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Groundwater Quality Analysis of Some Selected Areas of Hong Municipal Area, Adamawa State, Nigeria: Focus on Boreholes and Hand-dug wells

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Abstract
Physicochemical parameters and elemental composition of Borehole and Hand Dug Well Waters in selected areas of Hong Local government area of Adamawa State were determined. Ten (10) water samples from Borehole and Hand Dug well were collected from five locations. The samples were analyzed for the following parameters, pH, Temperature, Electrical conductivity (EC), Total dissolved solids (TDS) and Dissolved Oxygen (DO), using standard methods while the elemental content were determined by Atomic Absorption Spectrophotometer (AAS).The results showed that pH varied from 6.7±0.16 - 7.0±0.10 in borehole water and 6.9±0.20 - 7.7±0.33 in hand dug well. While that of temperature from 25.0±0.12-29.0±1.40°C and 25.0±0.10 - 29.0±1.30°C in borehole and hand dug well respectively. The Electrical conductivity varied from 172±0.82 - 292±0.82 µs/cm in borehole and 173.8±0.89 - 251±1.63 µS/cm in hand dug well. Total dissolve solid from 1.50±0.05-3.92±0.02 mg/L and 1.57±0.06 - 2.51±0.01 mg/L in borehole and hand dug well respectively. Dissolved oxygen ranges from 9.00±0.04- 11.00±0.05 mg/L jn bore hole and 9.70±0.02-11.59±0.01 mg/L in hand dug well. Turbidity ranges from 0 - 0.1 in both Boreholes and Hand Dug wells. The elements Cu, Pb and Zn were below detection limit. However, the concentration of Mn was found to be 0.06±0.00mg/l in hand dug well at Kukurpu. The concentrations of the investigated parameters in the ground water samples from the study area were within the permissible limits of the World Health Organization standard for drinking water quality guidelines.

Keywords: Physicochemical, Water, Quality, Elements, Borehole, Hand-dug well

Introduction
The raising demands for portable drinking water and the raising scarcities has placed mankind at a risk of global social crisis. Poor government policy on water quality for domestic consumption especially in developing economy like Nigeria leads to indiscriminate sinking of boreholes and hand-dug wells with no recourse to quality and standards. Is on record that unsafe drinking water coupled with poor sanitation remains a major player in the raising cases of water-borne diseases such as diarrhea, accounting to about 90% of diarrheal-related deaths [1,2] and contributed to about 1.6 million reported dead cases among children, with a gulping 84% of the cases found among the rural communities [3,4]. With all purposes and sincerity, ground water resources is under threat due to various anthropogenic related impacts and to more extend, due to poor waste management and low level of health/or hygiene related practices in the developing nations [5,6]. These development has become a big threat to global health, thus, ground water resource management and quality control remain a key fundamental, considering its direct role in defining a healthy ecosystem and maintaining the hydrological system [7].
The chemistry and mobility of ground water are controlled by several factors such as the degree of weathering, the geomorphological and mineralogical composition which involves rock-water interaction, soil-water interactions and precipitations [6, 8, 9]. Other factors that influence its purity and chemistry is contamination by plant protection products and inflow of water from farming activity such as irrigation, industrial influent and leaching activities from dump sites [10-13]. Therefore, the ability to understand the material composition and

quality profiles of domestic water sources is significant towards controlling the possibility of dissolved products and other physicochemical parameters exceeding the standard permissible limits for consumption purpose as recommended by World Health Organization [14, 15]. Thus, the finger print often used to identify water quality and purity includes but not limited to the presence of dissolved substances and suspended particulates, the pH, and other relevant physical, chemical and biological species [16].

Okunlola, *et al.*, [17] evaluated the quality of groundwater in shallow aquifers in Hong area of Adamawa State, Northeastern Nigeria. The study shows that, the high fluoride content in the groundwater samples in the selected villages are clearly geogenic in nature, originating from processes that involves chemical weathering, decomposition, dissociation and dissolution of fluoride bearing minerals (nacaphite) in the porphyritic granite. However, the study was limited to nearby villages located close to the rocky and mountainous areas. To this end, this present study is envisioned to capture areas heightened by both commercial and farming activities aimed at evaluating the purity and quality of their source of drinking water. The study areas are selected within and around the municipality of Hong local Government, Adamawa State, Nigeria (Fig.1). In the study areas, in addition to the commercial and other related activities, every available space is cultivated, a characteristics that defined the community as truly agrarians-base. Thus, the study hypothesis the possibility of activities such as use of plant protection products in cultivation, poor sanitation/or hygiene, indiscriminate dumping sites, and vehicular activity interfering with the soil-water chemistry and hence, the water quality and purity. Therefore, in this present study, the physicochemical parameters as well as some selected trace elements and heavy metals will be investigated. The outcome will provide additional information on the suitability of the ground water in the selected community for human consumption.

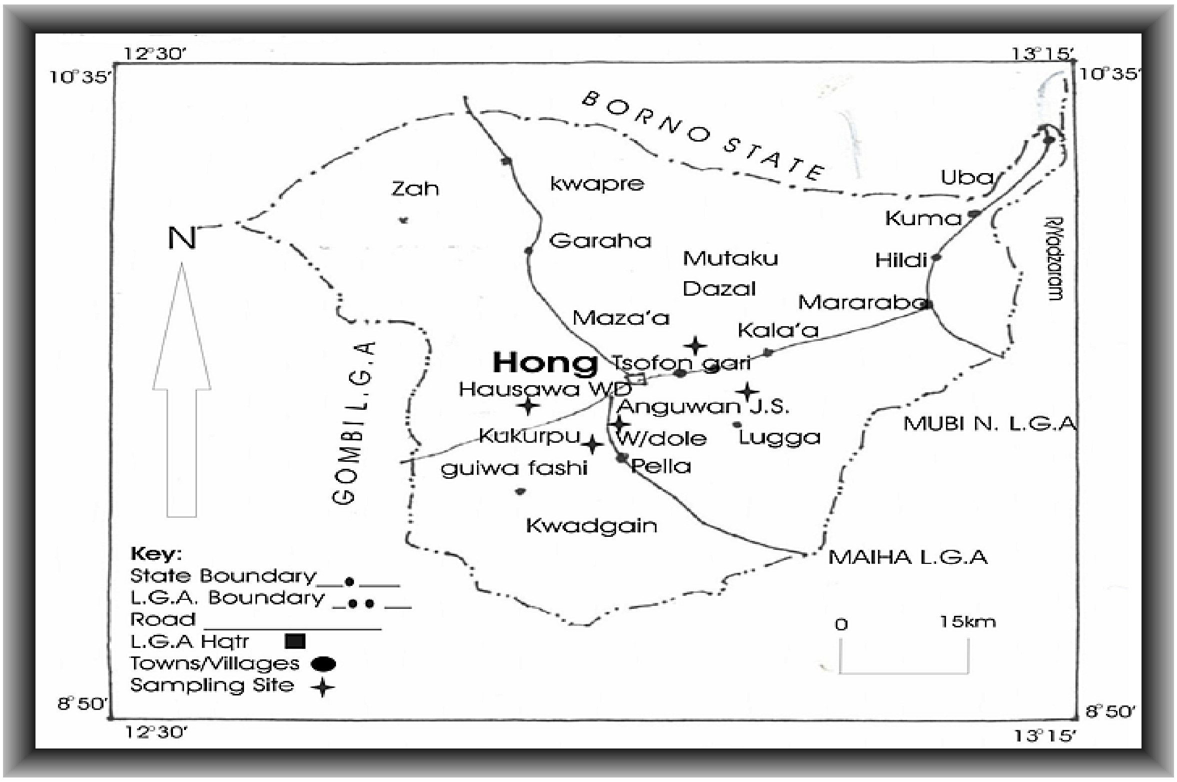

Fig. 1: Map of the Study Area. Where " ✦ " Signified the Sampling Areas.

Materials and Methods

Sample Collection and Analysis

A total of ten (10) borehole (BH) and hand-dug well (HW) water samples were collected from all the sample locations on a monthly basis from May to July 2017. The sample locations as represented in Fig.1 are Anguwan Jauro Sule, Kukurpu, Tsohon Gari, Hausawa Ward and Wuro Dolle. At each water sampling point, two set of samples were collected and subjected to laboratory analysis based on a standard procedure described in AOAC, [18].

The pH of the filtered water samples was measured in the field using Jenway 3505 pH meter and the color of the respective samples were determined quantitatively within 2 hours of sampling [19]. The physico-chemical parameters such as the total dissolved solids (TDS), Electrical conductivity (EC), turbidity, were determined based on the methods described APHA, [20]. The heavy metals (Cu, Zn, Mn and Pb) concentrations were determined using Atomic Absorption Spectrophotometer (PYE UNICAMP SP.9) as described by Mendham *et al.,* [21]

Results and Discussion

From the physico-chemical parameters investigated, it was observed that the pH values in all the sample locations as presented in Fig.2a falls within slightly acidic to near neutral. Confined mostly in the ranges from 6.7±0.16 to 7.0±0.10 in the samples collected from the BH and between 6.9±0.20 to 7.7±0.33 from samples collected from the HW. Irrespective of the sampling points and source of water sample, the pH values obtained were observed to fall within the WHO recommended range of 6.5 – 8.5 [14]. The slightly acidic values recorded further shows that activities such as dissolved carbon dioxide and presence of organic acids following the decomposition organic matters or plant materials played an insignificant role towards altering the water chemistry [22,23]. Furthermore, from the results in Fig. 2b, the temperature was observed to fall between 25.00±0.12°C to 29.00±1.40°C for the BH samples and similar trend observed for the HW samples, ranging from 25.00±0.10°C and 29.00±1.30°C respectively. Though, lower temperature favors slower rate of biological activity, high temperature on the other hand enhances the solubility and mobility of metals [24] and further doubled biological activity [25]. Furthermore, low water level could increase the temperature of the water body [26]. However, the ambient temperature range recorded in this study across the sample locations further suggest the low impact of chemical/or biological related phenomenon in the water.

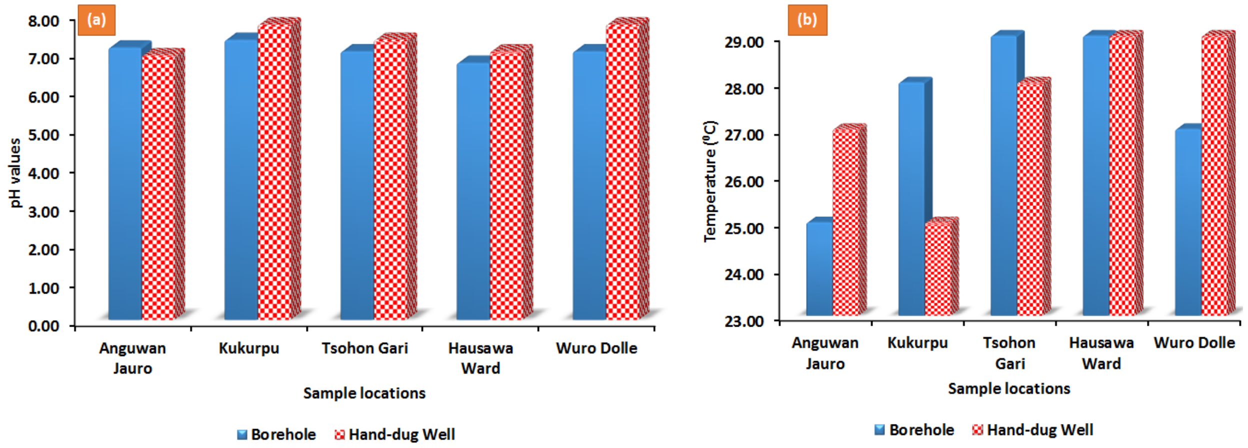

Fig. 2: showing (a) pH values of all the sample locations. The obtained pH values from the locations are compared with the WHO standard permissible values of 6.5 – 8.5. (b) Shows the temperature variation of BH and HW of all the sample locations

Further analysis of the water samples showed the electrical conductivity falling within 172±0.82 -292±0.82µS/cm and 173.8±0.89-251±1.63µS/cm for BH and HW samples respectively. From the results as presented in Fig. 3a, the BH samples collected from Hausawa Ward recorded the highest value (292±0.82µS/cm) with the lowest value of 172.8±0.82µS/cm recorded in samples collected at Tsohon Gari. Contrary to the value obtained from BH samples for Tsoho Gari samples, the highest EC value for HW samples was found in Tsoho Gari (292±0.82µS/cm) with the least (172±0.82 µS/cm) value recorded in samples collected at Aguwan Jauro. Although Electrical conductivity has no health implications, it helps to define the numerical expression and mobility of electric current in water at 25°C and same time provides an understanding in the nature and content of free ion or charged particles in water [5]. From the results, it was further observed that the EC is below the maximum permissible limit (300 µmho/cm) for drinking water [14]. The small rise in values especially for samples collected at Hausawa ward and Tsohon Gari could be due to the small impact of saline sources and some dissolved solids from mineral dissolution [5, 17].

The total dissolved solid (TDS) varied from 1.50±0.05 to 3.92±0.02 for BH and 1.57±0.06 – 2.51±0.01 for HW. TDS is an important parameter which impacts a peculiar task to water and reduces its portability. Desirable limit of TDS is 500 mg/L and maximum allowable limit is 1500 mg/L. The amount of TDS in a given source of water depends on the nature of the geological materials found in the area where the source is located. It also depends on the quantum of foreign materials that find their way into the source, as well as the chemistry of the source. However, because of the filtering capacity of the soil, suspended material rarely find their into the ground water systems. Based on this filtering capability, the respective TDS values obtained in the 10 samples did not exceed the maximum contaminant levels as recommended by WHOM [14].

The presence of suspended materials in water makes the water aesthetically unpleasant and provide adsorption medium for chemical and biological agents. The biological degradation of suspended organic solids leads to the formation of objectionable by-products [25]. Therefore, the palatability of water with a TDS level less than 500 mg/L is generally considered to be good [14].

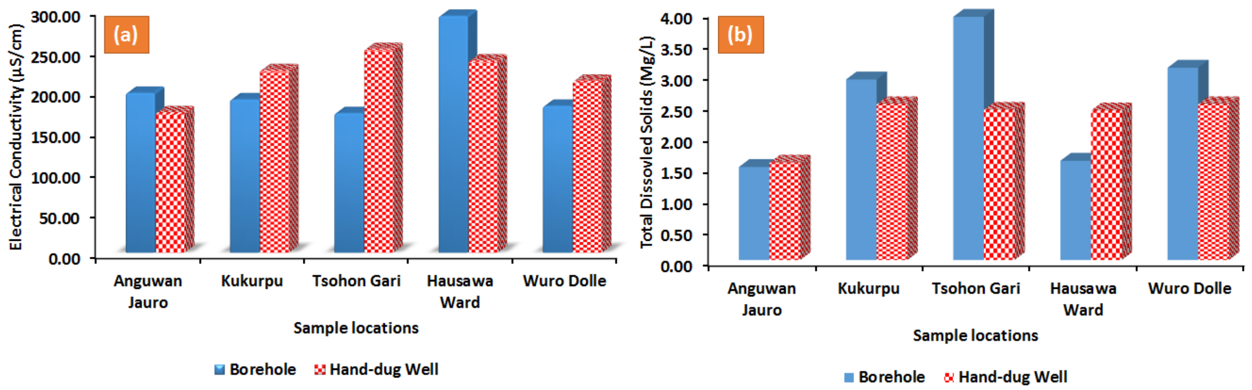

Fig. 3: showing (a) EC values of all the sample locations. The obtained EC values from the locations are compared with the WHO permissible limits of 300 µm/cm (b) Shows the TDS values for BH and HW for all the sample locations, the values were compared with the desirable limit 500 mg/L

The results of the dissolved oxygen (DO) for the water samples are presented in Fig. 4a. The values was observed to vary from 9.00±0.04 to 11.00±0.05mg/L for BH and 9.70±0.02 to 11.59±0.01mg/L for HW. The obtained values were within the WHO standard limit of 7 – 14 mg/L. Dissolved oxygen regulate and maintain an aerobic condition in natural water and serve as an indices in determining pollution load index in water [27]. Turbidity is the physical parameter, which is a measure of the cloudiness of water, often initiated from activity such as soil erosion, discharge from wastewater containing detergents and emulsifying agents. Such activity leads to the formation of stable colloids that results in turbidity (Snyder, 1998). Generally, Turbidity has no direct health effects, its presence in waters above certain levels makes drinking water aesthetically displeasing, provides binding sites for chemicals and serve as a culture medium for biological agents [25]. Therefore, the values recorded in this study further suggest the absence of such activity in the water samples. The value of the turbidity shown in Fig. 4b ranges from 0 - 0.1 in Boreholes but was not detected in the samples from Hand Dug wells. The detected values were below WHO and NAFDAC standard limit.

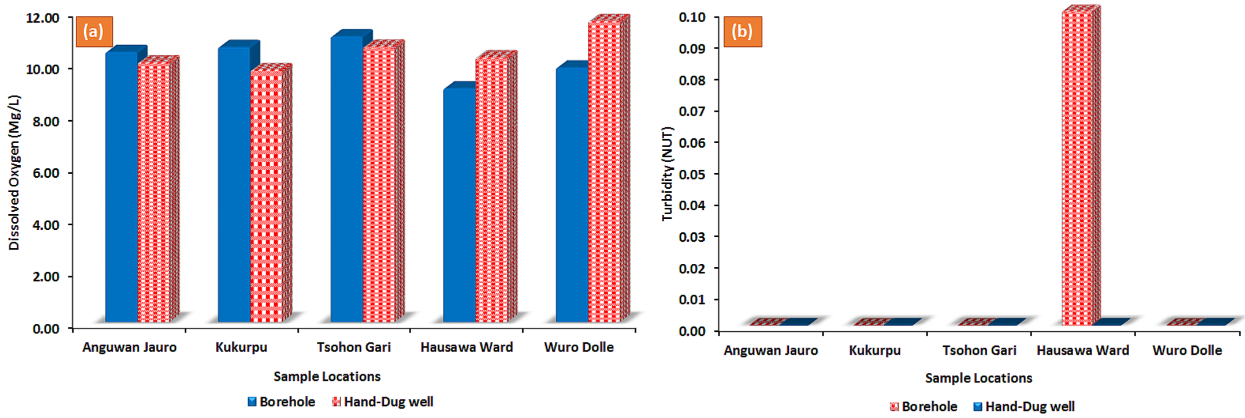

Fig. 3: showing (a) DO values of all the sample locations. The obtained DO values from the locations are compared with the WHO standard limits of 7 – 14 mg/L (b) Shows the turbidity values for BH and HW for all the sample locations, the values were compared with the permissible limit 0.1 NUT.

Generally, all the water samples showed unobjectionable taste/odour. Since taste and odour are strictly of chemical and microbial origin, this suggests that levels of materials causing taste/odour are minimal in the water samples. Colored water is aesthetically unacceptable for drinking and highly colored water is also considered unsuitable for both domestic and industrial applications [14]. According to WHO, [14], odour should totally be absent or very faint for water to be acceptable for drinking. Therefore, majority of the Hand Dug wells and Bore holes can be used for the purpose of drinking. The results are presented in Table1.

Table 1: Sensory Characteristic of the BH and HW samples by Sample Locations

	Colour		**Odour**	
Sample Points	Borehole	Hand-Dug well	Borehole	Hand-Dug well
Anguwan Jauro	Colourless	Colourless	Inoffensive	Inoffensive
Kukurpu	Colourless	Colourless	Inoffensive	Inoffensive
Tsohon Gari	Colourless	Colourless	Inoffensive	Inoffensive
Hausawa Ward	Colourless	Colourless	Inoffensive	Inoffensive
Wuro Dolle	Colourless	Colourless	Inoffensive	Inoffensive

In addition to the physical parameters investigated, the concentrations levels of the following elements Cu, Mn, Zn and Pb were investigated and the results presented in Table 2. From the table, it was observed that the concentration of Cu, Pb and Zn were Below the Detection Limit (BDL) in all the water samples [14]. Though falls below the WHO permissible limit, a traceable concentration of Mn (0.006 mg/kg) was detected in Kukurpu BH water samples with the results from the other locations BDL. Despites the fact Cu, Mn and Zn are considered an essential element, excessive exposure of these elements through drinking water could leads to a number of health implications [23, 28, 29]. Thus, the samples collected from the BH and HW in this study, based on the concentrations recorded are considered negligible to poise any health related implications.

Table 2: Metal Concentrations of the BH and HW samples by Sample Locations

		Borehole				**Hand-dug Well**		
	Cu	**Mn**	**Zn**	**Pb**	**Cu**	**Mn**	**Zn**	**Pb**
Anguwan Jauro	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Kukurpu	BDL	0.06	BDL	BDL	BDL	BDL	BDL	BDL
Tsohon Gari	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Hausawa Ward	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Wuro Dolle	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

Conclusion

The physicochemical parameters of boreholes and hand dug wells water were determined. The results of the temperature of the water samples for both Boreholes and Hand dug wells satisfied the WHO recommended standard. The pH was within the natural background levels for both Boreholes and Hand dug wells. The turbidity, TDS, and Electrical conductivity values observed in this study were all within the WHO permissible limit. The levels of trace metals (Cu, Pb, Zn) were Below Detection Limits in all the water samples with exception of manganese whose value was below WHO recommended standard. Based on the findings of this study, the water from Hand dug wells and Boreholes in the study area is acceptable for human consumption.

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