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RESEARCH PAPER

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Groundwater quality assessment of selected communities in Katsinala local government of Benue State, Nigeria

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ABSTRACT

Physico-chemical parameters of borehole water from different locations of Benue State Nigeria were investigated to assess the level of water pollution. The water quality parameters studied include dissolved oxygen, water temperature, pH, alkalinity, total dissolved solids, Carbon dioxide, chloride, hardness, NH3–Nitrogen, N-Nitrogen, biological oxygen demand, transparency and water depth. The result of the pH obtained from the study area ranges from 6.57 to 11.33 with a mean value of 7.44 with turbidity ranges from 3.29-365, electrical conductivity ranges from 43.6-1460 µs/cm with a mean value of 326.77 µs/cm, The concentration of total dissolved solids (TDS) obtained in the study area ranges from 21.8 to 730 mg/l with a mean of 163.4 mg/l and The magnesium contents in the analyzed samples from the study area range from 12 mg/l to 29 mg/l with a mean value of 15.9 mg/l, The calcium contents range from 2 mg/l to 36 mg/l with a mean value of 19.4 mg/l. All the water samples from the localities within the study area show that the concentration of pH, total dissolve solid (TDS), conductivity and total hardness fall within or below limit specified by WHO (2011) and NSDWQ (2007) with some exception. All the water samples within the study area showed that the concentration of cations and anions fall below the maximum limit given by WHO (2011) and NSDWQ (2007) except in Mbaauna 2 with high iron (Fe) concentration.

Keywords: Groundwater quality, physico-chemical parameters, NSDQ, WHO, water pollution

1. INTRODUCTION

Groundwater exploitation for rural water supply without proper understanding of its chemistry and changes that may be induced by physical processes and anthropogenic activities may be counterproductive [1]. Human and natural activities impact widely on our groundwater system and this makes groundwater resources to be dynamic in nature; factors such as the irrigation activities, industrialization and urbanization. More so, the inhabitants of the communities are good users of fertilizers, pesticides and herbicides for

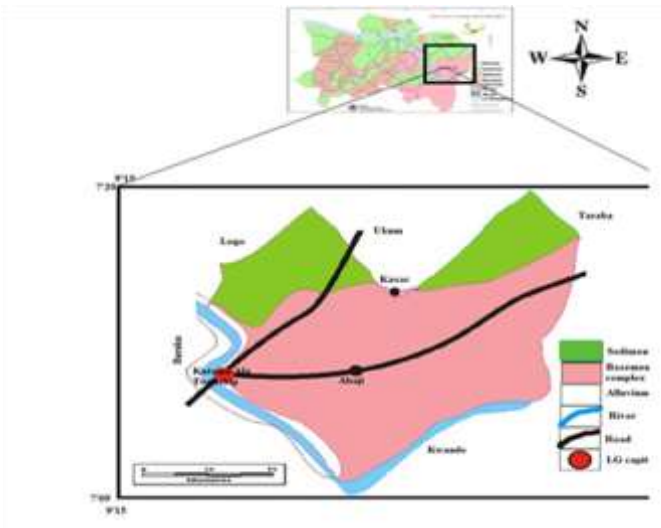

Fig 1. Geology of study area (Terhemba et al., 2016)

agricultural activities which eventually impact on the groundwater negatively. Also, population growth is one other major factor responsible for groundwater pollution due to poor sanitation systems, leakages and increased solid and liquid waste which eventually infiltrates our groundwater system. Hence, groundwater quality assessment and conservation becomes important. Water quality is a consequence of the natural physical and chemical state of the water as well as any alterations that may have occurred as a consequence of human activity [2]. Also the quality of water that we ingest, as well as the quality of water in our lakes, streams, rivers, and oceans, is a critical parameter in determining the overall quality of our lives [3]. It was estimated that globally, groundwater provides about 50% of current potable water supplies, 40% of the demand of self-supplied industry and 20% of water use in irrigated agriculture. Over much of Africa, groundwater is the most realistic water supply option for meeting dispersed rural demand [4]. The major source of groundwater for household, industrial and irrigation in the study area is the borehole. Most of the boreholes are vulnerable to pollution because of the nature of the overburden thickness viz-a-viz small thickness and unconfined nature and well depth as most wells around the study area ranged from 35m to 50m in depth.

The main objective of this study is to assess the groundwater quality based on the available physico-chemical data of some selected communities in Katsina-Ala Local Government Area of Benue State, Nigeria.

2. MATERIALS AND METHODS

2.1. Research design

All data used was acquired by Benue State Rural Water Supply and Sanitation Agency (BERWASSA). Primary and secondary sources of data were used to achieve the objective of this study. The primary data is the major data source for this study and comprises the field samples that were collected from different locations

2.2. Data Collection

2.2.1. Primary Source of Data Collection

The primary data used in this study was obtained from the field. Water samples were collected in selected parts of the study area.

2.2.2. Secondary Source of Data Collection

These were obtained from different published works: World Health Organization (WHO) and Nigeria Standard for Drinking Water Quality (NSDWQ) water quality values were used to compare the results of the selected

elements in order to assess the water quality of the study area.

2.3. Field and laboratory method

2.3.1. Sample collection

Water samples were collected from individual boreholes in ten (10) rural communities, from Gwanyi, Akuma/Gbaa 2, PHC Gbengeh, Ashuwa, Mbaagbaka/Imande Kwator and Shikaan Dangi, Mbanyikyaa, Mbagundu II, Gboraya and Mbaauna 2 in Katsinala, Benue State Nigeria, in the month of September, 2020.

The analyses of the water samples were carried out according to standards methods for examination of water and reported in line with the Nigeria Standard for Drinking Water Quality (NSDWQ) SON 2015 standards for drinking water [5-6]. Parameters analyzed include temperature, pH, total hardness, chloride, total dissolved solid, turbidity and alkalinity.

Temperatures of the water samples were taken in-situ using mercury thermometer. Total hardness, total dissolved solids, chloride and alkalinity were determined using various laboratory titration methods. pH was determined using Gallenkamp pH meter, electrical conductivity using Hach conductivity WPA 400 digital model meter, and turbidity using DREL spectrophotometer model 2100.

Finally, to ensure quality assurance, precautionary measures were observed during the collection, transportation, storage and analyses of the water samples.

Data Analysis

The result obtained from the laboratory analyses were plotted into bar charts to illustrate the concentrations of each parameters at sampling locations.

3. RESULTS AND DISCUSSION

All the result of parameters determined both in the field and laboratory is presented in Table 1. These results are then further represented in bar chart (Figure 2-4) to show variation in the water quality of the different location within the study area. The maximum, minimum and the mean value for all the parameters analyzed were then compared with both World Health Organization (WHO) standard (2011) and Nigeria Standard for Drinking Water Quality (NSDWQ) (2007) to ascertain the

Table 1. Summary of the physico-chemical properties analyzed

Sample location	Coordinates	Turbidity	Conductivity (µs/cm)	Total hardness (mg/l)	TDS (mg/l)	pH	Fe3+ (mg/l)	Mn2+ (mg/l)	Cu2+ (mg/l)	Ca2+ (mg/l)	Mg2+ (mg/l)	Cl- (mg/l)	SO42- (mg/l)	NO2- (mg/l)	NO3- (mg/l)	F- (mg/l)
Gwanyi	N 7.177282 E 9.283738	5	463	74	233	7.16	0.01	0.04	0.03	36	26	22	7	0.01	5.4	0.04
Mbanyikyaa	N 7.175215 E 9.383311	46.5	1460	85	730	11.33	0.24	0.14	0.24	25	0	0	0	0.04	34	0.17
Akuma/Gbaa 2	N 7.190782 E 9.502813	4.9	66.6	40	33.3	6.71	0.03	0.04	0	4	20	14	2	0	1.38	0.01
Mbagundu II	N 7.423158 E 9.474912	157	239	38	119	7.28	0.02	0.01	0.16	22	12	14	12	0.01	0.73	0.08
PHC Gbengeh	N 7.733368 E 8.768419	5	301	35	150	7.09	0.01	0.06	0.04	14	16	0	11	0	2.4	0.13
Ashuwa	N 7.21884 E 9.49073	5	43.6	57	21.8	7.07	0	0	0.02	32	23	36	10	0.03	4	0.07
Mbaagbaka/imande kwator	N 7.490948 E 9.517813	6	267	180	133	6.73	0.27	0.04	0.95	25	29	0	11	0.02	2.14	0.16
Gboraya	N 7.163485 E 9.286585	112	138	40	69	7.82	0.04	0.03	0	28	18	64	8	0.02	1.1	0.06
Shikaan Dangi	N 7.190882 E 9.619483	3.29	110.9	25	55.6	6.57	0.08	0.02	0.08	6	15	0	7	0.02	0.8	0.07
Mbaauna 2	N 7.474998 E 9.479213	365	178.6	25	89.4	6.76	0.33	0.05	0	2	0	26	61	0	1.38	0.17
Minimum value		3.29	43.6	25	21.8	6.57	0.01	0.01	0.02	2	12	14	2	0.01	0.73	0.01
Maximum value		365	1460	180	730	11.33	0.33	0.14	0.95	36	29	64	61	0.04	34	0.17
Mean value		70.87	326.77	59.9	163.4	7.44	0.1	0.043	0.064	19.4	15.9	17.6	12.9	0.015	5.33	0.17
Max. NSDWQ limit		5	1000	150	500	6.5-8.5	0.3	0.2	1	75	30	250	100	0.2	50	1.5
WHO limit		-	250	500	500	6.5-9.0	0.3	0.5	2	75	**50**	**400**	50	3	50	1.5

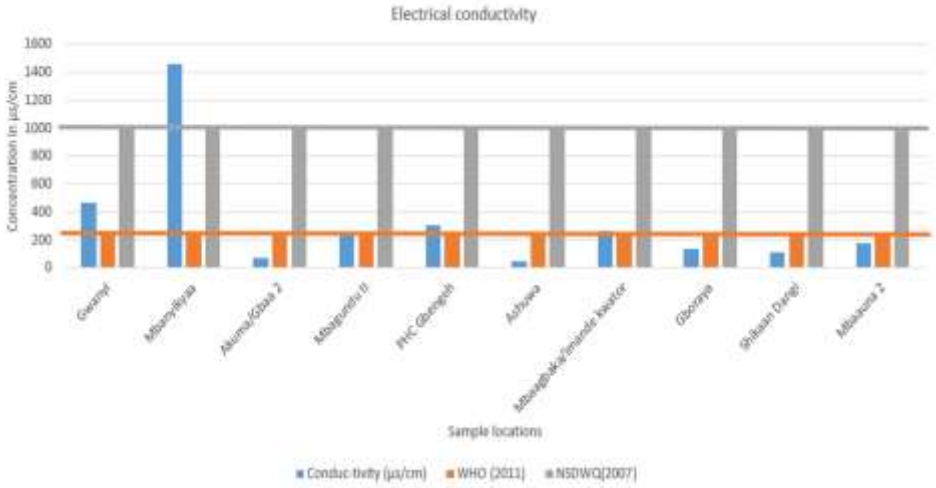

Fig 2. Concentrations of electrical conductivity for the water samples within the study area compared with WHO (2011) and NSDWQ (2007)

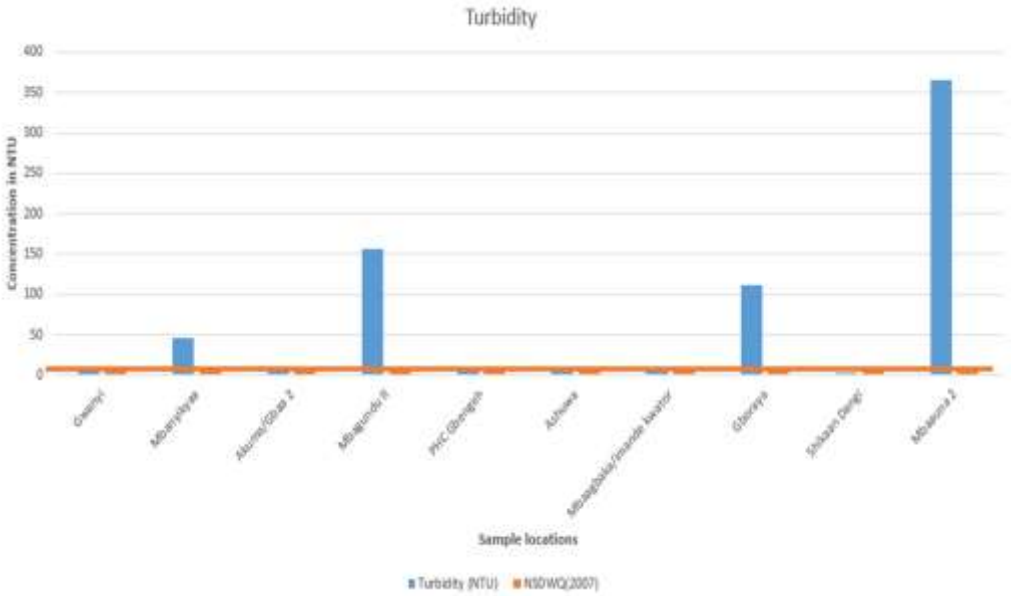

Fig 3. Concentrations of turbidity for the water samples within the study area compared with NSDWQ (2007)

quality of the water within the study area (table 1) [7-8].

The result of the pH obtained from the study area ranges from 6.57 to 11.33 with a mean value of 7.44. The normal range for pH for domestic water as recommended by WHO (2012) and NSDWQ (2007) is 6.5 – 8.5 [6, 9]. The pH value obtained at the study area falls within the limit except Mbanyikyaa having 11.33 which is above the acceptable limit.

The result of the turbidity ranges from 3.29-365 NTU with a mean value of 70.87 NTU. The value of turbidity for Gwanyi, Akuma/Gbaa 2, PHC Gbengeh, Ashuwa, Mbaagbaka/Imande Kwator and Shikaan Dangi fall within the NSDWQ (2007) maximum permissible limit (5.0 NTU) while those of Mbanyikyaa, Mbagundu II, Gboraya and Mbaauna 2 are above the acceptable limit.

The result of the electrical conductivity ranges from 43.6-1460 µs/cm with a mean value of 326.77 µs/cm. Mbanyikyaa has the highest electrical conductivity of 1460 µs/cm which is above the acceptable limit by WHO (2011) and NSDWQ (2007), while other locations have electrical conductivity values below the acceptable standards [6-7]. But when compared with WHO (2011) maximum limit (250 µs/cm), it was observed that the

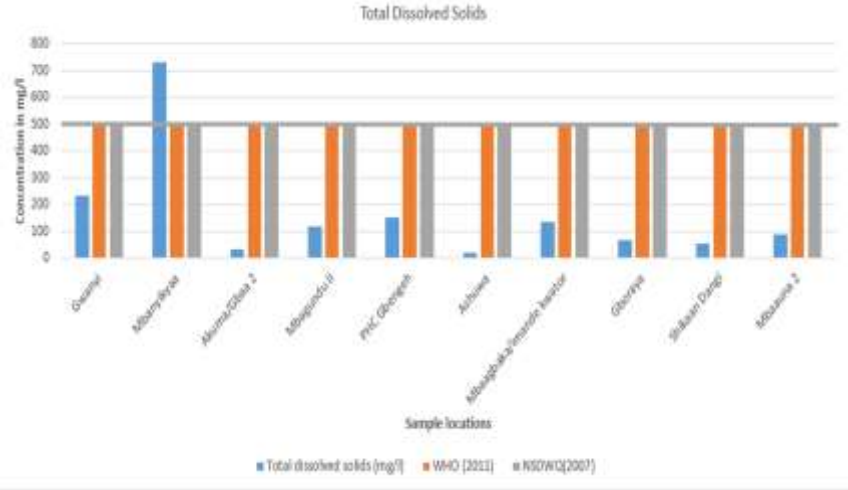

Fig 4. Concentrations of total dissolved solids for the water samples within the study area compared with WHO (2011) and NSDWQ (2007)

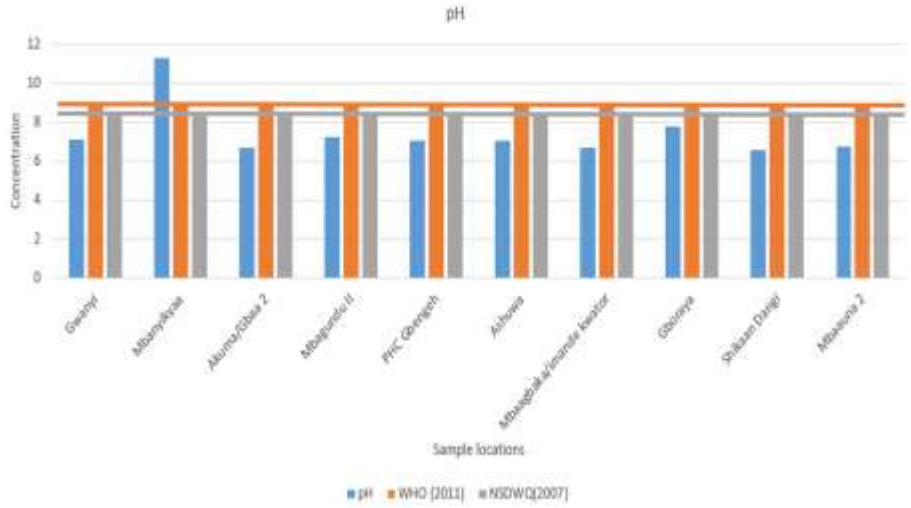

Fig 5. Concentrations of pH for the water samples within the study area compared with WHO (2011) and NSDWQ (2007)

electrical conductivity values in Akuma/Gbaa 2, Mbagundu II, Ashuwa, Gboraya and Shikaan Dangi are below the limit and the remaining locations (Gwanyi, Mbanyikyaa, PHC Gbengeh, Mbaagbaka/imande kwator) are above the limit (Table 1).

The concentration of total dissolved solids (TDS) obtained in the study area ranges from 21.8 to 730 mg/l with a mean of 163.4 mg/l. High concentrations of Total Dissolved Solids (TDS) reduce the water quality and cause water balance problems for individual aquatic organisms. According to WHO (2012) and NSDWQ (2007), the maximum permissible limit for TDS is 500 mg/l. Mbanyikyaa has the highest TDS value of 730 mg/l which is above the acceptable limit by WHO (2011) and NSDWQ (2007), while other locations (Akuma/Gbaa 2, Mbagundu II, Ashuwa, Gboraya, Shikaan Dangi, Gwanyi, PHC Gbengeh, Mbaagbaka/imande kwator and Mbaauna 2) have TDS values within the acceptable standards. Hence, water in these locations can be used for domestic purpose. The magnesium contents in the analyzed samples from the study area range from 12 mg/l to 29 mg/l with a mean value of 15.9 mg/l. The concentration of magnesium in water should be 50 mg/l and 30 mg/l respectively. The magnesium concentrations in the analyzed samples fall within the standards. Hence, water from these locations can be used for drinking. The calcium contents range from 2 mg/l to 36 mg/l with a

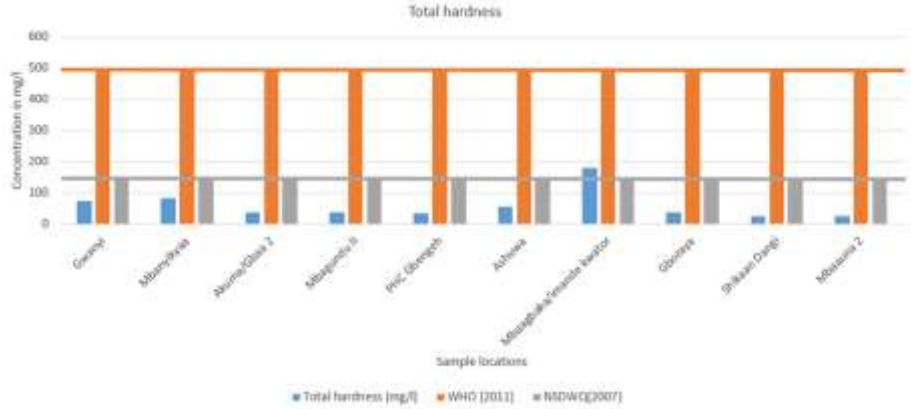

Fig 6. Concentrations of total hardness for the water samples within the study area compared with WHO (2011) and NSDWQ (2007)

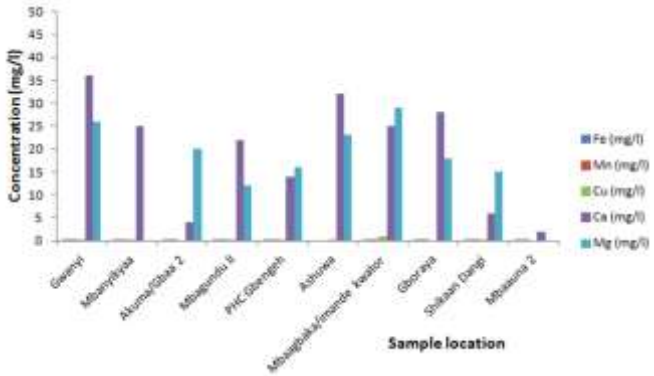

Fig 7. Concentration of cations for the water samples within the study area

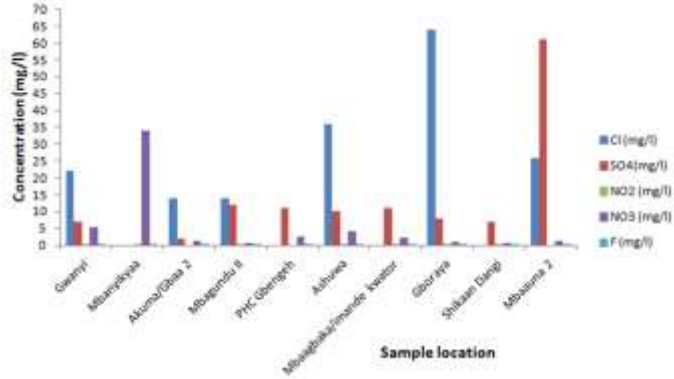

Fig 8. Concentration of anions for the water samples within the study area

mean value of 19.4 mg/l. The calcium contents of the samples falls within the acceptable standards by WHO (2011) and NSDWQ (2007) that recommended 75 mg/l. The concentration of copper, iron and manganese in the studied water samples fall within the acceptable limits.

4. CONCLUSION

All the water samples from the localities within the study area show that the concentration of pH, total dissolve solid (TDS), conductivity and total hardness fall within or below limit specified by WHO (2011) and NSDWQ (2007) except Mbanyikyaa with high TDS and pH value, and the Mbaagbaka/Imande Kwator with high conductivity and total hardness, therefore the water in these two localities should be treated for such parameters. The concentration of turbidity is high in all the localities and fall above the maximum limit as given by WHO (2011) and NSDWQ (2007) except Shikaan

Dangi with low value. Based on the average value of the turbidity the water is said to be turbid and should be treated for turbidity. The water in Mbayikyaa should be treated for turbidity, conductivity, TDS, total hardness and pH. The average pH value within the study area showed that the water is alkali in nature. All the water samples within the study area showed that the concentration of cations and anions fall below the maximum limit given by WHO (2011) and NSDWQ (2007) except in Mbaauna 2 with high iron (Fe) concentration.

5. ACKNOWLEDGEMENT

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6. CONFLICT OF INTEREST

The authors have declared that there is no conflict of interest.

7. SOURCE/S OF FUNDING

NA

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