Total Nitrate (mg/l)	Total Carbonate (mg/l)	Chloride (mg/l)	NH_3-N (mg/l)	NH_4^+ (mg/l)	NH_3 (mg/l)	NO_3-N (mg/l)	NO_3^- (mg/l)	PO_4^- (mg/l)
Dry	RBBW	18.00±5.50	2.98±1.05	73.63±12.84	110.23±4.01	1.99±0.2	2.22±0.	2.00±0.	0.65±.5	2.86±	0.92±.0
	RBTW	24.67±5.69	2.44±1.05	39.22±15.42	78.77±1.66	1.51±0.2	1.88±	1.93±	0.57±.2	2.53±	0.52±.2
	RBBdW	33.67±7.02	2.68±0.71	63.00±12.32	58.00±4.19	1.69±0.0	2.00±	1.83±	0.58±.1	2.57±	0.45±.0
	RBJW	33.67±4.01	2.90±0.63	75.20±8.23	59.33±8.29	1.71±0.1	1.84±	1.76±	0.98±.1	4.32±	0.66±.3
	RBVW	35.00±4.93	5.06±1.27	55.67±12.15	72.93±5.00	1.66±0.0	1.81±	1.90±	0.77±.3	3.41±	0.40±.5
	RBBbW	20.33±5.29	2.57±0.34	61.23±2.95	98.07±15.62	1.69±0.2	2.20±	1.89±	0.56±.2	2.71±	0.92±.0
	RBFW	27.67±11.55	3.14±0.54	78.38±4.85	95.37±2.28	1.31±0.4	1.62±	1.53±	0.75±.2	3.30±	0.44±.0
	RBB1W	26.33±5.01	2.87±0.49	76.43±7.82	67.53±6.65	1.64±0.1	2.03±	1.75±	0.78±.1	3.43±	0.52±.0
	RBB2W	21.00±8.33	2.45±0.79	37.53±9.78	55.27±11.58	2.02±0.1	2.46±	2.11±	0.50±.1	2.30±	0.55±.1
	RBCw W	27.67±8.74	4.23±1.26	55.45±7.57	84.27±10.54	1.72±0.0	2.00±	1.83±	0.69±.0	3.06±	0.46±.5
Wet	RBBW	41.00±2.08	20.50±0.36	55.77±12.47	40.00±5.20	1.14±0.0	1.50±	1.33±	0.81±.1	18.25±	1.00±.0
	RBTW	50.33±3.79	17.33±1.15	20.93±11.50	30.00±10.00	1.57±0.0	1.90±	1.78±	0.72±.1	17.00±	1.17±.0
	RBBdW	54.33±6.51	22.33±2.52	62.36±4.83	45.00±5.00	1.77±0.4	2.24±	2.11±	0.67±.0	21.00±	0.84±.0
	RBJW	72.33±12.12	17.33±12.06	37.14±6.03	42.33±8.03	1.42±0.5	1.79±	1.65±	0.51±.3	13.00±	0.87±.0
	RBVW	44.00±7.81	15.67±7.23	22.83±13.02	59.17±11.17	1.83±0.1	2.29±	2.14±	0.80±.1	16.00±	0.90±.0
	RBBbW	48.33±14.93	19.33±8.33	47.99±6.84	52.67±5.77	1.85±0.0	2.43±	2.15±	0.83±.1	21.00±	1.08±.2
	RBFW	57.00±5.03	16.33±10.15	29.19±6.52	40.00±12.58	1.83±0.2	2.17±	1.80±	0.61±.0	11.00±	0.86±.0
	RBB1W	34.67±7.77	18.83±6.43	41.31±5.57	59.17±12.66	1.41±0.7	2.03±	1.71±	0.62±.1	18.75±	0.68±.0
	RBB2W	55.33±12.66	15.47±2.08	40.05±4.26	49.40±6.07	1.74±0.7	1.95±	1.81±	0.84±.3	19.00±	0.86±.0
	RBCw W	44.33±11.24	14.00±8.08	32.08±5.58	51.67±10.00	1.66±0.6	1.90±	1.97±	0.91±.0	15.00±	1.33±.0

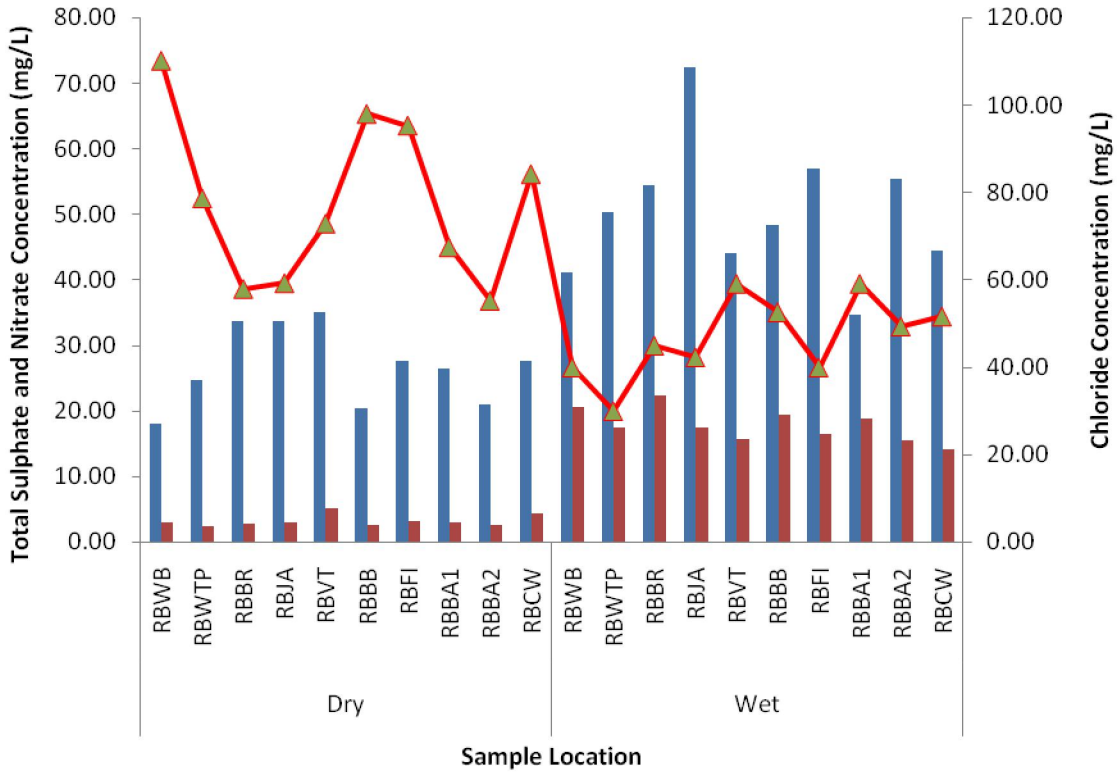

Figure 3-6a: Mean Variations of Total Sulphate, Total Nitrate and Chloride in different locations of River Benue

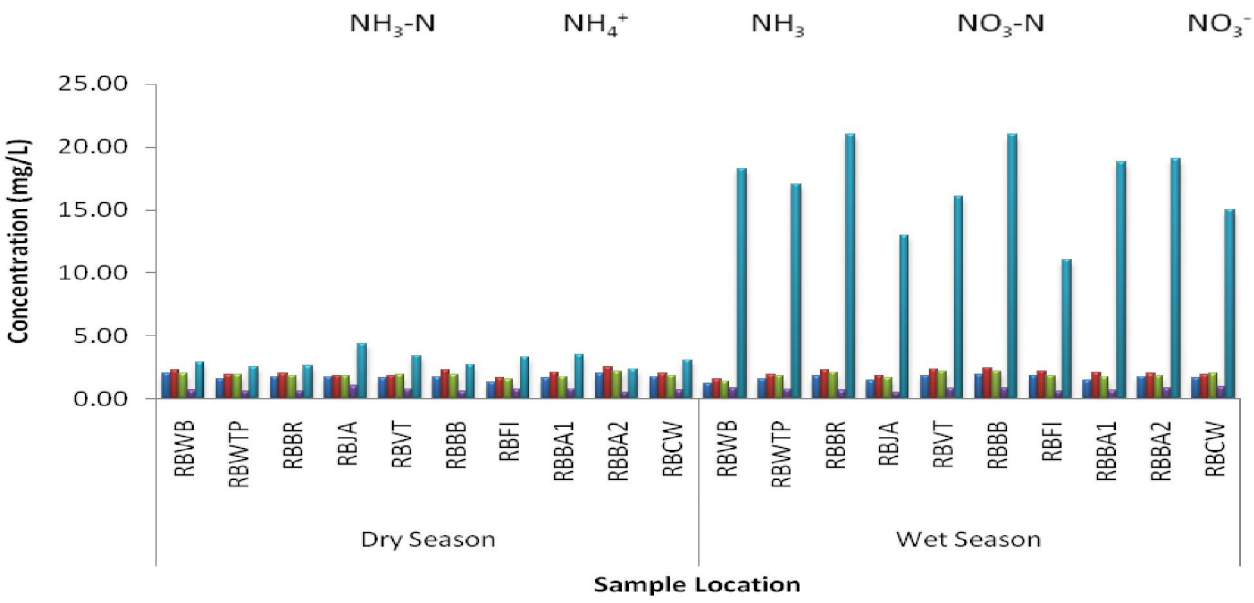

Figure 3.7a : Mean Variations of NH_3-N, NH_4+, NH_3, NO_3-N, NO_3- in different locations of River Benue

Conclusion

The infiltration of rainfall together with the biochemical and chemical breakdown of waste produces a leacheate which is high in varying organic and inorganic content. If these enters surface water before sufficient dilution occurs, serious pollution incidents can occur. Agricultural run-off and effluents from animal breeding in the area influence water quality of river Benue. This investigation of anion levels reveal high anion levels in this river, even though the values were still within the WHO (2006) and NAFDAC (2001) standards. However, further studies will be required in the area of bacteriological (faecal coliform) and heavy metal aspects of the river. It can be said that river Benue is still safe for irrigation and fishing activities, though it stands the risk of getting polluted in respects of the ion concentration levels.

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