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DETERMINATION OF GROUNDWATER QUALITY FOR HUMAN SUSTAINABILITY IN IDAH; KOGI STATE.

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ABSTRACT

This study was carried out to determine the physicochemical properties of groundwater (Borehole and Well) in Idah, Kogi State for human sustainability. Six water samples were collected from three Neighbourhoods in the study area, one for each season (rainy and dry seasons) and analysed in a standard Laboratory. Eleven water quality parameters – Total Hardness, Sulphate, Dissolved Oxygen, Chloride, Phosphate, Nitrate, pH, Temperature, Alkalinity, Chemical Oxygen Demand and Biochemical Oxygen Demand were investigated and results presented and discussed. The results from the analysis revealed that the values of the water parameters tested were within the permissible limit of WHO (2011) and Nigerian Standard for Drinking Water Quality (NSDWQ, 2007). Though the study did not include heavy metals and microbial analysis of the water parameters, the analysed result

Introduction:

Access to safe and quality drinking water is a necessity to healthy living in any human community. According to Fabrizi (2016), the amount of water needed by an individual on daily basis is dependent on factors such as climate, standard of living, hygiene awareness and workload influence of the individual. The expected (normal) consumption level ranges from 3-10 litres of water per day of which part may be derived from food. Fabrizi (2016) also noted that the basic requirements for drinking water are that the water should be clear (low turbidity), not salty, tasteless, odourless, non-corrosive, free from heavy

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shows that the water is relatively safe for human consumption and other domestic uses but should be subjected to adequate treatment to ensure sustainability.

metals, contain less sulphate and nitrate and importantly free from pathogenic organisms as bacteria and viruses which may cause diseases.

It is therefore very pertinent to assess the suitability of groundwater for drinking across the globe so as to determine the concentration of some important parameters like pH, Chloride, Nitrate, Phosphorus, Sulphate, Total Hardness and heavy metals. Hence Obeta and Ocheje (2013) opined that evaluation of water quality prior to its use will assist in freeing such from water-borne diseases and other attendant problems associated with impaired water. In accordance with this, the World Health Organisation (2017) identified ready access to quality drinking water as the single major factor influencing the general health and life expectancy of a population in many developing countries. The United Nations also estimated that about 1.2 billion people all over the world lack access to potable water (Oyeku *et al*, 2001).

The assurance of quality drinking water continues to be a problem and its safety thereof is also a challenge. Groundwater quality problems are majorly caused by land pollution and over exploitation, poor sanitation as well as open defecation, industrialization, point and non-point sources of pollution such as sewage discharge, industrial discharge, run-off from agricultural fields and urban run-off.

The bid to ensure a good quality of water for human consumption and other activities of man has necessitated the goals of this study which is to determine the quality of the groundwater samples in Idah to enhance sustainable living.

MATERIALS AND METHODS

Study Area

The town Idah is one of the urban centres in Kogi State and also one of the oldest settlements in Igala land. It is the traditional and cultural

headquarter of the Igala people as it holds the seat of the Monarch (Attah of Igala Kingdom). It is geographically located at the south eastern part of the State and on the eastern bank of River Niger. It is lying beside the middle course of the River Niger. It is the Headquarter of Idah local government area of Kogi State. It has commercial routes (waterways) on the River Niger linking Lokoja to the north of the country; Onitsha in Anambra State to the south; Agenebode in Edo State to the west; and Enugu to the east. It is a homogeneous community dominated by the Igala's and few of other tribes. The town plays host to the Federal Polytechnic, the School of Health Technology and the Technical College.

The area has a high lying soil of the Plateau which is shallow and sandy. The town is under-laid by a false-bedded sand stone formation (sedimentary rock) which could provide a source of ground water through the tapping of aquifer. The population of the area from the 2006 census figure put it at 79,755 (NPC, 2006) and by projection using the geometric growth model ($P_t = P_0(1+r)^t$ where r is the constant rate of change; P_0 is the initial population; P_t is the final population sought for) puts it at 108,698 for 2015. The climate and vegetation of Idah encourage agricultural practices. Hence much of cultivation is practised along the flood plains. It lies within the warm humid climate zone of Nigeria. The vegetation type is that of guinea savannah. The topography of the area is gently undulating and it slopes downstream (River Niger).

Climate and Hydrology

The tropical wet climate of Idah in Kogi State is influenced by the guinea savannah vegetation under which it lies and is characterised by two distinct seasons. The wet season which occurs roughly between 6-7 months of the year with moderate rainfall of about 200-300mm. It has high temperature of over 27^{o}C during hot season and an annual range of temperature of about 6^{o}C (Iwena, 2012).

Fig.1: Map of Idah Local Government Area showing the Neighbourhoods

Water Sample Collection

Water samples were collected in clean 100ml sterile bottles with corks and filled to the brim from wells and boreholes in study area. The study area is made up of 17 Neighbourhoods out of which three Neighbourhoods (Ede-Adejoh, Ofiji and Igalaogba) were sampled for the survey to ensure proportionate coverage of the entire town. Two sets of water samples were collected from both well and borehole representing groundwater in the three neighbourhoods chosen for the study. The two sets were carried during the rainy and dry seasons (ie one collection for each season).

Laboratory Analysis of Water Quality Parameters

The analysis of the water samples collected from boreholes and wells in the study area were carried out in a laboratory with standard equipments.

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This was meant to determine the physicochemical properties of the water samples which included – Temperature, Dissolved Oxygen, pH, Total Hardness, Sulphate, Nitrate, Phosphate, Alkalinity, Biochemical Oxygen Demand and Chemical Oxygen Demand. The WHO (2011) guidelines for drinking water quality and the Nigerian Standard for Drinking Water Quality (NSDWQ,2007) were adopted as a basis for the determination of the permissible limit.

Data Analysis

Simple descriptive statistics were employed in the interpretation of the raw data on the physicochemical parameters generated from the laboratory analysis. The parameters computed were mean, standard deviation and minimum and maximum values.

Table 1: Mean of Mineral Elements in the Water Samples from the Study Area

Water Property	Borehole (Mean)		Well (Mean)	
	Rainy season	Dry season	Rainy season	Dry season
Total hardness	23.17	13.75	28.33	13.0
Sulphate	0.22	0.52	0.24	0.32
Dissolved Oxygen	4.33	4.45	5.65	5.12
Chloride	12.25	24.5	9.45	25.9
Phosphate	4.63	18.59	5.05	16.15
Nitrate	0.83	9.48	0.86	9.13
Temperature	26.88	28.31	27.13	27.85
Alkalinity	20.83	18.75	26.67	22.0
COD	0.15	0.01	0.15	0.01
BOD	5.2	36.03	22.44	2.66
pH	5.93	5.96	7.07	6.01

Source: Author's Field Survey

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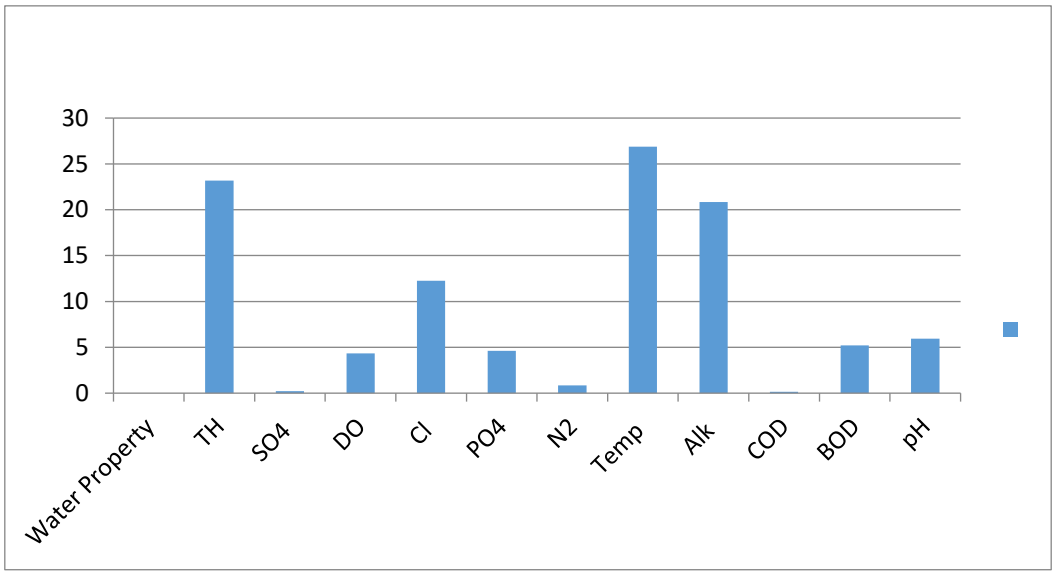

Fig.2: Borehole Mean for Rainy Season

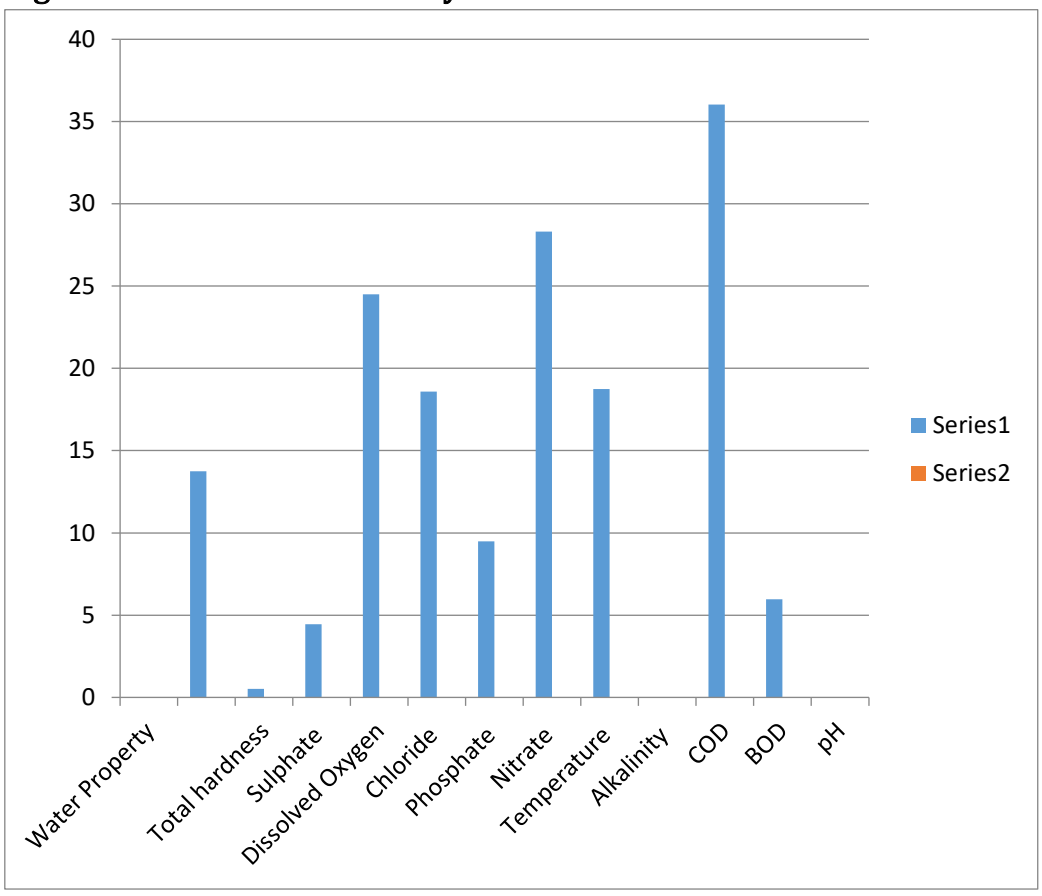

Fig.3: Borehole Mean for dry Season

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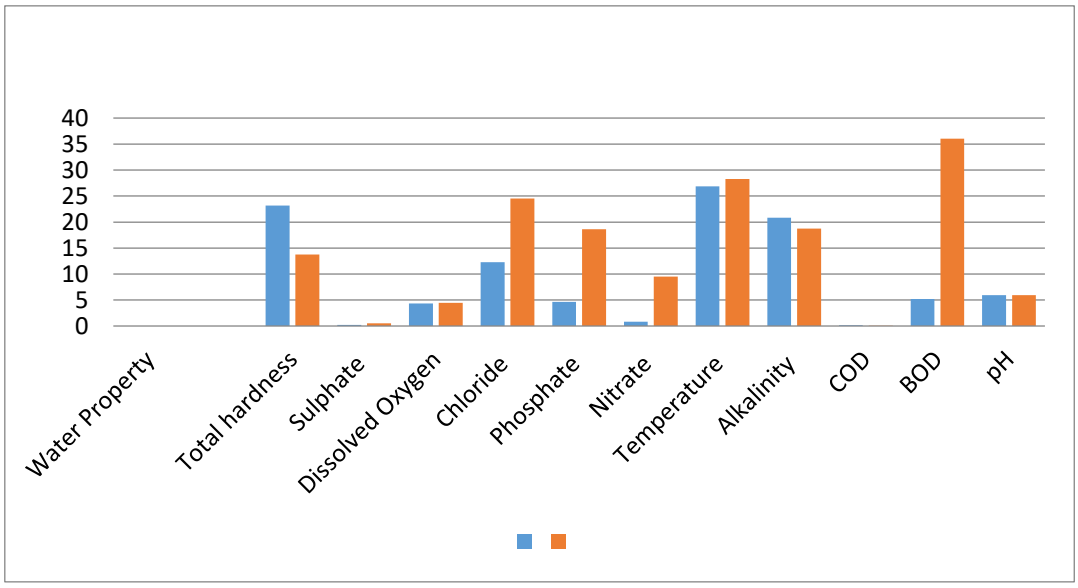

Fig.4: Borehole Mean for Rainy and Dry Seasons

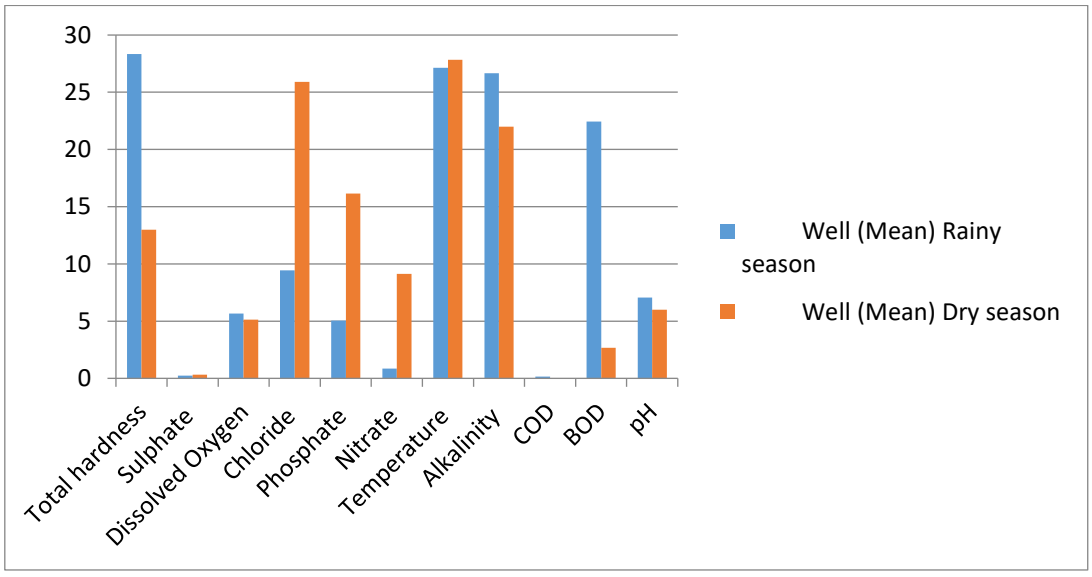

Fig.5: Well Water Mean for Rainy and Dry Seasons

RESULTS AND DISCUSSION

Variation in the Physicochemical Parameters of Groundwater Sources in Idah

Figs 1-4 above show the variation in the level of the physicochemical parameters in the groundwater sources collected from the three locations

in the study area. A close observation reveals that the temperature values of the water samples are relatively similar. The value of the BOD for borehole water during dry season appears to be higher than the other parameters, total hardness and Alkalinity have higher values for rainy season than other parameters, the value for Sulphate and COD are almost insignificant as compared to the other parameters tested. Dissolved Oxygen mean value falls within the same range for both rainy and dry season. On the whole, it is deduced that the mean value for the parameters for rainy season for water from the same source say well water are almost the same while those for borehole are also very similar. Hence it can be said that source affects the amount of physicochemical parameters it contains as well as the quality of the water.

Table 2: Composite Mean Distribution of Water Properties with Acceptable Threshold

Water Property	Borehole Composite Mean (Mg/L)	Well Composite Mean (Mg/L)	WHO Standard (2011)	NSDWQ (2007)
Total Hardness	18.46	20.7	150	150
Sulphate	0.37	0.3	100	100
Dissolved Oxygen	4.39	5.4	250	200
Chloride	18.38	17.7	250	250
Phosphate	11.61	10.6	250	-
Nitrate	5.16	5.0	50	50
pH	5.95	6.5	6.5-8.5	6.5-8.5
Temperature	27.6	27.5	Ambient	-
Alkalinity	19.79	24.3	150	-
COD	0.08	0.08	50	-
BOD	20.62	12.55	250	-

Source: Author's Field Survey

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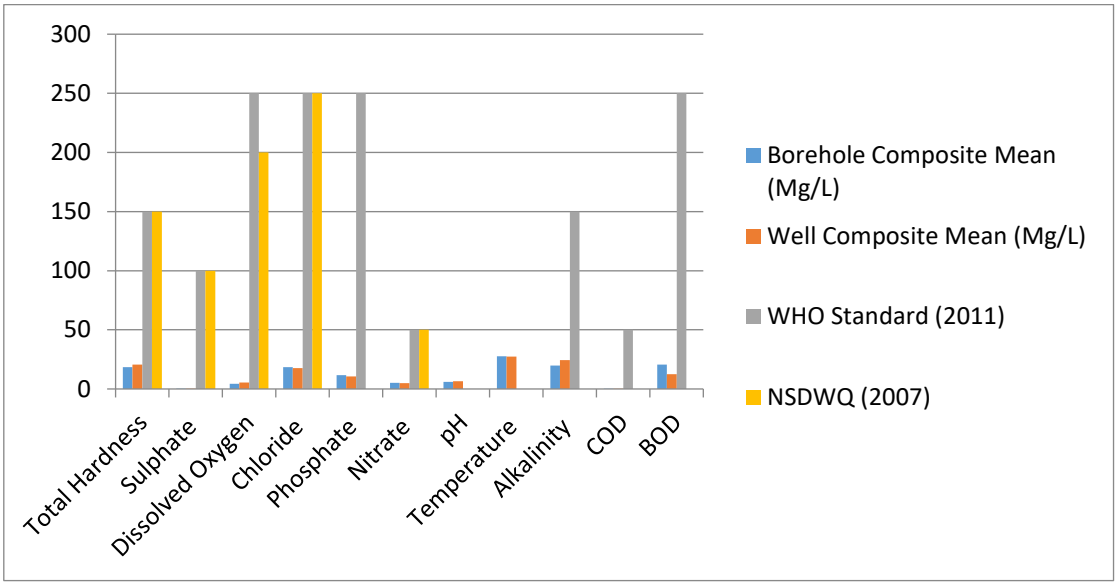

Fig.6: Comparison of Borehole and Well Water permissible Limits with WHO (2011) and NSDWQ (2007)

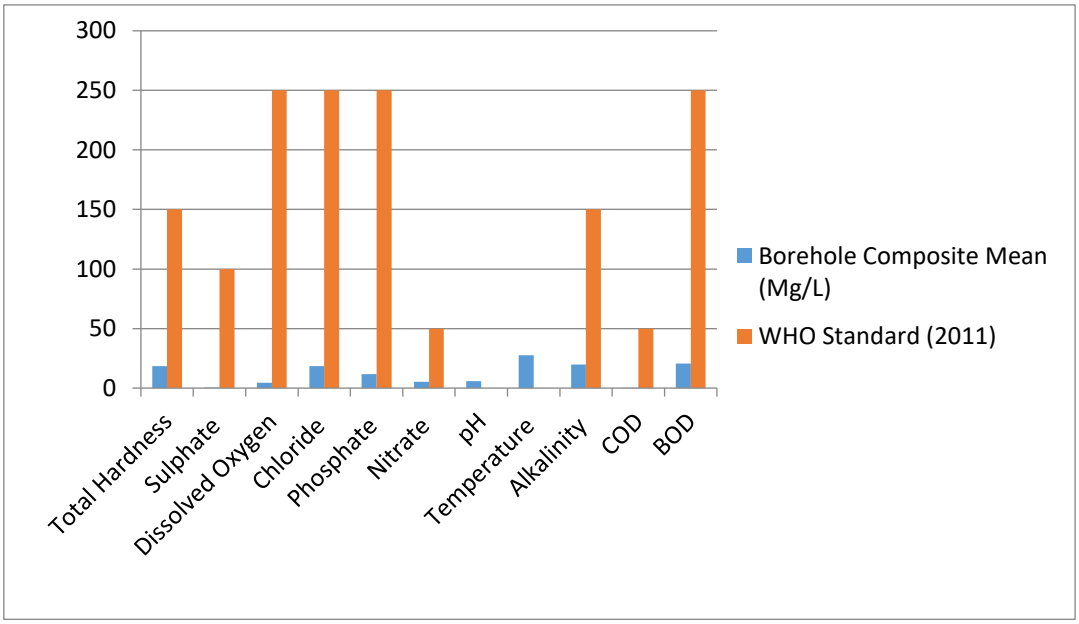

Fig.7: Comparison of Borehole water parameters and WHO (2011) Permissible Limit

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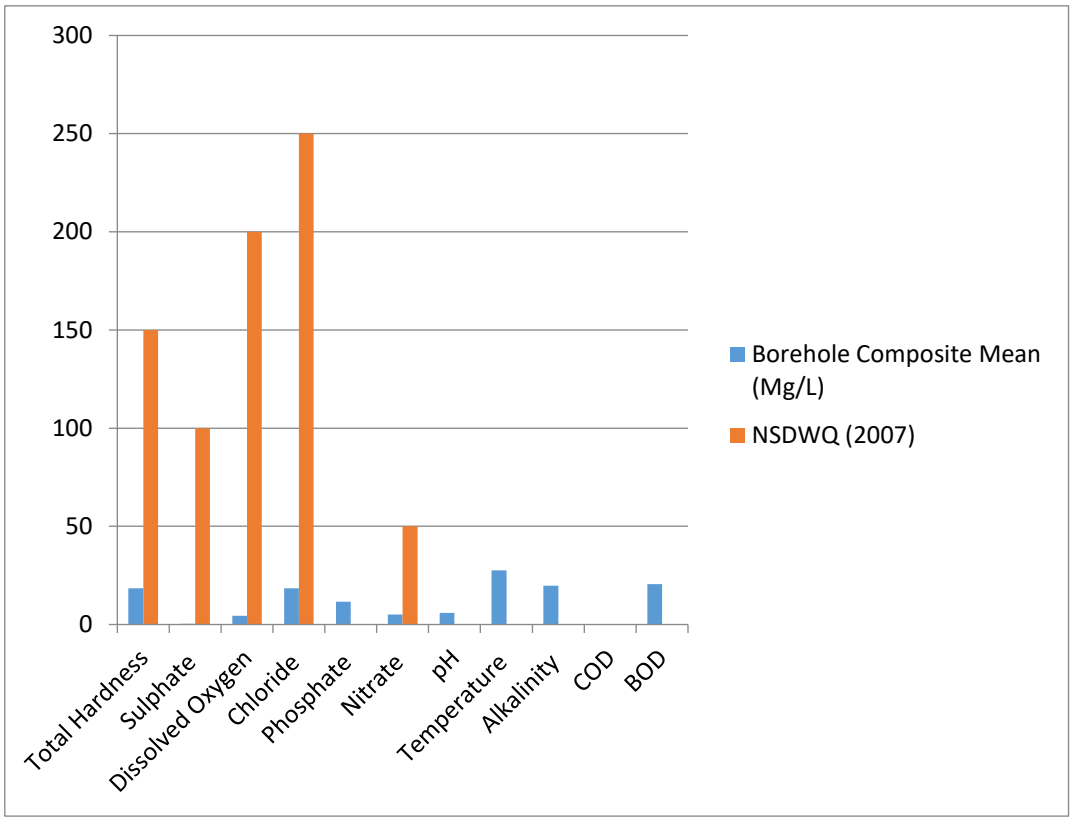

Fig.8: Comparison of Borehole Water Parameters and NSDWQ (2007) Permissible Limit

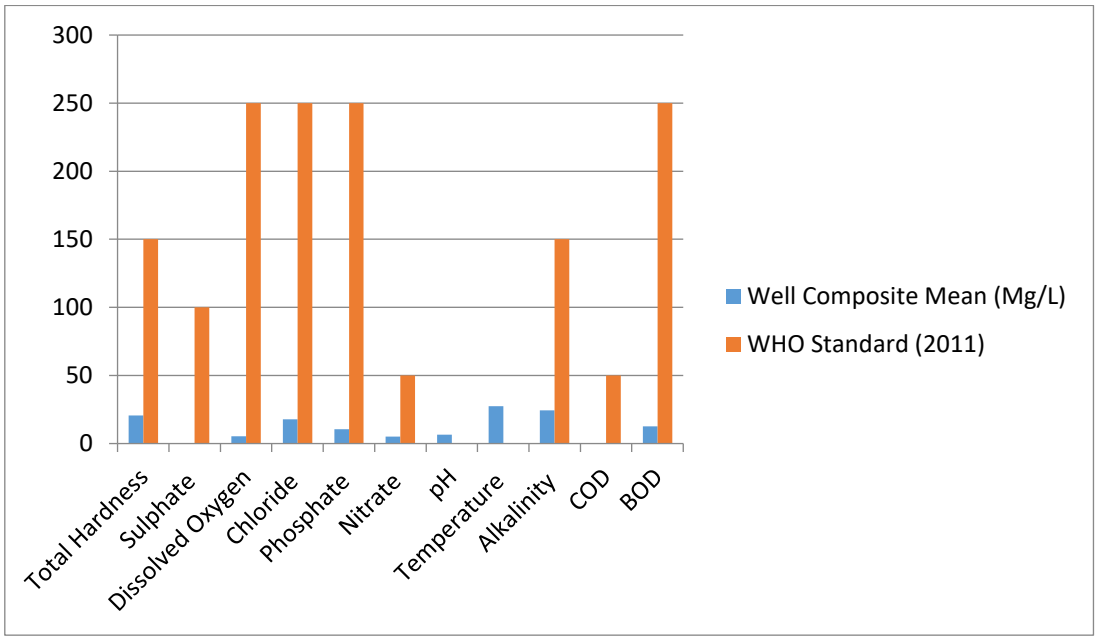

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Fig. 9: Comparison of Well Water Parameter with WHO (2011) Permissible Limits

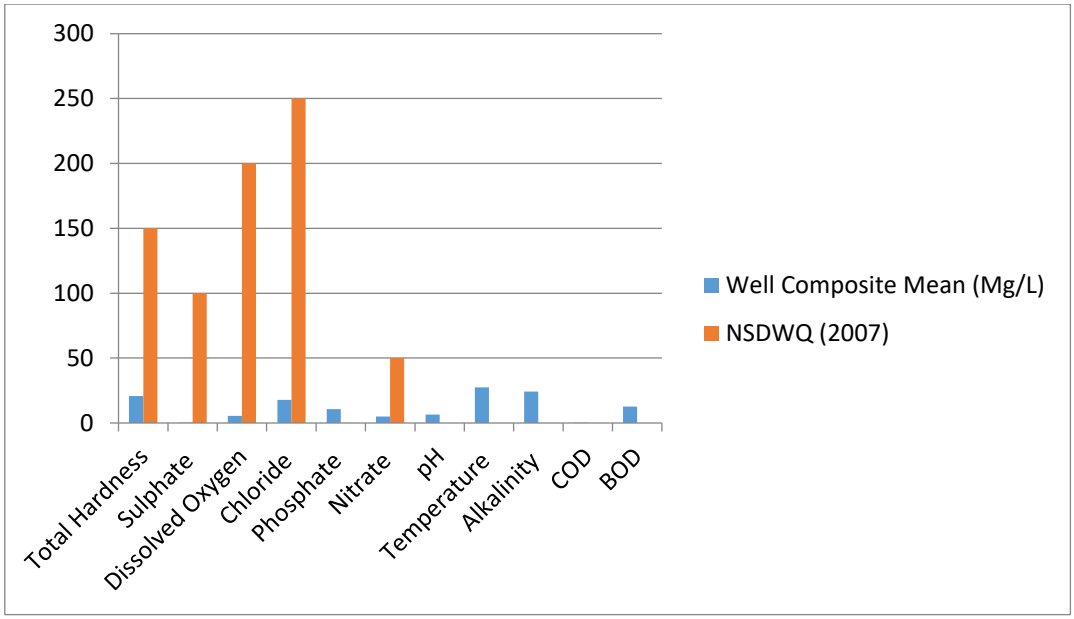

Fig. 10: Comparison of Well Water Parameter with NSDWQ (2007) Permissible Limits

Charts 5-9 show the statistical summary of the composite mean value of the physicochemical parameters of the groundwater samples analysed in the study area and their permissible limits according to WHO (2011) and Nigerian Standard for Drinking Water Quality (NSDWQ, 2007). The result revealed that none of the physicochemical parameters exceeded the permissible limit by WHO (2011) or NSDWQ (2007). Total Hardness values for borehole and well water were 18.46 and 20.7 respectively. This is because of the solvent action on the surface water coming in contact with soil and rock which is capable of dissolving Calcium and Magnesium and other ions that promote hardness into the groundwater. The existence of Hardness could be traceable to the local environment of the water points in terms of geology, soil and land use activities.

According to WHO (2011), no health-based guideline value is proposed for hardness, as it is not considered to be of major health concern at levels

found in drinking water, though it may affect its aesthetic acceptability (Okoro, Omeje and Osadedbe, 2017). The occurrence of Calcium can be beneficial for the growth of children whereas high intake of Magnesium causes a change in bowel habits (Diarrhoea) (Sengupta, 2013; Okoro *et al*, 2017).

The composite mean for Sulphate fall within 0.3-0.37 for borehole and well water which is in accordance with the standard of WHO (2011) and NSDWQ (2007). Water containing high concentration of Sulphate is known to cause dehydration and gastro-intestinal irritation as noted by Jidauna, Dabi, Saidu, Ndabula and Abaje (2014). The temperature range of the water samples collected was between 27.1-27.6^{o}C which according to UNICEF, 2008; Oyem, Oyem and Ezeweali, (2014), suggested that the water temperature is generally ambient and good for consumers and enhances the water quality; since high temperature negatively impact quality by enhancing the growth of micro organisms which may increase taste, colour, odour and corrosion problems. Hence it is important that the water temperature is not too high to avoid microbial proliferation, since temperature affects biological, chemical and physical activities in water (Yilmaz and Koc, 2014; Oyem *et al*, 2014).

CONCLUSION AND RECOMMENDATION

Ensuring sustainability when it comes to maintaining water quality requires the users and the community to maintain proper hygiene around the water source. There can be less doubt that water is a basic necessity for the survival of humans. The result from the study has shown that groundwater in Idah is relatively safe for human consumption and domestic use since none of the parameters tested exceeded the permissible limit of WHO (2011) and the NSDWQ (2007). The groundwater in the area suffer little or no pollution since open defecation is not a common practice and there are less of agricultural activities and industries are absent. This however, may be the reason there has not been any major outbreak of water-borne disease in the study area.

This assertion however is with reservations as the study did not include the assessment of heavy metals in the water samples tested, and other yardstick for water quality determination were not completely exhausted as the microbial analysis of the groundwater was not carried in this study. Hence the approval of the groundwater in Idah as safe and suitable for use was based on only the determination of the physicochemical parameters of the water. Hence the water needs to be treated for quality assurance before consumption and other use. In the light of this, the following recommendations are made to ensure a good and safe quality of water for the people of Idah.

- Water from borehole and well should be properly treated before use
- There should be public awareness on the need for environmental hygiene.
- Open defecation and improper agricultural practices be discouraged.
- Wells in the area should not be left open.
- The borehole constructors should ensure that the boreholes have great depth.
- The water should be tested in a standard laboratory to ascertain its quality before use.

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