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ASSESSMENT OF PHYSIO-CHEMICAL PARAMETERS IN DRINKING WATER SOURCES IN KALTUNGO TOWN, GOMBE STATE, NIGERIA.

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ABSTRACT

In spite of many decades of development planning and assistance, much of the diseases in developing countries are indirectly related to poor water quality. The study assessed groundwater quality in Kaltungo town, Kaltungo Local Government Area of Gombe state. The study focused on the assessment of the physico-chemical quality of domestic water among households in Kaltungo urban area. Stratified random sampling technique was used to obtain water samples from boreholes and hand dug wells. The study area was stratified into four strata and two sample points were picked from each stratum giving a total of eight points. The result of the data generated from laboratory were analyzed using tables and percentages. The findings indicated that four of the five physical parameters (colour, turbidity, odour and appearance) tested fell within the permissible limits sets by NSDWQ 2006, indicating that the water is suitable for consumption physically. The fifth parameter which is temperature was slightly above 33C^{o} in six of the eight samples. In the case of the chemical parameters, fluoride (12.8%), Nitrite (13.0%), Total Hardness ($Caco_3$) (20.3%), and Nitrate (NO_2) (13.1%) fell above the permissible limits indicating non suitability of the water chemically. In line with the findings, the study recommended that government should make proper planning of houses to avoid contamination of ground water from septic tanks and pit latrines. Also proper sansitasisation campaigns to the semi urban dwellers on the dangers of ground water contamination should be emancipated.

Keywords: Borehole water, hand-dug well, Kaltungo, physico chemical parameters, drinking water.

Introduction

Water is a unique substance that has many physical and chemical properties. It can be found inform of liquids, solids or gaseous materials existing on the earth surface. Today, globally, the issue of provision of pure, clean and safe drinking water and adequate water supply remain an uphill task (Abdu, 2010). Groundwater quality has become an important water resources issues due to rapid increase in population, urbanization, unplanned urban settlement and too much use of fertilizer and pesticides in agriculture (joarder, Raihan, Alam and Husanuzzaman, 2008).

McGhee (1991) noted that the provision of adequate potable water supplies in recent times for domestic and other uses are an over growing problem as the dynamics of man water relationship becomes more complex. The demand for potable water is rising rapidly as population grows and becomes more urban and as water need per capita increases. This truth is strongly expressed by the United Nations when it asserted that access to a secure, safe and sufficient source of fresh water is a fundamental requirement for the survival, well-being and socio-economic development of all humanity. Yet we continue to act as if fresh water were a perpetually abundant resource.

Study conducted by Malik et al., (2010) in Pakistan revealed that the issue of drinking water quality has a rising concern in developed world but little debate in developing countries. Pakistan is ranked a water stress country with the availability of about 1,200 m3 per capita that is rapidly declining. Moreover, the production of domestic and industrial wastewater is about 4 million acre feet (MAF) per year that is discharging directly into water bodies except a little amount of 3% that is brought under treatment. About 70 % of the people in Pakistan rely on ground water for their household uses.

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(Farrukh et al., 2004) was on the opinion that due to contamination and micro-biological impurities, majority of the Nigerian citizens have inadequate access to safe drinking water with poor water supply lines and faulty drainage system. Resultantly, this caused many diseases among people (Tanwir et al., 2003). UNICEF and Meta-Meta, (2009) observed that biological diseases caused high child mortality rate of 128/ 1000 per year. It is estimated that, in Nigeria, 30% of all diseases and 40% of all deaths are caused by bad quality of water (Global Water Partnership, 2000).

In Africa, 602 million people had access to improved drinking water sources in 2006. This shows that the coverage increased from 56% in 1990 to 64%. The rate at which Africans gained access to improved drinking water sources, 245 million people since1990, falls short of that requirement to meet the 2015 MDG drinking water target (Helmer, 1996).

Despite the general endowment of surface and groundwater, which are capable of meeting demands, the average national water supply coverage was about 57% (about 60% for urban areas, 50% for semi-urban areas, and 55% for rural areas). In urban areas, both surface water and groundwater are used as water sources. Urban systems require treatment plants, distribution systems, elevated tanks, piped systems, house connections, yard taps and public standpipes (UNICEF, 2005). In semi-urban areas, water supplies are mainly based on mechanized boreholes and overhead tanks, as well as piping with yard taps and public standpipes. Each public standpipe is generally intended to serve 250 people. Rural water supplies generally involve boreholes with hand pumps, and protected wells, although rainwater harvesting and natural springs are also used.

Ahmed, et al (2011) analyzed the chemical parameters of water in Toro Local Government Area. The study revealed that there are some chemical parameters in excess of the safety limits of the drinkable water based on the bench mark set by the WHO standard.

Quality of drinking water in Kaltungo Urban area just like in other urban areas is increasingly affected by pollutants that deteriorate its quality. Some of these pollutants like fluorine in groundwater is basically from mafic minerals which are concentrated in rocks. It's against this backdrop it became imperative to assess ground water quality in Kaltungo urban area of Kaltungu LGA of Gombe state, Nigeria.

Study Area

The study area lies between latitudes $9^{o}48'00''$N to $9^{o}50'38''$N of the equator and longitudes $11^{o}16'00''$E to $11^{o}19'45''$E of the green wich meridian. It is accessible through the Bauchi-Gombe-Kaltungo and the Numan-Cham-Kaltungo Federal Highway. It has a landmass of about 881km^2 (340sq/ml) with an average elevation of approximately 628meters above sea level. The population of the area is about 183,000 (NPC, 2006). It is located in Southern part of the state, bounded by Shongom LGA from the South, Billiri LGA from the West, Balanga LGA from the East and Akko LGA from the North (Balzerek, 2001).

The geology of Kaltungo is developed on basement complex rocks with adjoining sedimentary rocks formation. Subsequent dissection and stream incision in the area have therefore resulted in pediment landscape that extends into some parts of Gombe in the north and south. There is also discontinuous escarpment in some places particularly along Gombe-Billiri road to form sand stone hills cliffs which are over 160m above the surrounding plains (Balzerek, 2001).

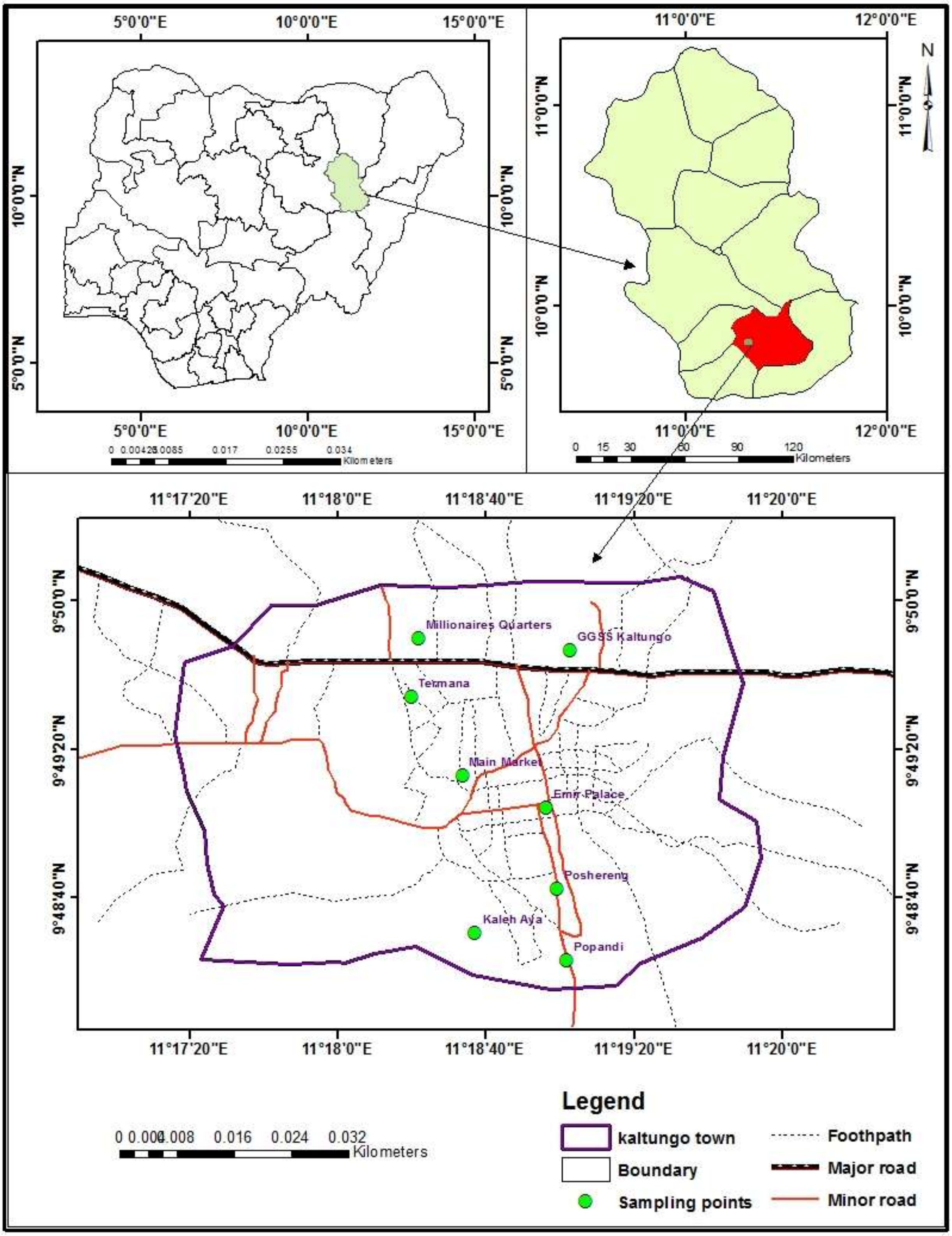

Figure1: Showing the Study area

Source: Adapted and Modified from Administrative Map of Gombe State

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Materials and Methods

The study adopted stratified random sampling to select the sample points. The whole of the study area was divided into four strata then the names of all the wards in each stratum were written on pieces of papers and folded, two point were picked from each stratum making eight which determines the sampling points. Global positioning system were used to collect the coordinate of the sample point. Water samples were collected from the selected sample points and analyzed for the presence of physical and chemical parameters using standard techniques. One sample source of drinking water was obtained at each sampling point. The water samples were acidified with nitric acid to suppress the growth of micro-organisms during storage. This is to ensure that the elements in the samples do not undergo chemical reactions. Five variables involving physical characteristics of the water quality were tested in the laboratory, namely; temperature, turbidity, colour, ordour and appearance. Seventeen (17) chemical parameters include (pH, Conductivity, TDS, Alkalinity, Calcium Hardness, Magnesium Hardness, Mg^2, Mn, Copper, Iron, Lead, Zinc, T.H, Chloride, Fluoride, Nitrate, and Nitrite) were tested in the laboratory. The results of water quality analysis were interpreted and compared with the Nigerian Standard for Drinking Water Quality. (NSDWQ, NIS: 306, 2008), published by Standard organization of Nigeria (SON, 2007) and that of WHO, 2007.

Table 1: Location of the Sample Points

S/N	Location of sampling points	Sampling points	Longitude(X)	Latitude(Y)	Elevation
1	Millionaires Quarters	KT1 (Borehole)	11^0 30’ 00’’	9^0 28’43’’	1560 fts
2	GGSS Kaltungo	KT2 (Dug well)	11^0 18’21’’	9^0 26’ 41’’	1567 fts
3	Termana	KT3 (Borehole)	$11^0$30’ 52’’	9^0 14’21’’	1698 fts
4	Main Market	KT4 (Dug well)	11^0 30’ 20’’	9^0 15’ 16’’	1660 fts
5	Poshereng	KT5 (Borehole)	11^0 13’ 18’’	9^0 11’54’’	1659 fts
6	Popandi	KT6 (Dug well)	$11^0$31’ 47’’	9^0 39’28’’	1682 fts
7	Kaleh Aya	KT7 (Borehole)	11^0 35’ 44’’	9^0 45’20’’	1732 fts
8	Emir’s Palace	KT8 (Borehole)	11^0 14’35’’	9^0 15’ 39’’	1641 fts

Source: Field Survey, (2017)

Laboratory Analysis of the Physical Parameters

Five variables involving physical characteristics of the water quality were tested in the laboratory, namely; temperature, turbidity, colour, ordour and appearance, as shown in the below table.

Table 2: Values of Physical Parameters of Water samples in the Study Area

Sample	Temperature	Turbidity	Colour	Odour	Appearance
KT1 (BH)	**33.1**	**2.58**	**1.2**	**un-obj**	**clear**
KT2 (DW)	**33.4**	**3.52**	**2.3**	**„**	**„**
KT3 (BH)	**33.0**	**2.56**	**1.1**	**„**	**„**
KT4 (DW)	**33.3**	**3.51**	**2.2**	**„**	**„**
KT5 (BH)	**33.3**	**2.59**	**1.3**	**„**	**„**
KT6 {DW}	**33.5**	**3.53**	**2.4**	**„**	**„**
KT7 (BH)	**33.1**	**2.59**	**1.2**	**„**	**„**
KT8 (DW)	**33.0**	**2.58**	**1.2**	**„**	**„**
NSDWQ	**33**	**5**	**3**	**un-obj**	**clear**

Source: Field Survey, 2017

Table 2 revealed that the appearance of water in the study area is visually clear in all the eight (8) samples and it is suitable for domestic purposes. The water appearance must be unobjectionable for such water to be potable. From the results of the analysis all samples show clear water appearance which is suitable for domestic uses among the Households. Also the result shows that the colours ranges from 2.2mg/l - 2.4mg/l for Dug Well (KT2, KT4, and KT6) and 1.1mg/l - 1.2mg/l for Borehole (KT1, KT3, KT5, KT7, and KT8). All the results are within the permissible limit of NSDWQ NIS: 306, (2008) and WHO (2010) of 3mg/l this shows that water colour is suitable for domestic purposes among households. From the results of laboratory analysis, all samples show un-objectionable odour indicating that the water is odourless therefore fit/suitable for domestic purposes/uses. Odour is an important physical parameter that influenced the portability of water. Three (3) samples of Dug well (KT2, KT4, KT6) from the study area revealed objectionable taste while samples obtained from boreholes (KT1, KT3, KT5, KT7 and KT8) showed that the water is tasteless. This revealed that the water from dug well is not fit for domestic use while borehole water is fit, this is due to the fact that most dug well are not well drill and it can easily be affected with any septic tank that is close to the well.

The result of the laboratory analysis indicated that the temperature values ranges between 33.0^{o}C to 33.5^{o}C. This result shows that the values are within the limits set by NSDWQ NIS; 306, 2008 and WHO which is ambient hence, the water quality is suitable for domestic uses.

Laboratory Analysis of the Physico- Chemical Parameters

Seventeen parameters were analyzed for each of the eight samples at the Gombe State Ministry of Water Resources' Laboratory. They include pH,

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Conductivity, TDS, Alkalinity, Calcium Hardness, Magnesium Hardness,, Mg^2, Mn, Copper, Iron, Lead, Zinc, T.H, Chloride, Fluoride, Nitrate, and Nitrite.

Table 3: Physico-Chemical Parameters of Water Samples in the Study Area.

	PARAMETERS	UNIT	SAMPLE POINTS								NSDWQ NIS:306, 2008 LIMIT	WHO Standard (2010)
			KT1 BH	KT2 DW	KT3 BH	KT4 DW	KT5 BH	KT6 DW	KT7 BH	KT8 BH		
1	pH	-	6.9	6.8	6.9	6.6	6.9	6.9	6.9	6.9	6.5-8.5	6.5-8.5
2	Conductivity	Us/cm	315	292	313	290	314	294	317	316	1000	NA
3	Alkalinity	Mg/l	60	50	58	52	59	48	61	62	200	250
4	Calcium Hardness	Mg/l	66	58	64	56	65	60	67	68	-	-
5	Ca^{2+}	Mg/l	26.4	33.2	25.4	33.1	26.3	33.3	26.5	26.6	-	NA
6	Mg^2	Mg/l	19.4	3.36	19.1	3.38	19.5	3.34	19.6	19.4	40	50
7	Mn (II)	Mg/l	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.1
8	Copper	Mg/l	0.27	0.24	0.27	0.22	0.24	0.26	0.28	0.29	1.00	2.0
9	Iron (Total)	Mg/l	0.03	0.07	0.02	0.06	0.03	0.08	0.04	0.03	0.30	0.3
10	Lead	Mg/l	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.01	0.01
11	Zinc	Mg/l	0.70	0.61	0.67	0.60	0.72	0.62	0.71	0.70	3.00	3.0
12	T.H as ($caco_3$)	Mg/l	134	70	134	72	131	68	136	135	100	500
13	Chloride	Mg/l	12.4	17.7	12.0	17.5	12.6	17.9	12.5	12.5	100	250
14	Fluoride	Mg/l	1.46	1.48	1.44	1.46	1.48	1.50	1.45	1.47	1.0	1.0
15	Nitrate as (NO_3)	Mg/l	11.2	11.8	11.0	11.7	11.4	11.9	11.1	11.3	10	10
16	Nitrite as(NO_2)	Mg/l	2.15	2.4	2.14	2.34	2.16	2.36	2.15	2.15	0.1	3
17	TDS	Mg/l	158	146	156	144	160	146	157	159	500	500

Source: Federal Ministry of Water Resources Gombe Laboratory analysis (2017).

Turbidity of the ground water is influenced by the rain. This is because the run-off water carries soil particles into surface water sources and render them more turbid. The result of the laboratory analysis ranges between2.56mg/l to 2.59mg/l for borehole and ranging between 3.51mg/l to 3.53mg/l for dug wells. This indicated that all the groundwater sources fell within the standard limits of NSDWQ (5.00mg/l) and that of WHO. Therefore, it is suitable for human consumption among households.

pH play an important role in clarification process and disinfection of drinking water. For effective disinfection with chlorine, the pH should be preferably be less than eight, however, lower pH water (< 7) is more likely to be corrosive. Failure to minimize corrosion can result in the contamination of drinking water and adverse effect on its taste and appearance. The pH value of both dug well and borehole in the study area ranges between 6.8mg/l to 6.9mg/l. This means that the values are within the WHO and NSDWQ guideline of 6.5-8.5mg/1 which is suitable for domestic uses. Also the result of laboratory analysis from table 3 indicated that fluoride ranges between 1.44mg/l to 1.48mg/l for the samples obtained from borehole (KT1, KT3, KT5, KT7, and KT8) and between 1.46 to 1.50mg/l for the samples obtained from dug wells (KT2, KT4 and KT6). This shows that all the samples have higher concentration of fluoride above the maximum permissible limit of 1.0mg/l (NSDWQ, 2008 and WHO). This indicates that the water is not good for drinking or domestic uses.

Furthermore, the result revealed that majority of the samples points value range from 11.8mg/l - 11.2mg/l for both Dug well and Borehole. The results indicated that nitrate levels at all samples are above the maximum permissible level of 10mg/l making it unfit for consumption. High Concentration of nitrate (NO_3) in drinking water leads to blue baby syndrome in infants under three (3) months.

The results from table 3 indicated that there are traces of nitrite (NO_2) dictated in all the samples. It ranged between 2.14mg/l to 2.16mg/l for Borehole (KT1, KT3, KT5, KT7, and KT8) and 2.34mg/l to 2.36mg/l for Dug well (KT2, KT4, and KT6). Nitrite (NO_2) concentration in both sample are above the NSDWQ maximum permissible limit of 0.1mg/l as such the water is not good for human consumption and domestic purposes.

The result from the four (4) samples points (Borehole KT1, KT3, KT5, KT7 and KT8) shows a high concentration of total hardness of 131mg/1 to 136mg/l which is above the permissive standard limit of 100mg/1 by NSDWQ and this makes the water not suitable for human consumption and domestic purposes while the samples from three dug wells (KT2, KT4, KT6) shows low concentration of total hardness ranging between 68mg/l to 72mg/l which is within the permissible standard limit, with this result one will said that the water in this sample point is suitable for human use.

Also the result from table 3 indicated that zinc ranges between 0.60-0.71mg/l from the both sample which is below the permissible limit of 3.00mg/l. Low zinc in water serves as Co-factor in enzymes activities in the body (WHO, 2011). This result showed that the water is safe for consumption.

The results from table 3 show that there is low concentration of Magnesium Hardness in ground water in the study area. This is due to the fact that the of values of magnesium Hardness of ground water in the sample points ranges between 10mg/l to 68mg/l for both dug wells and boreholes. The permissible limit is 50mg/l. Magnesium Hardness is useful to the nervous balance of the body but at high concentration predisposes the body to the formation of kidney or bladder stone and irritation of the Urinary passage.

Table 3 revealed that there is dictated copper in all the eight samples but were all below the acceptance limit of 1.00mg/l recommended by NSDWQ. The concentration ranges from 0.22mg/l to 0.29mg/l. This indicates that the water quality is suitable for human consumption or domestic purposes.

Table 3 shows that the value of calcium hardness is between 58mgl – 68mgl which makes the water suitable for consumption. Calcium Hardness is important for human nutrition and a major component in the formation of bone as well as maintaining integrity of the muscles of the body.

The laboratory analysis of iron total from table 3 revealed that shows that all samples values fell below the (NSDWQ and WHO) maximum permissible limit of 0.30mg/l. The result ranges between 0.02mg/l to 0.04mg/l for borehole and between 0.06mg/l to 0.07mg/l for dug well. The result shows that the water is suitable for human consumption and domestic purposes. The Iron total has no any adverse health effect on human but it imparts bitter taste to water when it is in high concentration.

The presence of total dissolved solids in water may affect its taste. The result of total dissolve solid from table 3 showed concentration of TDS that range from 144mg/l - 159mg/l in all the samples. The maximum recommended permissive limit of NSDWQ is 500mg/l. This result showed that the values fell below the NSDWQ standard limit of water quality as such the water is suitable for human consumption and domestic uses.

Alkalinity in the water may be due to hydroxide, carbonates and bicarbonates. The results showed that all the samples indicated a least concentration of alkalinity below the standard limit of 200mg/l as set by NSDWQ which ranges between 52mg/l to 62mg/l for borehole and 48mg/l to 52mg/l for dug wells which is suitable for human consumption and domestic purposes among Household. Alkalinity of water quality is buffer to maintain constant pH, a buffer solution is a solution which acts by controlling acidity and alkalinity in a solution.

Conductivity is a parameter in water affected by the presence of dissolved ions. Organic compounds do not conduct electric current very well and hence their contribution to conductivity is very low. Significant changes in the conductivity could then be an indicator that a discharge or some pollutant has entered in water. From table 3 the results of the laboratory analysis revealed that conductivity ranged between 313µs/cm-317µs/cm for Borehole which is below the acceptance standard limit of 1000µs/cm and it ranged between 290µs/cm-294µs/cm for dug well which is below the acceptance standard limit of 1000µs/cm. The water is good for domestic purposes. High concentration of electrical concentration is having no effect on health status.

The results from table 3 revealed that lead was not detected in all samples. This show that the water quality in the study area is safe for drinking as far as lead is concern. High lead concentration cause toxic to human, an accumulation of this metal causes brain damage, affect the red blood cell chemistry and delay mental and physical development in children (WHO, 2006).

Also the results from the above table revealed that there is zero concentration of chloride in all the sample points (0.0mg/l to 0.0mg/l). This show that is far below the acceptance standard limit of NSDWQ and WHO 0.2mg/l to 0.25mg/l. The water quality from the all samples in the study area is safe and good for human consumption and domestic purposes.

The results from table 3 of magnesium ion shows that all the samples points from both dug wells and boreholes recorded values that range between 3.34mg/l to 19.6mg/l, which are below the acceptance standard level limit of NSDWQ 40mg/l, this means that quality of the water in all samples is safe for human consumption and domestic uses among Households.

From table 3, the results of the laboratory analysis indicated that all the eight samples recorded zero values of Mn (II) which is far below the standard accepted level limit of 0.2mg/l. The quality of water in all the samples points are good and safe for human consumption or domestic purposes.

Conclusion and Recommendations

The assessment of the quality of groundwater in Kaltungo urban area showed that the water is physically potable, but some chemical parameters were found to be above the standard limit for all and some of the sample points as sets by NSDWQ. These include: fluoride, Nitrate, Nitrite and Total Hardness. Lead was not detected in all samples in the study area, this show that the water quality in the study area is safe for drinking as far as lead is concern. Also there is samples least concentration of alkalinity in all the water collected for laboratory analysis in the sample point. Also the turbidity of the water in all the sample collected in the study area fell within the standard limits of NSDWQ. Based on the findings from the study, the following recommendations were made:

I. Government should make proper planning of houses to avoid contamination of ground water from septic tanks and pit latrines.

II. Proper sansitasisation campaigns to the semi urban dwellers on the dangers of ground water contamination.

III. An increased evaluation of domestic water quality should be advocated. Water quality laboratory should be established in the local government area headquarter to make examination of essential parameters of the water a routine exercise. This monitoring will help in having a resource inventory of water quality data.

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