NAUB JOURNAL OF SCIENCE AND TECHNOLOGY
(NAUBJOST)
e-ISSN:2811-2350
Email: jost@naub.edu.ng http://journal.naub.edu.ng/naubjournal/

WATER QUALITY ASSESSMENT OF SELECTED BOREHOLES IN BIU LOCAL GOVERNMENT AREA OF BORNO STATE, NIGERIA

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Abstract

This study investigates water quality of some selected boreholes water in Biu Local government area of Borno State to ascertain their suitability for domestic usage. Water samples were collected from ten (10) wards of Biu Local Government. Two samples were collected from each ward, one during the rainy season and another during the dry season, a total of 22 samples were collected in all. Analysis was done using Smart Spectrophotometer machine to determine the concentration of 20 parameters. Which are Total Dissolve Solid, Turbidity, Total Hardness, Chloride, Sulphate, Phosphate, Nitrate, Colour, Odour, PH, Total Alkalinity, Total Salinity and the following metals: Potassium, Calcium, Magnesium, Copper, Lead, Cadmium, Zinc and Cadmium. Nitrate, phosphate, cadium, hardness, sulphate, ammonia, potassium and turbidity. Result obtained was compared with the stipulated guideline values for drinking water provided by World Health Organization (WHO) and Standard Organization of Nigeria (SON). Further analysis using Analysis of Variance (ANOVA) was carried out at p – value < 0.05 and it was observed that there is significant difference between the water qualities across the 10 location in Biu Local Government Area of Borno State. This study however concludes that regular monitoring of these parameters should be carried out.

Key Words: Boreholes, Ground Water Resources, Water Quality.

Introduction

The availability of adequate water supply both in quality and quantity is essential for human existence. With the exponential increase in population, access to improved water remains an important pre-condition for sustaining human life, maintaining eco systems and for achieving sustainable development (Waziri *et al*, 2012). Accessibility and availability of fresh clean water is a key to sustainable development and an essential element in health, food production and poverty reduction (Adekunle *et al.,* 2014). A water resource such as rain, river, groundwater and sea is one of the major components of environmental resources that are under serious threat from over exploitation or pollution from anthropogenic activities in Olowoyo (2012). Fresh water resource deterioration is now a global problem and is increasing at a faster rate (Mahananda *et al.,* 2005). Discharge of toxic chemicals, over pumping of aquifers and contamination of water bodies with substances that promote algae growth are some of the major causes of water quality deterioration (Awoyemi *et al.,* 2014).

Today there are traces of contamination not only of surface water but also of groundwater, which are susceptible to leaching from waste dumps, mine tailings and industrial production sites (Mahananda *et al.,* 2005). Groundwater is an increasingly important resource all over the world. The term groundwater is usually reserved for the subsurface water that occurs beneath the water table in soils and geologic formation that are fully saturated (Uzomah and Scholz, 2002) cited in Awoyemi *et al.* (2014). Groundwater is generally less susceptible to contamination and pollution when compared to surface water bodies (Zaman 2002). Importantly, groundwater can also be contaminated by naturally occurring sources. Groundwater is generally very difficult to remediate, except in small defined areas and therefore the emphasis has to be on preventing contamination (Mahananda *et al.,* 2005). Water quality reflects the composition of water as affected by natural cause and man's cultural activities expressed in terms of measurable quantities and related to intended water use (Kumar, 1997). One way of determining quality of water is to evaluate its physical and chemical properties (World Health Organization WHO 2011).

As far as North Eastern Nigeria is concerned, ground water in the form of boreholes are common in the entire savannah zone. Due to this increase of boreholes as a major source of drinking water in the region, there has been a growing concerned about the quality of water from this source (Mustafa *et al.,* 2012). It is against this back ground that the physical and chemical properties of boreholes water from Biu Local Government Area of Borno State were investigated with the aim of assessing how safe is the water for drinking compared with the standard of WHO and SON and to generate information that can serve as a guide in monitoring water contamination in the region.

Materials and Methods

Description of Study Area

The study area is Biu Local Government Area which is made up of 12 wards, located in the southern part of Borno State. Biu lies between latitude 10^0 40^0N and longitude $10^0 55^0$E covering an area of about 1, 0213 km^2 and has a population of 176,062. The area is generally characterized by fine grain of basalt pyroclastic materials which is overlaid igneous under laying rocks comprises of granite and volcanic silts of metamorphic rock which co-exist side by side with the granites intrusion and they are believed to have been formed by regional metamorphic It has a tropical climate, with marked rainy and dry seasons; the mean annual rainfall is over 800mm on the Biu plateau. The drainage system is dominated by Biu dam, river Hawul and other minor streams and ponds. Biu is an important economic center because of its agricultural and mining activities (Dibal *et al*., 2020).

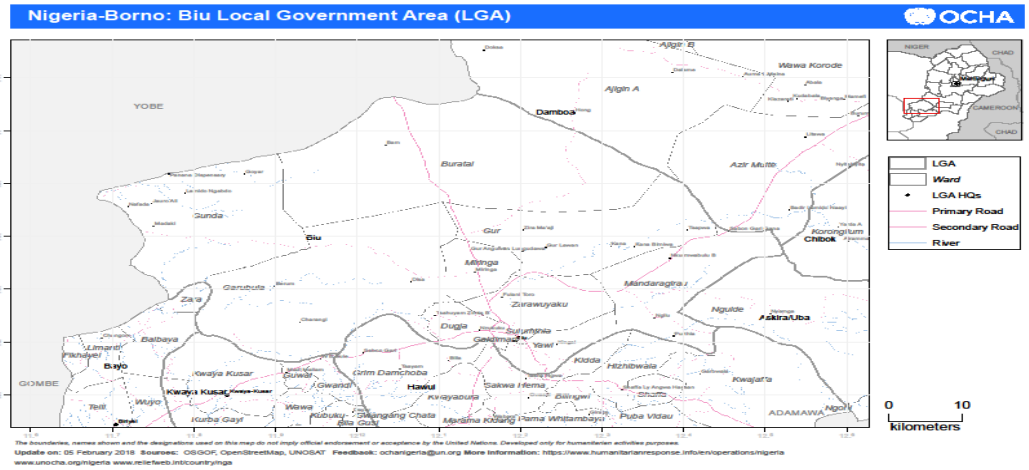

Fig 1 Map of Biu Local Government area
(Source: Department of Geography, MAUTECH Yola)

Sampling Collection and Analysis

Water samples were collected randomly from selected boreholes across the (10) wards of Biu Local Government Area during rainy and dry seasons. Water samples were collected using clean and well labeled polyethylene bottles and were immediately taken to the laboratory section of National Agency for Food and Drug Administration and Control in Maiduguri for the evaluation of physio-chemical parameters. Analytical water test tablets (photometer grade) reagents for specific test were used for preparation of all solutions. Water samples from the sampled boreholes were analyzed using a smart spectrophotometer, each sample was analyzed for 20 parameters. These are Total Dissolve Solid, Turbidity, Total Hardness, Chloride, Sulphate, Phosphate, Nitrate, Colour, Odour, PH, Total Alkalinity, Total Salinity and the following metals: Potassium, Calcium, Manganese, Copper, Lead, Cadmium and Zinc.

Result and Discussion

The result shown in the table 1 and table 2 shows that most of the parameters examined were within the permissible limits of SON 2007 and WHO 2011. However, there were cases where some of the parameters exceeded the WHO standard but were within SON allowable limit.

Table 1: Mean values of the physicochemical properties of the boreholes in the wards of Biu Local Government Area of Borno State

Parameters	Dugja	Yawi	Garubula	Dzara wuyaku	Miringa	Galdimare	Silumtha	Gur	Buratai	Gunda	SON	WHO
Colour	6	12	7	7	5	8	7	4	7	12	-	-
Ph	7.0	9.9	7.4	8.0	7.7	8.8	7.8	7.4	8.8	7.0	**6.5-8.5**	**6.5-8.5**
Turbidity NTU)	4.7	8.0	4.4	10.0	6.30	4.0	8.0	10.0	7.0	6.40	**45.00**	**6.12**
Hardness mg/l	60	41	39	35	60	51	34	50	60	77	**150**	**200**
Sulphate Mg/l	1.42	1.40	1.57	1.30	1.74	1.30	1.30	1.40	1.70	1.47	**100**	**250**
Nitrate Mg/l	0.17	0.17	0.10	1.18	3.00	2.10	2.15	2.19	1.19	3.00	**50**	**50**
Phosphate Mg/l	0.011	0.001	0.015	0.001	0.012	0.004	0.006	0.014	0.14	0.015	-	-
Ammonnia Mg/l	0.19	0.10	0.10	0.02	0.09	0.03	0.04	0.17	0.03	0.10	**0.19**	**0.03**
Total Dissolve Solid mg/l	370	210	440	180	330	180	240	180	152	180	**500**	**1000**
Total Salinity	46.00	40.00	42.00	46.10	47.50	29.00	19.00	0.02	10.00	60.05	-	--
Total Alkalinity	39.10	55.05	37.00	14.00	30.00	3.40	19.00	22.00	22.00	10.22	-	-

Table 2: Metal concentration (mg/l) in the borehole waters

Parameter	Dugja	Yawi	Garubula	Dzara wuyaku	Miringa	Galdimare	Silumtha	Gur	Buratai	Gunda	SON	WHO
Potassium (K^{-}) (Mg/l)	7.0	6.0	10.0	6.5	10.0	5.0	8.0	10.3	10.0	8.0	-	--
Calcium (Ca^{2+}) (Mg/l)	20	80	140	18	100	50	55	110	136		-	-
Manganese (Mn^{2+}) (Mg/l)	0.017	0.018	0.051	0.024	0.014	0.013	0.012	0.015	0.21	0.024	**0.02**	**0.04**
Zinc (Zn) (Mg/l)	0.87	1.9	2.4	0.9	2.0	0.8	0.54	0.21	2.2	1.00	**3.0**	**5.0**
Cadium (Cd) (Mg/l)	0.001	Nil	0.001	Nil	Nil	0.001	0.001	Nil	0.002	Nil	**0.03**	**0.03**
Lead (Pb) (Mg/l)	0.010	0.002	Nil	0.001	0.005	Nil	0.001	0.01	0.001	0.001	**0.01**	**0.01**
Copper (Cu) (Mg/l)	0.18	0.10	0.16	0.37	0.10	0.19	0.3	0.10	0.12	0.9	**1**	**2**

Discussion of Result

Turbidity

Turbidity is physical parameter, which is a measure of the cloudiness of water. It is caused by particles suspended or dissolved in the water that scatter light making the water appear

cloudy or murky, (Nemade *et al,* 2009). Turbidity generally has no direct health effects; however, it can interfere with disinfection and provide a medium for microbial growth (Adekola *et al.,* 2015). The values of turbidity obtained in this study were relatively higher than those obtained in the work of Mustapha *et al.* (2012) in Maiduguri Borno State which could be attributed to the change in soil characteristic. The values of turbidity in this studies are however relatively lower to those recorded by (Adekola *et al.,* 2015) Karin Lamido, Taraba State. Water samples with higher values exceeding SON (2007) and WHO (2011) permissible limits were those obtained from Yawi 8.0, Dzara Wuyaku 10.0, Silutha 8.0 and Gur wards 10.0.

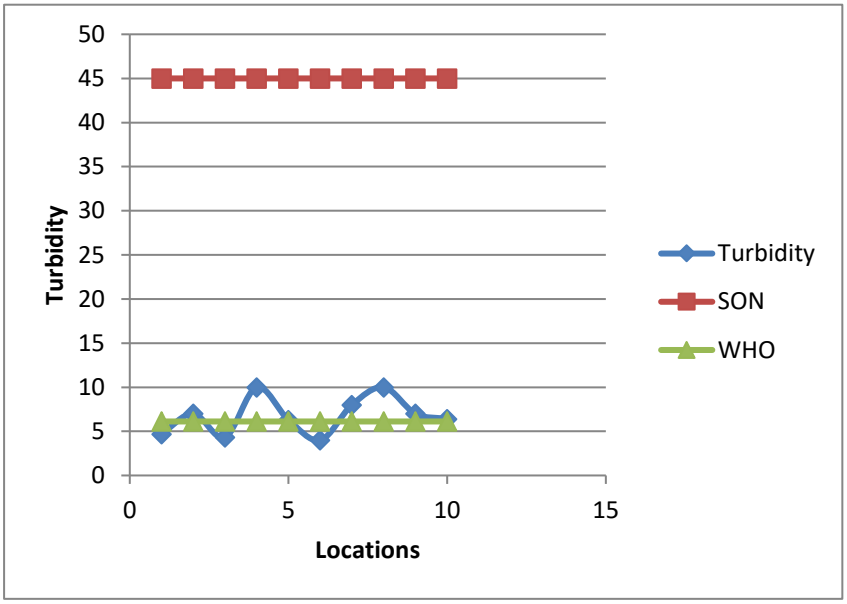

Fig 2: Turbidity of sampled water at various locations

pH

pH values obtained fails within permissible values except in Yawi 9.9, Galdimare 8.8 and Buratai 8.8 where values exceeded the upper limits. This is consistent with the work of Mustapha *et al.,* (2012) where some of the water sample studied had their pH values outside permissible limits. Although pH usually has no direct impact on consumers, it is one of the most important operational water quality parameters (WHO 2011).

Total Hardness

Total hardness in water is usually taken to comprise mainly of dissolved calcium and magnesium salts (Oyakhilome *et al.,* 2014). In this study, the total hardness values obtained for the samples analyzed were lower than 150 mg/l (SON 2007) and 200mg/l (WHO 2011) permissible limits for drinking water. The values gotten in this study were generally moderate. However, in a similar study, Bashir *et al.* (2012) recorded much lower total hardness that ranged from 12.67-36.67mg/l in Jimeta, Adamawa State Nigeria. Although, hard water is known to be undesirable for laundry and for boilers, soft water used for drinking has been significantly correlated with elevated mortality rate from certain types of cardiovascular disease (Adebola, 2001).

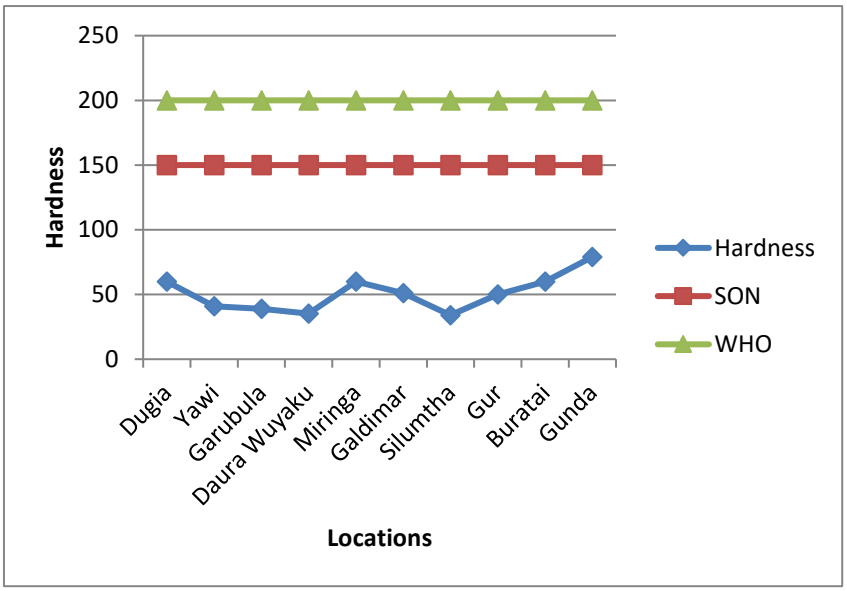

Fig 3: Hardness of sampled water at various locations

Ammonia

Ammonia can occur naturally in ground water, while in the environment, ammonia originate from metabolic, agricultural activities especially from the intensive rearing of farm animals. Ammonia in water is an indicator of possible bacteria, sewage and animal waste pollution (Adekola *et al.,*2015). In this study, the values that exceeded permissible limits suggested WHO were those obtained from Dugja 0.19, Miringa 0.9, Silumtha 0.4, Gur 0.17 and Gunda 0.10 wards.

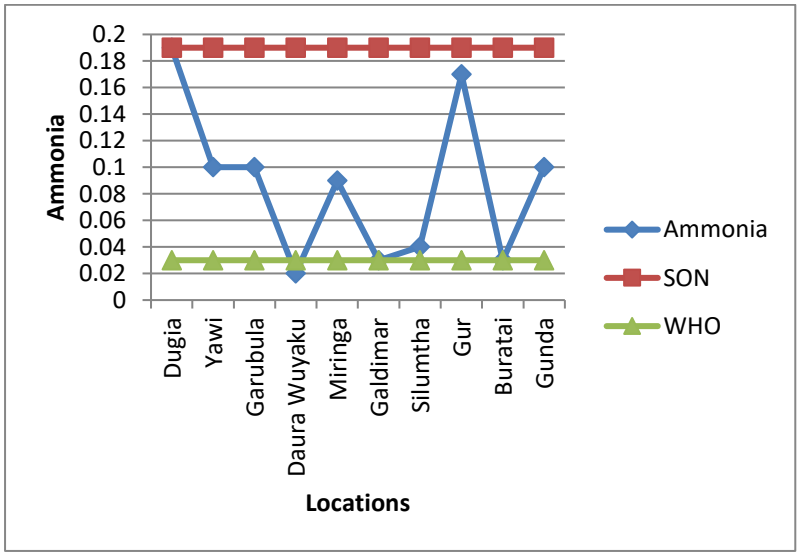

Fig 4: Ammonia of sampled water at various locations

Nitrate

The major source of nitrate contaminant in water is through run off from farmlands (Chiroma *et al.,* 2007). Concentration of Nitrate in water samples within the permissible limits of WHO (2011) and SON (2007) included those obtained from Miringa 3.00, Silumtha 2.15, Gur 2.19, Gunda 3.00, Buratai 1.19, Dugja 0.17, Yawi 0.17, Garubula 0.10, Dzarawuyaku1.18 wards. Nitrate is a major ingredient of fertilizer and is necessary for crop production. Nitrate can also

get into ground water from leaking of waste water (where latrines and septic tanks are poorly sited) or other organic waste from animal livestock, fish and birds into groundwater (Adekola *et al.,*2015). This is so because of the fact that most of the wards with high nitrate content are agrarian (Miringa, Gunda, and Garubula) this is related to run off from farm lands due to wide scale use of nitrogenous fertilizer (nitrogen- phosphorus- potassium). Nitrate in water is deleterious to health, water containing nitrate is injurious to industrial processes such as dying of wool and silk materials, and it is undesirable in fermentation processes (Imoisi *et al.,* 2012).

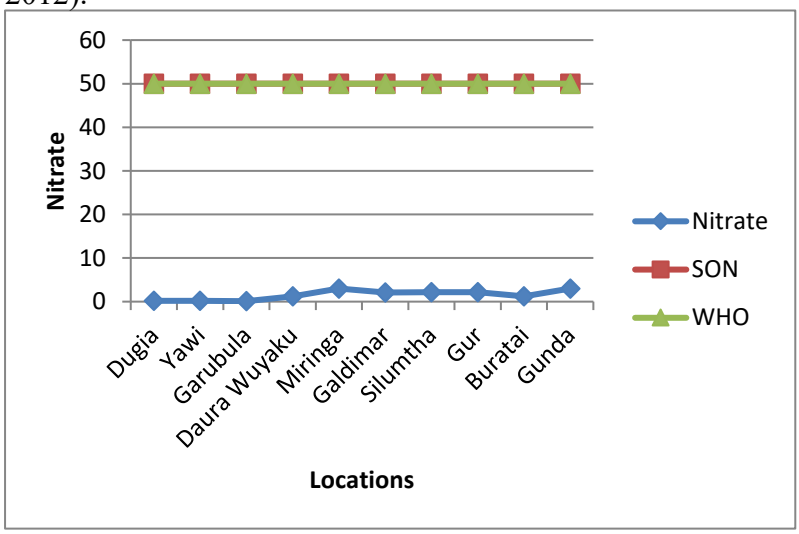

Fig 5: Nitrate of sampled water at various locations

Manganese

In this study, manganese is well within WHO permissible limit for all the wards except that of Gunda 0.024 and Dzara wuyaku 0.024 were above (WHO and SON) prescribed limit. Similarly, Odiana and Edosomwan (2019) reported Mn of within WHO (2011) desirable limit. In comparing with other study, it was also seen that the concentrations of Mn in all the water samples were below the regulatory desirable level for the metal in the various water sources (Oluyemi *et al.,* 2010).

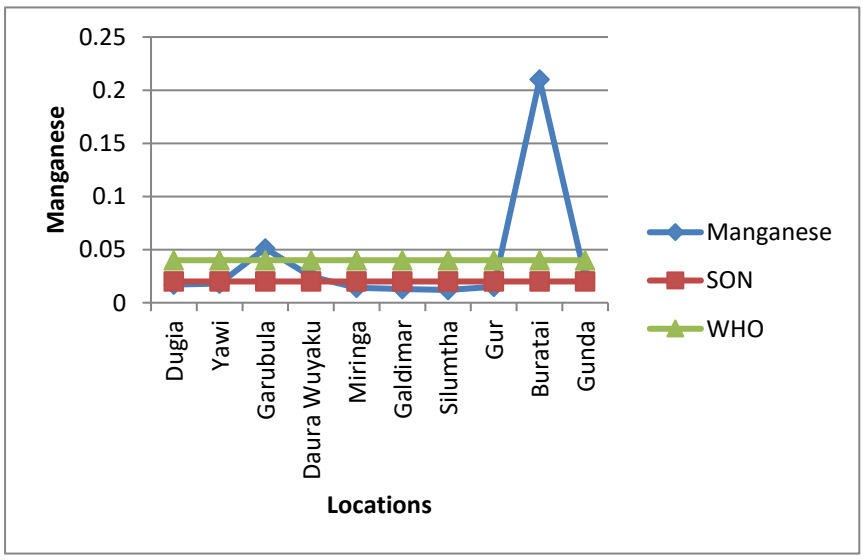

Fig 6: Manganese of sampled water at various locations

Lead

Lead presence is primarily from corrosive water effects on household plumbing systems containing lead in pipes, solder or fittings (including alloy fittings with high lead content), or from the service connections to homes. Exposure to lead is associated with a wide range of effects, including various neurodevelopmental effects, mortality (mainly due to cardiovascular diseases), impaired renal function, hypertension, impaired fertility and adverse pregnancy outcomes (WHO, 2011). In this study, the concentration of lead in all the water samples with the exception of water samples from Yawi 0.002, Dugja 0.010 and Miringa 0.005, wards were above regulatory allowable level. This may likely be due to plumbing system and corrosion of the piping system. This is in contrast with the work of Odiana and Edosomwan (2019) where they reported Pb content of 96% of the water samples examined was below permissible limits.

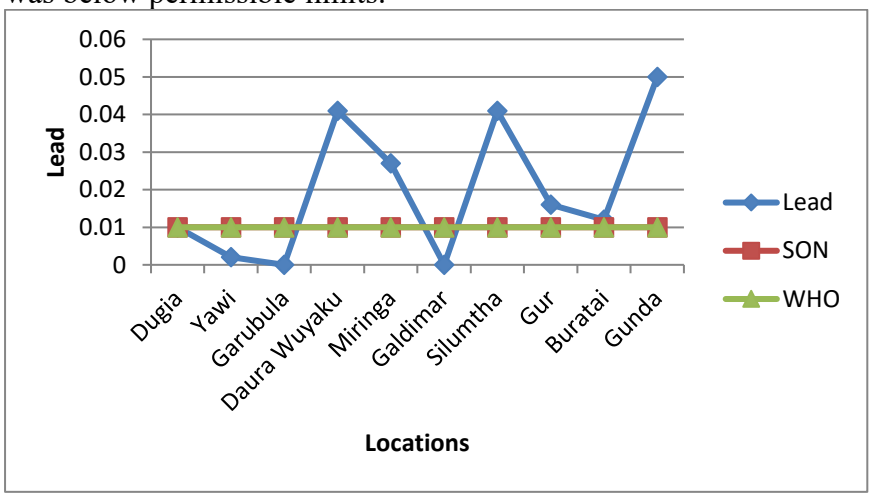

Fig 4.10: Lead of sampled water at various locations

Table 3: Analysis of Variance (ANOVA) of the Physicochemical Properties of the Boreholes in the Wards of Biu Local Government Area of Borno State across the locations.

ANOVA

		Sum Squares	of Df	Mean Square	F	Sig.
Colour	Between Groups	188.800	9	20.978	9.833	.000
	Within Groups	42.667	20	2.133		
	Total	231.467	29			
PH	Between Groups	31.383	9	3.487	3.105	.017
	Within Groups	22.460	20	1.123		
	Total	53.843	29			
Turbidity	Between Groups	122.359	9	13.595	12.217	.000
	Within Groups	22.257	20	1.113		
	Total	144.616	29			
Hardness	Between Groups	5434.875	9	603.875	117.822	.000
	Within Groups	102.507	20	5.125		
	Total	5537.382	29			

Sulphate	Between Groups	.701	9	.078	38.016	.000
	Within Groups	.041	20	.002		
	Total	.742	29			
Nitrate	Between Groups	34.346	9	3.816	991.225	.000
	Within Groups	.077	20	.004		
	Total	34.423	29			
Phosphate	Between Groups	.047	9	.005	31.331	.000
	Within Groups	.003	20	.000		
	Total	.051	29			
Ammonia	Between Groups	.094	9	.010	25.542	.000
	Within Groups	.008	20	.000		
	Total	.102	29			
Total Dissolve Solid	Between Groups	264371.500	9	29374.611	569.327	.000
	Within Groups	1031.907	20	51.595		
	Total	265403.407	29			
Total Salinity	Between Groups	9695.676	9	1077.297	430.962	.000
	Within Groups	49.995	20	2.500		
	Total	9745.671	29			
Total Alkalinity	Between Groups	6391.523	9	710.169	425.748	.000
	Within Groups	33.361	20	1.668		
	Total	6424.884	29			

Table 3 above shows the Analysis of Variance (ANOVA) of the Physicochemical Properties of the Boreholes across the locations. It can be observed from the result that there is significant difference between the water quality across the 10 location in Biu Local Government Area of Borno State with P-Value<0.05

Conclusion and Recommendation

This study assessed some chemical contamination indicators in water and has revealed that borehole water in Biu local Government is not of acceptable quality as far as the WHO and SON guidelines are concerned. The study found that concentrations of pH, Turbidity, Hardness, Nitrate, Ammonia and Total dissolve Solid in some wards deviate from the WHO and SON allowable limits. Borehole water in these wards with high lead and nitrate content should be treated before use as it poses serious health effect to population. Setting up of water sanitary agencies will enable monitoring of water contamination at ward levels and over hauling including complete change of all piping systems is highly recommended.

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