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Assessment of Groundwater Quality and its Suitability for Drinking in Nguru

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Despite the importance of groundwater, quality assessment of groundwater has received little attention. Therefore, this study assessed the physicochemical qualities of drinking water in Nguru town, Nguru LGA, Yobe State where eight (8) samples were collected from boreholes using purposive sampling technique. Standard laboratory analysis were carried out to determine the concentration of major physicochemical elements while major comparisons were made with World Health Organization (WHO), Nigerian Standard for Drinking Water Quality (NSDWQ). The result revealed that all parameters tested were within permissible limits except for Turbidity and Lead are higher in Nglewa-Tsoho Nguru ward. Iron tend to be higher than the permissible limit for Hausari and Bulabulin wards. The result of the student t-test shows that all the parameters were within the acceptable drinking limit specified by WHO and NSDWQ with all p-values less than the t-critical of 2.14. The study concluded that the water is suitable for drinking. It is recommended that individuals *are advised to take responsibility of their well-being by testing their drinking water sources periodically and treatment of water before they can be used for drinking and other domestic purposes.*

Key Words: Groundwater, Physicochemical, Turbidity, Total hardness, Drinking, WHO

INTRODUCTION

Almost every day, water makes the headlines somewhere in the world. Drought, Flood and Pollution are all big News, as water becomes the most precious and most contested essential resources. Man requires water for cooking, drinking, sanitation, agriculture and manufacturing processes. However, because water is freely available through rainfall, man has, until fairly recently, taken this unique resource for granted. Although more than 70 percent of the earth's surface is water, water has become a scarce commodity in many parts of the world. The threat of a world water crisis is becoming increasingly real in the face of increasing demand, relative static supply and deteriorating quality due to pollution (Ayoade & Oyebande, 1978, as cited in Yusuf 2013).

In the last few decades, there has been a tremendous increase in the demand for fresh water due to rapid growth of population and the accelerated pace of industrialization. Groundwater is an important source of drinking water for many people around the world, especially in rural areas and semi-arid regions, including the North Eastern region of Nigeria. This is so because, groundwater, which is the sub-surface water that fully saturates pores and cracks in soils and rocks are more protected compared to the surface waters (Udak *et al.,* 2018).

Furthermore, the tremendous increase in population resulted in increased demand for groundwater not only for its widespread occurrence and availability but also for its constituent good quality that makes it ideal for supply as drinking water. However, the quality has been compromised from both natural and anthropogenic activities. Most of the pollutants resulting from these activities make their way through the soil or rocks which acts as "protective filter or barrier" (Udak *et al.*, 2018).

Groundwater pollution does not only affect the water quality but also threatens human health, economic development and social prosperity. These resources cannot be optimally used unless its quality assessed. These makes it of prime importance to have prior information on the quality of water resources available. According to WHO organization, about 80% of all the diseases in human beings are caused by water. Once the groundwater is contaminated, its quality cannot be restored by stopping the pollutants from the source (Udak *et al.*, 2018).
According to WHO (2002), in the next thirty years alone, accessible water is unlikely to increase more

than ten percent (10%), but the earth's population is projected to rise by approximately one-third. The growing demand for adequate quality of water for domestic purposes requires an urgent need to link research with improved water management, better monitoring, assessment, and forecasting of water resources and sanitation issues with much emphasis on the roles of stakeholders (Yamaguchi & Wesselink, 2000 as cited in Boyi *et al.,* 2017).

It must however be emphasized that adequate water need seems to have improved greatly in some regions and countries especially in the developed world but for poor nations this is still a major issue as contaminated water kills more people than cancer, AIDS, wars, terrorism or accidents. It is pertinent that the water meant for human consumption be free of disease-causing germs and toxic chemicals that pose a threat to public health according to Third World Academic of Sciences [TWAS], (2002). It is therefore necessary to have an update on the quality of the water being supplied to the masses so as to create a consciousness for the need to treat water supplied to ensure healthy living (Boyi *et al.,* 2017).

Research on water quality and pollution is very paramount, particularly in the developing countries like Nigeria where water availability to serve both domestic and industrial demands continues to be a problem of great concern. Therefore, continuous assessment of the quality of water supplied to the public is very important and necessary, in order to meet the United Nations' campaign for providing good quality drinking water for all by the twenty first century (Knapp, 1989). The quality of water plays an important role because its mere availability does not qualify it for use. Biswas, (1998) reported that the qualities of water defines the extent of the uses it could be put. The better the quality of water the wider the range of uses it could be put. Thus, the need to properly assess the quality of water before and after treatment is of paramount importance.

Distribution of fresh water resources is uneven throughout the world and the fresh water availability is becoming scarce day by day owing to population growth and diverse human activities. In the absence of fresh surface water resources, groundwater is exploited to meet the demand exerted by various sectors. Groundwater is a vital resource, especially in arid and semi-arid areas. Sufficient groundwater with high quality is required to meet increasing domestic, agricultural, and industrial needs. According to World Health Organization, about 80% of all the diseases in human beings are caused by water. Once the groundwater is contaminated, its quality cannot be restored by stopping the pollutants from the source. Therefore, it becomes very important to regularly monitor the quality of groundwater and to device ways and means to protect it (Mukhtar, 2018).

Different scholars have carried out different researches. For example, (Iguisi *et al* 1999, Dim *et al*, 2000, Butu 2002), carried out a research on the quality of groundwater, surface water, and pipe borne water, which some pollutants were found to be above the international permissible limit for water meant for domestic and agricultural uses. Bichi and Amatobi (2013) carried out a study on assessment of the quality of water supplied by water vendors to households in Sabon-Gari Area of Kano; Northern Nigeria that found out that water quality was compromised at the private commercial supply, during hawker's distribution and in the household storage. Mohammed (2013) worked on quality assessment of potable water in Sabon-Gari, Kano State, by comparing the quality of some of the most patronized water considered consumable in Sabon Gari Area of Kano State with the World Health Organization (WHO, 2002) set standard. The study revealed that there is a significant difference in the level of concentration of physicochemical parameters of the water samples tested with WHO.

Despite the importance of groundwater, quality assessment of groundwater has received little attention. In order to protect this valuable resource, a regular monitoring and assessment program is required, which will provide a reliable information on the quality of groundwater resource. It is on this basis that the study tend to assess the groundwater quality and its suitability for drinking in Nguru town, Nguru LGA, Yobe State by identifying the sources of groundwater supply, determining the level of concentration of the physicochemical parameters and comparing their level of concentrations with the acceptable drinking water quality standard according to WHO and NSDWQ.

THE STUDY AREA

Nguru Local Government Area is located approximately between latitude $12^0 52' 45''$N and longitude $10^0 27' 09''$ E of the equator, it has a land area of 916km^2. It is bounded to the north by Karasuwa LGA, to the south by Machina LGA and to the west Bade LGA. Nguru is located along Gashua – Kano road. The climate of the area is tropical wet and dry type coded as AW by Koppen. The annual ocean rainfall is between 500mm – 1000mm with a variation of up to 30% of the mean value. The mean annual temperature is about 39^0c but the mean monthly value range between 27^0c in the coolest months of December and January and 32^0 C in the hottest months of April to May. The climate shows the availability of water for domestic consumption.

MATERIALS AND METHODS

The type of data required for this research includes data from GPS locations for each sampled point, data from laboratory analysis of water for the various sampled locations including pH, Colour, Total Hardness, Conductivity, Calcium, Magnesium, Chlorides, Sulphate, Sodium, Turbidity, Copper, Manganese, Zinc, Lead and Iron. The primary source of data required for this study comprise data collected directly from the field using Hand-held Global Positioning System for location (Latitudes and Longitude) of various sources of groundwater within the study area.

For the purpose of this research, only the wards located within the town were used because of their population density. Nguru LGA has 10 wards of which four are within the urban centre while six are in the rural areas. The study is only restricted to the wards found within the urban centre of Nguru because of its population density, thus will be of more significant importance than the rural wards. The four wards sampled were Hausari, Bulabulin, Sabon Gari and Nglewa-Tsohon Nguru wards. The groundwater sources to be considered for this study are the public boreholes built by government in each ward which predominates in the study area. Open wells were unavailable because they no longer exist or not in used at the time this research was conducted. Two each of these boreholes will serve as the sampling point making a total number of (8) eight sampling points. The samples collected and stored in 250ml plastic bottles pre-cleaned by washing with non-ionic detergents, rinsed with distilled water. Each sample was labelled and transported to Yobe State University Damaturu for the analysis. The collected water samples were analyzed using standard procedures.

The differences in concentrations were revealed from the results obtained and then compared with the secondary data gotten from publications of the WHO (2010) and NSDWQ (2007) standards to ascertain conformity with the international and national guidelines using t-test at 95% confidence level.

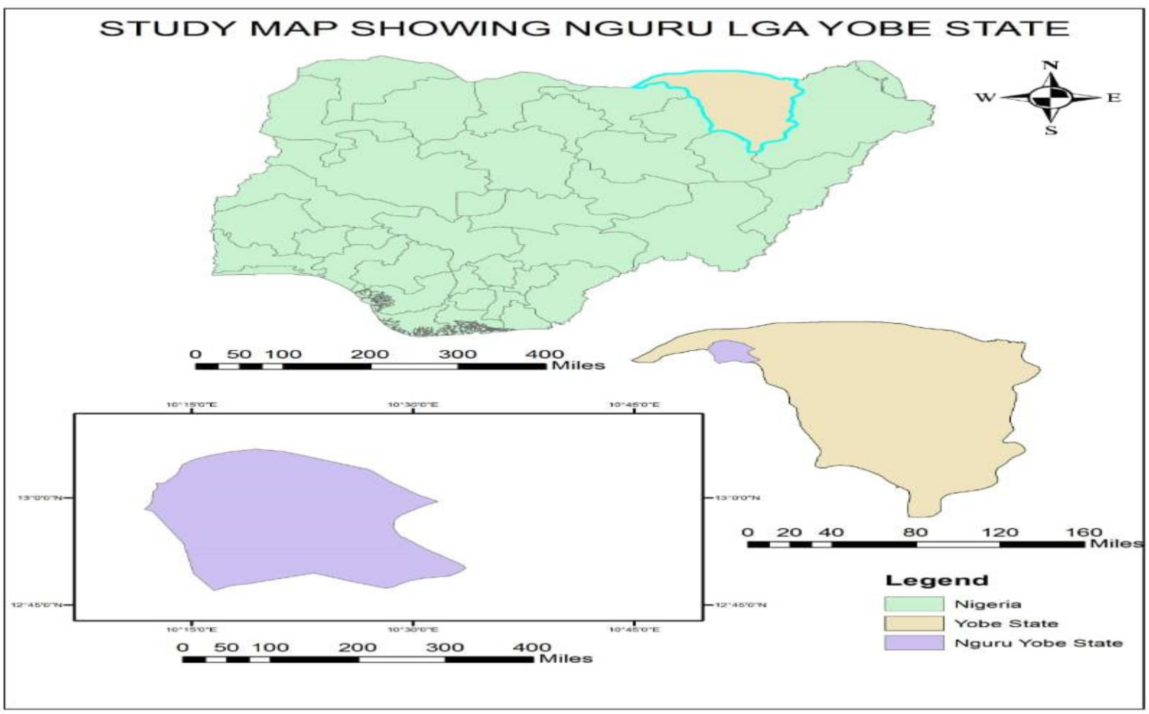

Fig 1: Map of Yobe showing the study area
Source: Adapted from the Adminsitrative map of Yobe State

RESULTS AND DISCUSSION

From Table 1, the mean concentration for pH showed higher values in Sabon Gari, Hausari and Nglewa-

TsohoNguru wards while a lower value in Bulabulin ward respectively. Sabon Gari, Hausari and Bulabulin wards shows similar values for the color parameter but a lower value in Nglewa-TsohoNguru ward. The concentration for total hardness higher values in Bulabulin, Hausari and Nglewa-TsohoNguru wards, while Sabon Gari recorded lower value. Conductivity concentration showed higher values in Bulabulin and Hausari wards respectively while Nglewa-TsohoNguru and Sabon Gari recorded lower values. The concentration for turbidity showed much higher value in Nglewa-TsohoNguru ward compare to the other three wards, which have lower values. Lead concentration showed considerably lower values across the Wards while no trace was recorded for Sabon Gari Ward.

Table 1: Mean Concentration of Physicochemical Parameters for Boreholes water

Physicochemical Parameters	Hausari ward	Bulabulin ward	Sabon Gari ward	Nglewa-TsohoNguru
PH	7.34	6.71	7.52	7.29
Colour (tcu)	5.00	5.00	5.00	3.75
Total hardness (mg/l)	74.25	87.68	4.32	12.23
Conductivity (μS/cm)	400.95	530.00	4.59	7.58
Calcium (mg/l)	3.75	13.43	4.29	4.78
Magnesium (mg/l)	14.98	15.73	0.69	1.00
Chlorides (mg/l)	19.28	72.18	0.55	0.86
Sulphate (mg/l)	3.19	7.63	1.34	2.18
Sodium (mg/l)	16.01	12.72	0.59	5.38
Turbidity (ntu)	3.48	2.70	0.30	12.96
Copper (mg/l)	1.18	0.27	0.02	0.36
Manganese (mg/l)	0.92	0.02	0.02	0.05
Zinc (mg/l)	1.91	1.46	0.15	0.26
Lead (mg/l)	0.01	0.03	0.00	0.02
Iron (mg/l)	3.26	2.17	0.04	0.45

The result from Table 2 shows the level of concentration of parameters in Hausari Ward with the acceptable drinking water standard using WHO 2010 standard and Nigeria standard for drinking water respectively. Each of the parameters in the ward were between the permissible limit for both the WHO and NSDWQ. In addition, the student's t- test was used to test the hypotheses which shows the p-value (0.39) is lower than the critical value (2.14) for the WHO 2010 and also the p-value (0.07) is lower than the table value (2.14) for NSDWQ standard. Consequently, for both comparison between the level of the parameters and the acceptable drinking water standard is shows no significant difference. Thus, the water are good for consumption for drinking. The study is similar to that of Fasae and Omolaja (2014) who worked on the assessment of drinking water quality from different sources (tap, well, rain, stream and borehole) in smallholder ruminant production in Abeokuta, Nigeria

Table 2: Difference in the level of concentration of parameters and acceptable drinking water standard for Hausari Ward

Physicochemical Parameters	Hausari ward	WHO Standard (2010)	P-value	Remarks	NSDWQ Standard (2007)	P-value	Remarks
PH	7.34	6.5-8.5	0.390226	No sig diff	8.5	0.075348	No sig diff
Colour (tcu)	5.00	15			15		
Total hardness (mg/l)	74.25	500	t-critical		150		
Conductivity (µS/cm)	400.95	NA	2.144787		1000	2.144787	
Calcium (mg/l)	3.75	NA			NA		
Magnesium (mg/l)	14.98	50			0.20		
Chlorides (mg/l)	19.28	250			250		
Sulphate (mg/l)	3.19	250			100		
Sodium (mg/l)	16.01	50			200		
Turbidity (ntu)	3.48	5.0			5.0		
Copper (mg/l)	1.18	2.0			1.0		
Manganese (mg/l)	0.92	0.1			0.2		
Zinc (mg/l)	1.91	3.0			3.0		
Lead (mg/l)	0.01	0.01			0.01		
Iron (mg/l)	3.26	0.3			0.3		

The result from Table 3 shows the level of concentration of parameters in Bulabulin Ward with the acceptable drinking water standard using WHO 2010 standard and Nigeria standard for drinking water respectively. Each of the parameters in the ward were between the permissible limit for both the WHO and NSDWQ with the exception of iron and lead. In addition, statistically, the student's t- test was used to test the hypotheses which shows the p-value (0.60) is lower than the critical value (2.14) for the WHO 2010 and also the p-value (0.60) is lower than the table value (2.14) for NSDWQ standard. Consequently, for both comparison between the level of the parameters and the acceptable drinking water standard is shows no significant difference. Thus, the water are good for consumption for both drinking and domestic usage.

Table 3: Difference in the level of concentration of parameters and acceptable drinking water standard for Bulabulin Ward

Physicochemical Parameters	Bulabulin ward	WHO Standard (2010)	P-value	Remarks	NSDWQ Standard (2007)	P-value	Remarks
PH	6.71	6.5-8.5	0.600847	No sig diff	8.5	0.065899	No sig diff
Colour (tcu)	5.00	15			15		
Total hardness (mg/l)	87.68	500			150		
Conductivity (µS/cm)	530.00	NA	2.144787		1000		
Calcium (mg/l)	13.43	NA			NA		
Magnesium (mg/l)	15.73	50			0.20		
Chlorides (mg/l)	72.18	250			250		
Sulphate (mg/l)	7.63	250			100		
Sodium (mg/l)	12.72	50			200		
Turbidity (ntu)	2.70	5.0			5.0		

Copper (mg/l)	0.27	2.0			1.0		
Manganese (mg/l)	0.02	0.1			0.2		
Zinc (mg/l)	1.46	3.0			3.0		
Lead (mg/l)	0.03	0.01			0.01		
Iron (mg/l)	2.17	0.3			0.3		

The result from Table 4 shows the level of concentration of parameters in Sabon Gari Ward with the acceptable drinking water standard using WHO 2010 standard and Nigeria standard for drinking water respectively. Each of the parameters in the ward were between the permissible limit for both the WHO and NSDWQ. In addition, statistically, the student's t- test was used to test the hypotheses which shows the p-value (0.06) is lower than the critical value (2.14) for the WHO 2010 and also the p-value (0.10) is lower than the table value (2.14) for NSDWQ standard. Consequently, for both comparison between the level of the parameters and the acceptable drinking water standard is shows no significant difference.

Table 4: Difference in the level of concentration of parameters and acceptable drinking water standard for Sabon Gari Ward

Physicochemical Parameters	Sabon Gari ward	WHO Standard (2010)	P-value	Remarks	NSDWQ Standard (2007)	P-value	Remarks
PH	7.52	6.5-8.5	0.062845	No sig diff	8.5	0.104416	No sig diff
Colour (tcu)	5.00	15			15		
Total hardness (mg/l)	4.32	500			150		
Conductivity (μS/cm)	4.59	NA	2.144787		1000		
Calcium (mg/l)	4.29	NA			NA		
Magnesium (mg/l)	0.69	50			0.20		
Chlorides (mg/l)	0.55	250			250		
Sulphate (mg/l)	1.34	250			100		
Sodium (mg/l)	0.59	50			200		
Turbidity (ntu)	0.30	5.0			5.0		
Copper (mg/l)	0.02	2.0			1.0		
Manganese (mg/l)	0.02	0.1			0.2		
Zinc (mg/l)	0.15	3.0			3.0		
Lead (mg/l)	0.00	0.01			0.01		
Iron (mg/l)	0.04	0.3			0.3		

The result from Table 5 shows the level of concentration of parameters in Nglewa-Tsoho Nguru Ward with the acceptable drinking water standard using WHO 2010 standard and Nigeria standard for drinking water respectively. Each of the parameters in the ward were between the permissible limit for both the WHO and NSDWQ with the exception of iron and lead. In addition, statistically, the student's t- test was used to test the hypotheses which shows the p-value (0.06) is lower than the critical value (2.14) for the WHO 2010 and also the p-value (0.10) is lower than the table value (2.14) for NSDWQ standard. Consequently, for both comparison between the level of the parameters and the acceptable drinking water standard is shows no significant difference. Thus the water are good for consumption for both drinking and irrigation usage.

Table 2.5 Difference in the level of concentration of parameters and acceptable drinking water standard for Nglewa-Tsoho Nguru Ward

Physicochemical Parameters	Nglewa-Tsoho Nguru	WHO Standard (2010)	P-value	Remarks	NSDWQ Standard (2007)	P-value	Remarks
PH	7.29	6.5-8.5	0.067362	No sig diff	8.5	0.109313	No sig diff
Colour (tcu)	3.75	15			15		
Total hardness (mg/l)	12.23	500			150		
Conductivity (µS/cm)	7.58	NA	2.144787		1000	2.144787	
Calcium (mg/l)	4.78	NA			NA		
Magnesium (mg/l)	1.00	50			0.20		
Chlorides (mg/l)	0.86	250			250		
Sulphate (mg/l)	2.18	250			100		
Sodium (mg/l)	5.38	50			200		
Turbidity (ntu)	12.96	5.0			5.0		
Copper (mg/l)	0.36	2.0			1.0		
Manganese (mg/l)	0.05	0.1			0.2		
Zinc (mg/l)	0.26	3.0			3.0		
Lead (mg/l)	0.02	0.01			0.01		
Iron (mg/l)	0.45	0.3			0.3		

CONCLUSION

Assessment of groundwater quality using some major physicochemical parameters in Nguru town, Nguru LGA, Yobe State was carried out using laboratory techniques. The result revealed that all parameters tested were within permissible limits except for Turbidity and Lead in Nglewa-Tsoho Nguru ward. Iron tend to be higher than the permissible limit for Hausari and Bulabulin wards. The result of the student t-test shows that all the parameters are within the acceptable drinking limit specified by WHO and NSDWQ with all p-values less than the t-critical of 2.14. Thus, we can conclude that the water is suitable for drinking. It is recommended that Individuals are advised to take responsibility of their well-being by testing their drinking water sources periodically and treatment of water before they can be used for drinking and other domestic purposes.

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