Assessment of Water Quality in Agaie-Lapai Dam: Implication for Water Supply in IBB University

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ABSTRACT
The environmental impact of developmental activities on land, water, air as caused by noise pollution and disruption of the delicate eco-system and the need to evolve an efficient approach to deal with such effects is now receiving focused attention. Therefore, the study was an environmental impact assessment of Agaie-Lapai Dam for irrigation and domestic water supply to IBB University, Lapai. This study carried out water quality assessment in of the area.Water quality, water samples were taken from the upper, middle and lower course of the River. The samples were analyzed at the National Cereal Research Badeggi Laboratory. The result of pH of the water samples were observed to range from 6.15-6.80, while Turbidity and Electrical Conductivity of the water samples were found to be in the range of 0.20-7.0 NTU and 50-1010 µs/cm, while results of the chemical tests for the water samples revealed that the total Alkalinity and total hardness range from 50-1150 mg/l and 3.9-18 mg/l and ranges of 0.7-2.2 mg/l. Also 2.88-5.36 mg/l were recorded for BOD and COD and the Concentrations of Nitrate and Ammonia-Nitrogen of the water samples were observed to range from 3.47-60.58 mg/l and 0.08-2.90 mg/l respectively, Therefore, the result for water from Agaie/Lapai dam can be used for domestic purposes and it needs further treatment as a measure for it to be consumable.

Keywords: *Assessment, Impact, Supply, Quality, Water*

Introduction

At the moment, there has not been any major form of utilization of the Agaie-Lapai dam for its intended developmental activities such as irrigation, domestic water supply and electricity generation. However, while the justification of developmental activities from socio-economic considerations cannot be overemphasized, the cumulative environmental consequences of such activities need to be brought to fore with due emphasis on scientific basis. It is apparent that

previously developmental activities are normally carried out, almost purely, on the basis of economic consideration (Saidi et al., 2014). The environmental impacts of developmental activities such as potential land, water, air and noise pollution and possible dislocation and disruption of the delicate balance of the fragile eco-system and the need to evolve an efficient approach to deal with such effects are now receiving focused attention (Syvitski ans Kettner, 2011).. Therefore, the aim of this work is to conduct water quality assessment of Agaie-Lapai dam for the purpose of water supply to IBB University located in Lapai.

Methodology

Lapai-Agaie dam is a surface water body located near Bakajeba Village which is about 20 km from Lapai town and about 25 km from Paiko town. It is sited at Latitude 9^{o}14N and 9^{0} 15N and Longitude 6^{o}34E and 6^{0} 35E (Fig. 1). The dam has been constructed to completion by the Upper Niger River Basin Development Authority, Minna.

Figure 1: Image of the dam location

Agaie is situated between Longitude 6º16'16"E and 6º25'18"E of the Meridian and Latitude 8º59'01"N and 9º5'00"N of the Equator. It is accessible through Paiko-Lapai road, Lambata-Lapai road and Bida-Agaie road. The area alternates between dry and rainy seasons and fall within the Guinea Savannah which comprises different species of shrubs and becomes (gallery forest) along stream channels. The maximum daylight temperature is about 34ºc in the month of March while a minimum temperature of about 24ºc is recorded in December. The mean annual temperature is about 31ºc (Niger State Bureau of Statistics, 2011 Edition). The study area is well drained by River Tankpolo, and its tributaries. These streams are seasonal and are dry in most part of the year except during the rainy season, hence the need for a groundwater source as a good alternative in the area. The study area stands at an elevation between 140m and 150m above sea level in the East and drop

slightly to 125m in the Northwest and Southwest. The study area is low lying with some hills at the northeastern portion, around Ebugi and Mashina.

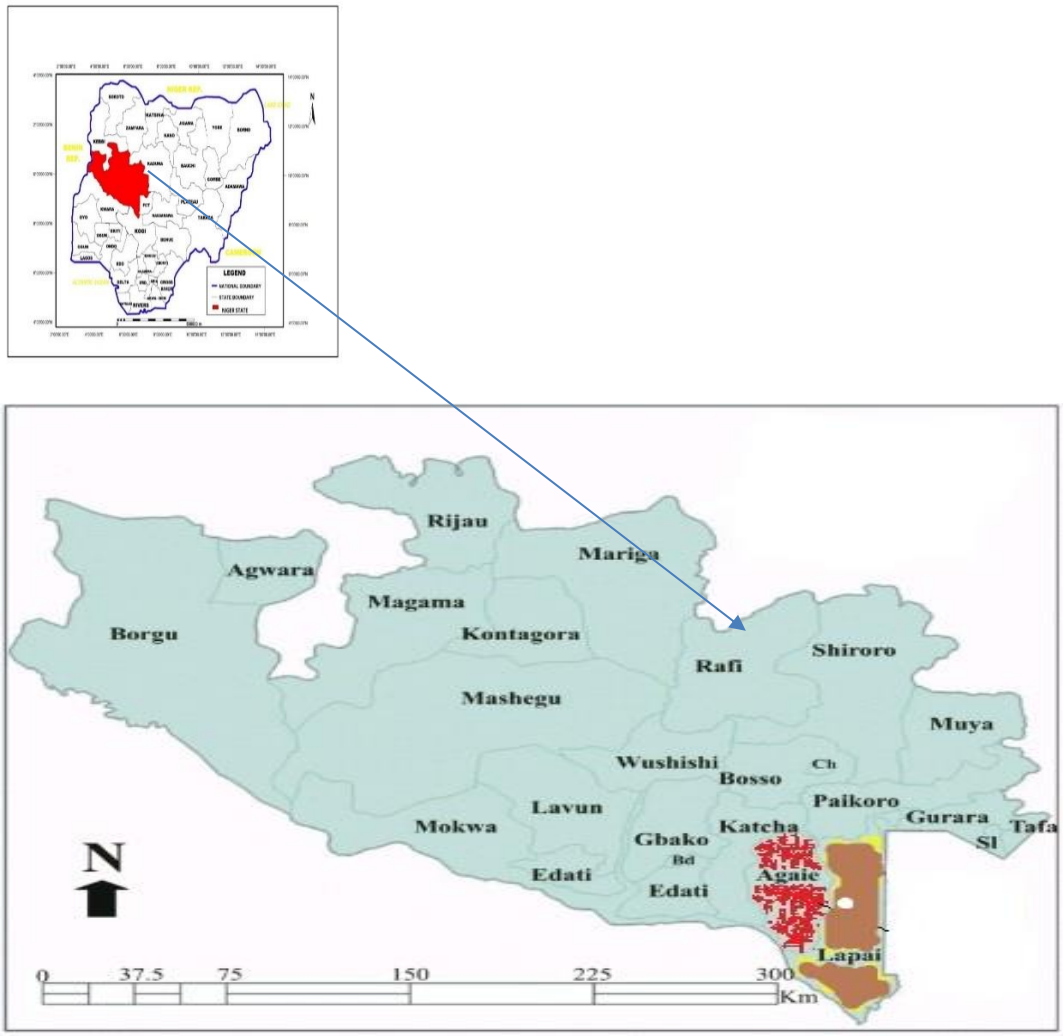

Figure 2: Map of Niger State showing Lapai and Agaie (The Study Area)

The average monthly relative humidity, rainfall, temperature, and wind speed of Niger State are as presented in Figure 3 and 4. The average monthly relative humidity of the study area is lowest between the months of December-March and highest between the months of July-September with the peak usually recorded in August in the range of 80-93 %. The average monthly rainfall of the project area is lowest during the months of November-March and highest during the months of June-October with the peak usually recorded in August in the range of 128-480 mm. The average monthly air temperature of the study area is lowest between the months of July-September and highest between the months of February-April with the peak usually recorded in March in the range of 30.9-32.9^{o}C, and a second peak recorded in the month of November in the range of 26.3-31.4^{o}C. The average monthly wind speed of the study area ranges from 3.0-13.57 knot.

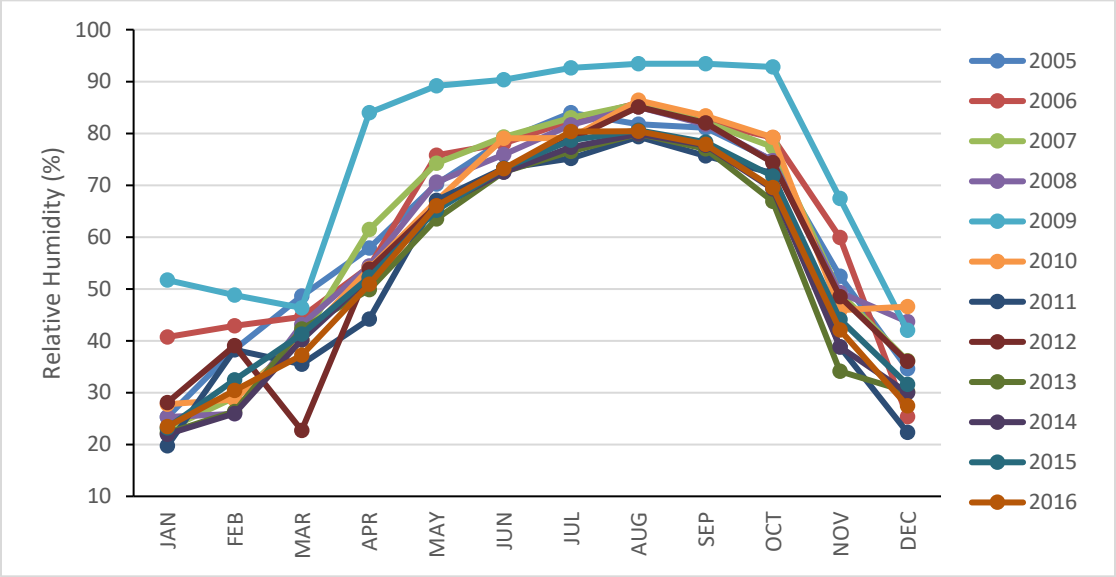

Fig. 3: Average Monthly Relative Humidity (2005-2016)

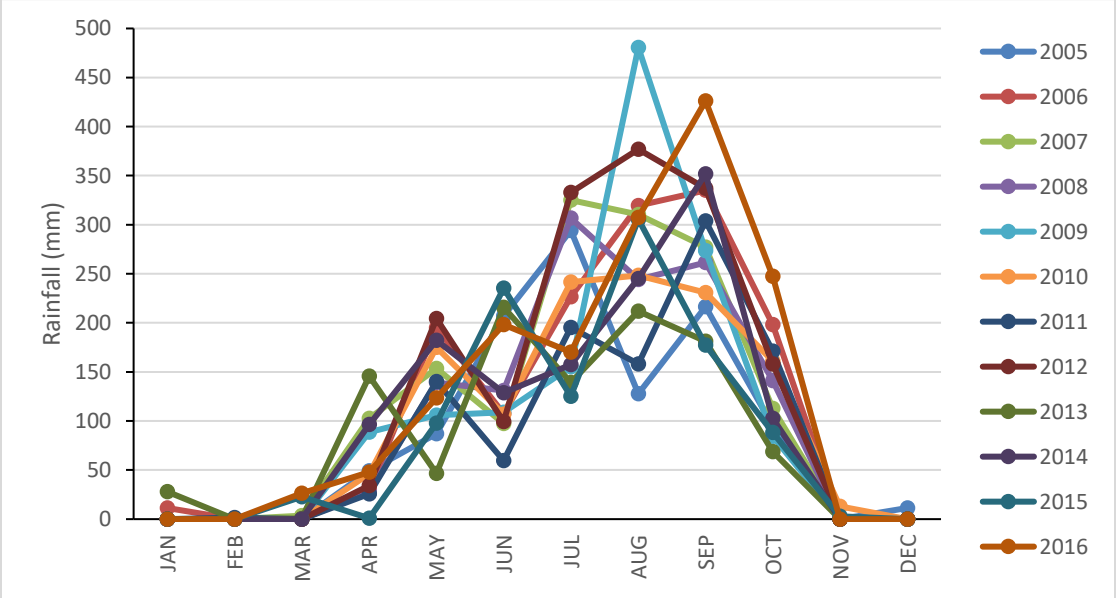

Figure 4: Average Monthly Rainfall (2005-2016)

Samples of water were obtained from Agaie-Lapai dam in Bakajeba Village of Lapai Local Government area of Niger State, Nigeria. The samples were collected in sterile glass bottle with screw closure maintaining aseptic condition. They were transferred in cool boxes to the Microbiology laboratory of National Cereal Research Institute, Badeggi for subsequent analysis.

The pH and total dissolved solids (TDS) of the collected samples of water were determined at the point of sampling using portable hand pH meter (Hanna instrument, Beiging, China) and digital TDS- meter as described by WHO (2011). Turbidity of water samples was determined using a tubidimeter as described by APHA (2005). Titration method involving 0.1M disoldium salt of ethylenediamine Tetraacetic acid (EDTA) WITH 25 mL of water sample and erichrome black T

indicator (sigma- Aldrich, steinheim, Germany) was used to determine the total hardness of water samples (APHA, 2005). Tests for odour and taste were carried out according to the method described by sule *et al*. (2011). For each water sample 20 mL volume was poured into a clean beaker. The beaker was then shaken vigorously to check for any frothing and allowed to settle. The beaker was then observed under bright light for presence of any particulate matter and then brought close to the nose to observe presence of odour. Bacteriological test was carried out following the method described by APHA (2005). The viable bacterial count was determined in duplicate using pour plate method with nutrient agar as the medium of choice. The plates were inoculated aerobically at 37^{O}C for 24h . The total coli form count per 100Ml of the water sample was determined using multiple tube fermentation technique with reference to the Most Portable Number (MPN) . A 100mL of water sample was inoculated into bottles of sterile double strength MacConkey broth each bottle containing an inverted Durham tube for gas collection and detection. This was inoculated aerobically at 37^{o} C for 24h and positive tubes were noted.

Results and Discussion

The results of assessment of the surface water and ground water quality of the study area are as presented in Tables 1and 2 respectively. The pH of the water samples were observed to range from 6.15-6.80, while Turbidity and Electrical Conductivity of the water samples were found to be in the range of 0.20-7.0 NTU and 50-1010 µs/cm respectively. Also, the concentration of Total Dissolved Solids (TDS) and Total Suspended Solids (TSS) of the water samples range from 33-666.6 mg/l and 9-1000 mg/l respectively.

The results of the chemical tests for the water samples revealed that the total Alkalinity and total hardness range from 50-1150 mg/l and 3.9-18 mg/l, also ranges of 0.7-2.2 mg/l and 2.88-5.36 mg/l were recorded for BOD and COD respectively. Concentrations of Nitrate and Ammonia-Nitrogen of the water samples were observed to range from 3.47-60.58 mg/l and 0.08-2.90 mg/l respectively, while Nitrite was not detected. The Sulphate, Chloride and Phosphateconcentration of the water samples were found to range from 8.12-33.76 mg/l, 6.68-61.94 mg/l and 1.05-3.89 mg/l respectively. Also, range of concentrations of 6.9-49.9 mg/l, 8.4-13 mg/l and 13.8-1144mg/l were recorded for Sodium, Potassium and Calcium respectively.

The results of the heavy metal analysis of the water samples of the project area indicated that the concentration of Zinc; Lead and Iron were found to be in the range of 1.16-5.20 mg/l; 0.02-0.23 mg/l; and 1.19-2.27 mg/l respectively, while Manganese was not detected. The physicochemical composition of water samples ranges between 6.18 to 6.32 which is within the limit considered suitable for human consumption (WHO, 2011). The pH of water plays an important role in the survival rate of microorganisms and neutral pH will support a large number of bacteria. Turbidity of water measures the degree to which water loses its clarity due to the presence of suspended particles. These suspended particles could serve as reservoirs for diseases causing organisms such as viruses, bacteria and other particles, which can pose a health hazard (Frank et al , 2019). From the present study of water samples taken from Agaie-Lapai dam , some samples have high turbidity value greater than 5 neuphelometric turbidity units (NTU) which is the limit recommended by WHO (2011) . This implies that water from these sources act as potential habitat for pathogenic organisms due to high levels of suspended particles. Suspended particles act as substrate for microorganisms in water, thus promoting growth of microbial population. The high value of turbidity in some samples can be attributed to sediments of soil and plants as well as the shallow

nature of water bodies (River Lafiyagi and Bobo) which could lead to acquisition of suspended particles. (Palamulem and Akorth, 2015)

Total dissolved solids in water measures the combined content of inorganic and organic substances confined in molecular, ionic and micro granular suspended forms. All water samples taken from the Dam and boreholes in the area have total dissolved solids within the acceptable limits recommended by World Health Organization. However, those samples taken from the wells have high suspended solid. High total suspended solids in water may interfere with clarity, colour and taste of water thereby , indicating the presence of toxic minerals and microorganisms of health importance (Onyango et al, 2018).Total dissolved solids are primarily affected by depth, turbulence, runoff and sediment load generated by the flow dynamics of aquatic system. Total hardness of water samples ranges between 3.9 to 16.6 mg/L. These values were within WHO acceptable limits of 500mg/L for drinking water and water for domestic use. Hard water does not only affect laudry at home, it also causes discoloration of cooking utensils at home, water hardness is occasioned by carbonate and bicarbonate of calcium and magnesium. Their relative low concentration as recorded indication of low contents of carbonate and bicarbonate.

The people of Bakajeba and IBB University community and other nearby communities rely on borehole, hand-dug well and sometimes rain water as source of water supply due to inaccessibility or of pipe-borne water supply. Primary and secondary schools are fairly well spread in Paikoro LGA with the host community, Bakajeba village having a primary school. There are road facilities in Paikoro LGA such as the Paiko-Lapai Trunk “B” road which passes through the host community. However, there are a number of feeder roads that interconnect the host community with other communities. There are many Primary Health Care (PHC) facilities spread across Paikoro LGA which are owned and maintained by Paikoro LGA. There is presence of PHC facility in Bakajeba village.The host community, Bakajeba village have access to electricity and it is connected to National Grid for power supply. The common means of transportation used in Paikoro LGA including the host community are cars, buses, pick-up, trucks, lorry, motorcycles, bicycles. Motorcycles are widely used particularly in the host community especially for conveying farm produce. There are modern buildings in Bakajeba village as well as traditional/local buildings that are constructed with mud. In order to disseminate information in respect of government program and entertainment, the host community receive signal network from the radio of the Niger State Broadcasting Corporation.The mobile network facilities from Glo, MTN, and Airtelcover Bakajeba community and many part of Paikoro LGA

Table 1: Physico-chemical characteristics of surface water samples collected from Agaie Lapai Dam (Dam Area, River Zule, River Lafiyagi and Bobo)

S/N	Parameters	Water Samples									
		Spill Way A	Spill Way B	Mid-Dam A	Mid-Dam B	Zule River A	Zule River B	River Lafiyagi A	River Lafiyagi B	Bobo River A	Bobo River B
1	pH	6.82	6.73	6.88	6.66	6.88	6.79	6.63	6.80	6.81	6.81
2	Odour	OD	OD	OD	OD	OD	OD	OD	OD	OD	OD
3	Colour	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS
4	Taste	TS	TS	TS	TS	TS	TS	TS	TS	TS	TS
5	Turbidity (NTU)	4	4.4	3.4	3.2	7	7	3.1	3.3	0.3	0.3
6	Electrical Conductivity (µs/cm)	50	50	50	50	50	50	50	50	50	50
7	Total Dissolved Solid (mg/l)	33	33	33	33	33	33	33	33	33	33
8	Total Suspended Solid (mg/l)	170	300	390	150	400	280	400	320	11	9
9	Total Hardness (mg/l)	5.6	5.6	18	3.9	11.9	6.85	10.9	9.8	16.6	7.2
10	Total Alkalinity (mg/l)	100	100	100	120	100	90	100	90	110	50
11	DO (mg/l)	3.28	3.12	3.28	4.8	4.16	5.28	5.36	5.04	4.08	4.72
12	BOD (mg/l)	1	0.9	1.3	1.27	1.2	1.2	1.7	1.6	1.2	1.2
13	COD (mg/l)	300	292	168	1536	1072	864	1172	1464	1160	636
14	Sulphate (mg/l)	11.79	9.49	10.68	11.97	28.21	33.76	10.68	9.32	19.74	15.56
15	Nitrate (mg/l)	60.37	60	30.81	32.32	42.62	40.76	60.58	60.5	5.79	6

16	Nitrite (mg/l)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
17	Chloride (mg/l)	13.37	12.48	11.14	48.13	11.59	6.68	9.36	15.6	8.02	8.02
18	Phosphate (mg/l)	3.89	1.09	1.08	1.16	1.06	1.05	1.31	1.06	1.05	1.1
19	Ammonia -Nitrogen (mg/l)	2.77	2.9	1.78	1.65	2.66	2.66	2.71	2.68	2.55	2.58
20	Sodium (mg/l)	11.5	11.2	11.1	11.9	14.3	10.5	15.1	10.5	8.4	11
21	Potassium (mg/l)	11.5	11.5	12.7	11.6	12.1	11.4	12.6	11.6	11.3	12.4
22	Calcium (mg/l)	13.8	20.5	456	10.3	684	102	884	174	51.6	290
23	Zinc (mg/l)	5.09	-	5.2	-	5.05	-	5.16	-	3.95	-
24	Manganese (mg/l)	ND	-	ND	-	ND	-	ND	-	ND	-
25	Lead (mg/l)	0.23	-	0.002	-	0.23	-	0.23	-	0.03	-
26	Iron (mg/l)	1.21	-	1.57	-	2.27	-	1.58	-	1.56	-

Table 2: Physico-chemical characteristics of ground water samples collected from Agaie-Lapai Dam Area (Wells and Boreholes)

S/N	**Parameters**	**Samples**			
		Well Water A	**Well Water B**	**Borehole Water A**	**Borehole Water B**
1	pH	6.15	6.18	6.32	6.27
2	Odour	OD	OD	OD	OD
3	Colour	CS	CS	CS	CS
4	Taste	TS	TS	TS	TS
5	Turbidity (NTU)	4.2	4.4	0.2	0.25
6	Electrical Conductivity (µs/cm)	1000	1010	50	50
7	Total Dissolved Solid (mg/l)	660	666.6	105.6	105.6
8	Total Suspended Solid (mg/l)	900	1000	11	12
9	Total Hardness (mg/l)	5.00	5.2	7.2	5.4

10	Total Alkalinity (mg/l)	110	150	60	60
11	DO (mg/l)	3.2	2.88	2.88	3.36
12	BOD (mg/l)	2.2	1.87	0.7	0.8
13	COD (mg/l)	612	1200	200	176
14	Sulphate (mg/l)	8.12	8.97	18.97	20.43
15	Nitrate (mg/l)	53.95	52.11	3.47	3.47
16	Nitrite (mg/l)	ND	ND	ND	ND
17	Chloride (mg/l)	61.94	54.36	14.71	13.37
18	Phosphate (mg/l)	1.22	3.3	1.57	1.68
19	Ammonia-Nitrogen (mg/l)	2.34	2.32	0.11	0.08
20	Sodium (mg/l)	49.9	12.3	11.1	6.9
21	Potassium (mg/l)	8.4	11.8	11.4	13
22	Calcium (mg/l)	111	15.6	27.9	1144
23	Zinc (mg/l)	1.16	-	2.05	-
24	Manganese (mg/l)	ND	-	ND	-
25	Lead (mg/l)	0.03	-	0.03	-
26	Iron (mg/l)	1.33	-	1.19	-

Conclusion

The study examined the physiochemical characteristics of surface water samples collected from Agaie-Lapai Dam (Dam Area, River Zule, River Lafiyagi and Bobo) and of ground water samples collected from Agaie-Lapai Dam Area (Wells and Boreholes) for the purpose channeling the water to IBB University for domestic water supply. Although some of the physiochemical parameters fall within the WHO acceptable limits, some were however observed to be above the requirements .Water samples obtain from River sources were found to have high suspended particles that contaminate the water. With the exception of boreholes, the bacteriological quality of wells and rivers was not within the outlined quality standard according to WHO. The condition of the water from the dam and well will need proper treatment for it to be used for drinking and other domestic uses in IBB University and the Bakajeba area. We therefore, conclude that there is potential risk of contracting diseases if the water is used untreated.

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