Analysis of Water Quality for Domestic use in Lafia Town, Nasarawa State, Nigeria

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Abstract

Lafia is a town in the middle belt of Nigeria, located within Latitude 8° 25W and 8° 35W and Longitudes 8°28?E and 8°34?E. Lafia covers an area of about 258km2 and has a population of about 330,712 inhabitants. This population caused environmental pollution as a result pressures exerts on the available water sources. It is against this background that this study is carried out to analyze the water quality for domestic use in Lafia town with the aim of examining the water quality status of the area compared to the World Health Organization permissible guidelines for portable water. The method adopted involves the use of reconnaissance survey. Data were collected from both primary and secondary sources and subjected to descriptive and laboratory analysis. The result shows that stream water source is the most polluted in Lafia with colour concentration of 10.5pt/co, turbidity of 8.5NTU and temperature of 26.4°c. The chemical properties for all the water sources sampled were slightly above the World Health Organization permissible guidelines. The result also shows that none of the water sources met the permissible guidelines in terms of chemical and microbiological properties. It was recommended amongst others that Nasarawa state water board should be provided with modern facilities for efficient address of domestic water use in Lafia. Clear water for everyone in Lafia for sustainable development.

Index terms— water, quality, domestic, uses, chemical.

1 Introduction

ater is a universal solvent that is chemically made up of two molecules of hydrogen atoms (H 2) and one molecule of oxygen atom (0) combined to form the compound, H 2 0 (water). Water is a major constituent of every living matter and it is very essential for life sustenance on earth. Water supports plant and animal lives, and is equally a very important raw material for industries. Without water, life and industry cannot function. All Living organisms are composed of cells that contain at least 60% of water **??**Enger and Smith, 2002). About two-third of human body is made up of water (Ayoade and Akintola, 1999). According to the National Health and Medical Research Council (NHMRC)(2006) the human brain contain 95% water, heart 73%, blood 83%, bone 22%, liver 96%, lungs 86% and muscles 75%. In the mechanics of the body water is a very valuable substance that regulates body temperature and also helps to alleviate constipation by circulating food through intestinal tracts and eliminating waste from the body. All the cells and organs that make up entire anatomy and physiology of human body depend on water for their proper functioning.

Water has no substitute; however, due to its abundance mankind uses it extensively for various purposes. The different uses of water affect both quality and quantity of the available water supply. Proper management practices therefore plays an important role in local, national and international polices on water supply quality **??**Chaplin, 2008). According to Eziashi (1997), much of the earth's water is in the ocean (97%) or rock as ice (18%). The largest volumes of fresh water are stored as underground water accounting for about (0.6%). Only a tiny fraction (0.01%) is present as fresh water in lakes, streams and rivers. It is this proportion of water on earth that is important for many of the terrestrial ecosystems, including man for several uses such as domestic, commercial and industrial use. Some countries of the world have abundant supply of water from deep wells and underground springs. Others have to make extensive use of rivers, lakes and other sources. The supply of drinking water derives from these sources must not constitutes danger to both health of consumers either through infectious organisms (bacteria, virus protozoa) or through the presence of toxic waste inorganic or radioactive materials ??Maud, 1990).

The quality of water is very important as its quantity. Many human activities and their bye-products have the potential to pollute water, as well as large and small industrial enterprises, water industry, urban infrastructure, agriculture, transport, discharges from abandoned mines, deliberate or accidental pollution incidence, all affects water quality. Pollutants from the aforementioned may enter surface or underground water directly or indirectly, or may affects atmospheric water quality such pollution may arise as point sources such as discharges through pipes, or non-point sources and hence more dispersed and diffused.

Water must be substantially free from dissolved salts, plants and animal waste, and bacterial contamination to be suitable for human consumption. The ocean which covers approximately 70% of the earth's surface contains over 97% of water. However, saltwater is not suitable for human consumption and some industrial process. Freshwater is devoid of salt found in ocean water. Unpolluted freshwater suitable for drinking is known as potable water. Early human migration routes and settlement sites were influenced by availability of drinking water. During the ancient time clean freshwater supplies were considered inexhaustible. But in recent times, despite advancement in drilling, irrigation and purification, the location, quantity, quality and control of potable water becomes an important factor for consideration. It is only recently that man began to understand that all the useable water supply could probably be exhausted because of the rapid world population increase compared to available water supply. This resulted to increased demand for water supply for industrial, agricultural and personal needs. The present shortage of water supply the world over can be attributed to human negligence in water management policies, population increased and climate change. Water pollution has negatively affected water supplies throughout the world for example Rivers in Poland, Latin America and Asia are severely polluted as a result of high population density and industrial activities. Aquifers used as sources of drinking water in many parts of the world are becoming contaminated with pesticides, herbicides and hazardous organic chemicals.

In China for instance, 41 large cities get their drinking water from polluted water sources. During the passage of water through hydrological cycle, water is usually polluted by sediments, washed from the land into surface water by erosion and farming activities, mining, grazing construction works, excess nutrients from soil erosion, human and animal waste and effluent from sewage treatment plants pathogens from sewage and livestock waste, and hazardous chemicals produced by industrialized nations. All these categories of waste are increasing because of rapid population growth and industrialization. The geology of Lafia town is made up of Basement Complex rocks. The geological setting of the area offers limited numbers of good aquifers as they are found far below underground. As a result, availability and reliability of surface and ground water in terms of both quality and quantity is uncertain, since yields from such aquifers are not enough to meet the water demand of the inhabitants, ??Carter, 1953). The topography of Lafia town is made up of gentle undulating terrain generally below 400 metres with series of slopes to the wider Benue plain. This is because the town is located between the Benue valley and the Jos plateau. The town is drained by several streams such as Amba stream, Akurba stream, etc. The soils type is tropical ferruginous soil and is categorized as reddish brown which suggest the presence of microbial activities. It supports agricultural production. The vegetation type is Southern Guinea Savanna; it is characterized by discontinuous canopy, shrubs with luxuriant and dense grasses with tress attaining an average height of about 15 to 30 metres. The common tress found in the area includes locust bean, Shea butter, palm trees, etc. the Most important crops grown in the area includes maize, sorghum, cassava, cowpea, yarn etc.

2 II.

3 Study Area

4 a) Materials and Methods

This study employs volumetric techniques in analyzing physical and chemical parameters of the sampled water. In addition, microbiological analytical techniques were employed for biological parameters namely fecal coli form count and total coli form count. The two techniques are chosen because of the availability of reagents required for the analysis which also reduced the cost of the analysis.

Using laboratory analysis, the physical, chemical and microbiological properties of the water collected from the different five sources were analysed. The analysis involves the measurement of the presences of group of contaminant and their properties. Also analyze was the physiochemical parameters such as colour, turbidity, H, temperature, hardness and presences of sulphate, lead, chlorides, iron, copper, and total dissolved solids (TDS). Analyses were equally done with regards to microbiological characteristics which measures total coli form count (TC) and coli form organization unit. The instruments used in carrying out the analysis include: The results generated from the laboratory analysis were presented in tables, figure and graphs.

5 III.

6 Results and Discussion

The data gathered from various sources for this study were presented in tabular forms. Graphs and figures and analyzed as follows 3 to further illustrate the concentration of the physical parameters with reference to WHO permissible guidelines. Below is the graphical representation of concentration of physical parameter in sampled water shown in Figure 3. Figure 3 shows that colour concentration was highest in stream water 10.5pt/Co and lowest in rain water 2.0pt/Co the range was 8.5 well water sample 6.4pt/Co, and borehole water 6.0pt/co was above the guidelines value of 5pt/co for potable water include tap water, 4.0pt/Co and rain water 2.0 pt/Co which recorded colour concentration below the guideline value of WHO. High colour concentration in stream water can be attributed to dissolved coloured materials in stream due to surface exposure. The range is therefore wide by this result. In terms of turbidity. stream water recorded 8.5NTU highest above WHO guideline and rain water 1.4 NTU lowest below the guidelines and the range was 7.INTU a wide range). Hence only stream water recorded turbidity concentration above the WHO guideline for potable water. Well water with 4.5 NW, borehole 3.0 NW and tap 2.9 NUT turbidity concentration fall below/WHO guideline value for potable water. The high turbidity in stream was due to suspended material in water brought about by human activities such as swimming; eroded materials from the land through run-off and other natural processesin the case of temperature, the result shows that stream water has the highest temperature 26.4°C above the guideline value of WHO for potable water other samples are, well water23.4°C, borehole water 22.5°C, tap water 20.5°C rain water 15.4°C below the permissible guidelines of WHO for portable water. The range in temperature was 11°C. High temperature in stream water can be attributed to the heat of the day.

Health implication of the findings: Colour if holmic substances are present in water such as Arsenic-rich water over a long period of time, it results in skin problems also if the colour is associated with red phosphorus it renders the water fairly unreliable for other organisms.

7 B

Turbidity: Health implication of turbidity is simply aesthetic for human and on other organisms; it renders the inability of fish gills to absorb dissolved oxygen.

Temperature: Implication of temperature on human health is not direct; however, temperature alters the rate of microbiological activities in water.

8 b) Chemical Properties of Sampled Water

i. pH, Calcium, Nitrates, Chlorides, and sulphates) of sampled water in Lafia.

The above properties ranges are presented in Figure 4 below as drawn from Table 2. 4 show that, pH of the five different sources of water falls within the guideline value of WHO. However, pH concentration in well water was highest with 7, 5 and lowest in tap water 6.3. This implies that water in wells was slightly alkaline and borehole, rain, streams and Tap water were, weekly acidic in Lafia. Calcium concentration is highest in rain water 109mg/I. However, the five water samples fall above WHO guidelines. Nitrate concentration was highest in stream water 40.5mg/i and lowest in borehole water 22mg/l. Below WHO guidelines rain, tap, and well water slightly fall above the standard in the cases of chloride, borehole water has the highest concentration of 26.1mg/I above WHO permissible guidelines for potable water and the least was rain Water 20.5 mg/I. however, borehole, well and tap water falls below the guideline value.

9 ii. TDS and Hardness of sampled water in Lafia.

The data gathered concerning chemical properties (TDS and Hardness) from five water sources sampled are presented and analyzed in figure **??** below, been drawn from Table 3. **??** to show the distinct reference to the WHO permissible guide lines, shown below Figure **??** shows that stream water has the highest concentration of TDS of 406mg/l and lowest in rain water 42mg/I. However, the five water sources have TDS concentration below WHO guidelines. With regards to hardness, the aforementioned water source has the hardness concentration above WHO acceptable guidelines. Well water has the highest hardness 14mg/l and the lowest rainwater 105mg/l among the different water sources.

10 iii. (Lead, Copper and Iron) of Water samples in Lafia.

The data obtained with regards to chemical properties (lead, copper, and iron) from five water sources were analyzed and presented in Table 4 as represented in Figure 6 below. 6 indicating concentration levels in each of the water sources as shown in Figure 6 below. Figure 6 shows that, lead concentration was highest in tap water 0.08mg/I above WHO guidelines. The other four sources of water (borehole 0.4 well, 0.03mg/I rain, 0.01mg/I and stream 0.02mg/l) fall below WHO permissible guidelines for potable water. Rain water shows the least lead concentration 0.01mg/I. Copper shows high concentration of 0.4mg/i in tap water and lowest in rain water 0.01mg/i. However, the five water sources (borehole, stream and tap lies above the WHO permissible guidelines for potable water while well and rain water sample fall below the WHO guidelines. In the case of iron, stream water has the highest Iron concentration of 0.08mg/i follow by well water 0.7mg/I, tap water 0.6mg/i while borehole 0.4mg/i and the rain 0.3mg/I lies below WHO guidelines. The health implication of high concentration of led in water inhibit oxygen and mental development in babies and children, hence, children arc mostly prone to health effect of lead. Iron and copper: excessive dose of iron and copper leads to severe mucosal irritation, gastrointestinal irritation disorder of the respiratory mechanism, liver and kidney disorder. Based on this finding and health implication association with these trace elements, proper water treatment and mitigation measure should be adopted against those trace elements event thought the different is not significant.

11 c) Microbiological Parameter of Sampled Water in Lafia

data gathered from five different water sources concerning microbiological parameters ofwater are presented and analyzed in Table 5 and the graph is shown in Figure **??** below. In figure 6, it is evident that none of the five water sources meet the maximum allowable concentration faecal coli form of count of 0 count/100mI set by WHO and NAFDAC, the highest concentration of faecal coli form was observed in stream water 0.05 count/100ml, other samples have the following concentrations well water 0.04MPN/100ml, borehole 0.03 MPN/100ml, tap 0.2 MPN/100ml and the lowest rain 0.01 MPN/100ml.In the case of total coli form, stream water has the highest T. coli form count of 0.7 Count MPN/100ml followed by borehole 0.5MPN/100ml, well 0.4MPN/100ml, Tap 0.2MPN/100ml and rain 0.1MPN/100ml. Hence none of the five water sources meet the WHO permissible guidelines for potable water.

The health implication of the finding is that presence of micro-organisms in stream water can lead to number of disease which can be transmitted by pathogenic microorganisms. This could lead to outbreak of several water-related diseases such as typhoid fever, cholera, acute diarrhoea, bacillary dysentery etc. This renders stream water unsuitable for human consumption unless proper water treatment strategies is adopted otherwise stream water is not suitable for human consumption in Lafia.

12 IV.

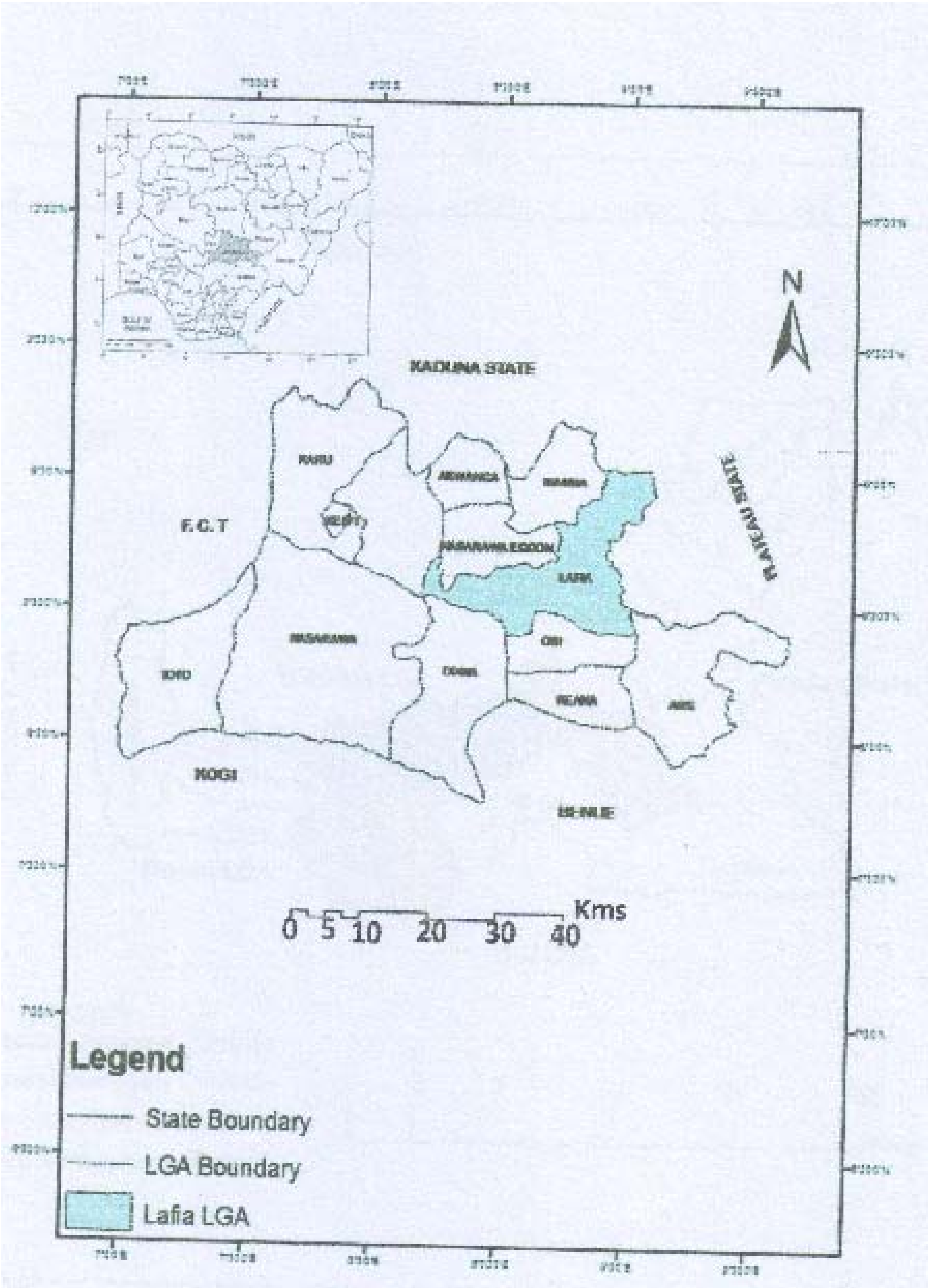
13 Conclusion

Water quality in simple terms pertains to the physical, chemical and microbiological characteristics of water relative to its specific use. The study found that stream water source was the most polluted source of water as a result of exposure to different materials making it prone to high concentration of physical, chemical and microbiological properties. By way of qualitative description, stream water has the highest concentration of physical and microbiological properties of water. However, by statistical analysis, the five sources of water in Lafia have no statistical significance difference from the WHO permissible guidelines for potable water. It is therefore the collective responsibility of both private and public sectors for ensuring effective management of water sources for greater sustainability. Furthermore, the research has provided explanatory information statistically and descriptively on the quality status (Physical, Chemical and Microbiological) parameters of five common sources of water for domestic uses in Lafia. [1] [2] [3]

[1] Analysis of Water Quality for Domestic use in Lafia Town, Nasarawa State, Nigeria

[2] BAnalysis of Water Quality for Domestic use in Lafia Town, Nasarawa State, Nigeria

[3]



12

Figure 1: Fig. 1 :Fig. 2 :

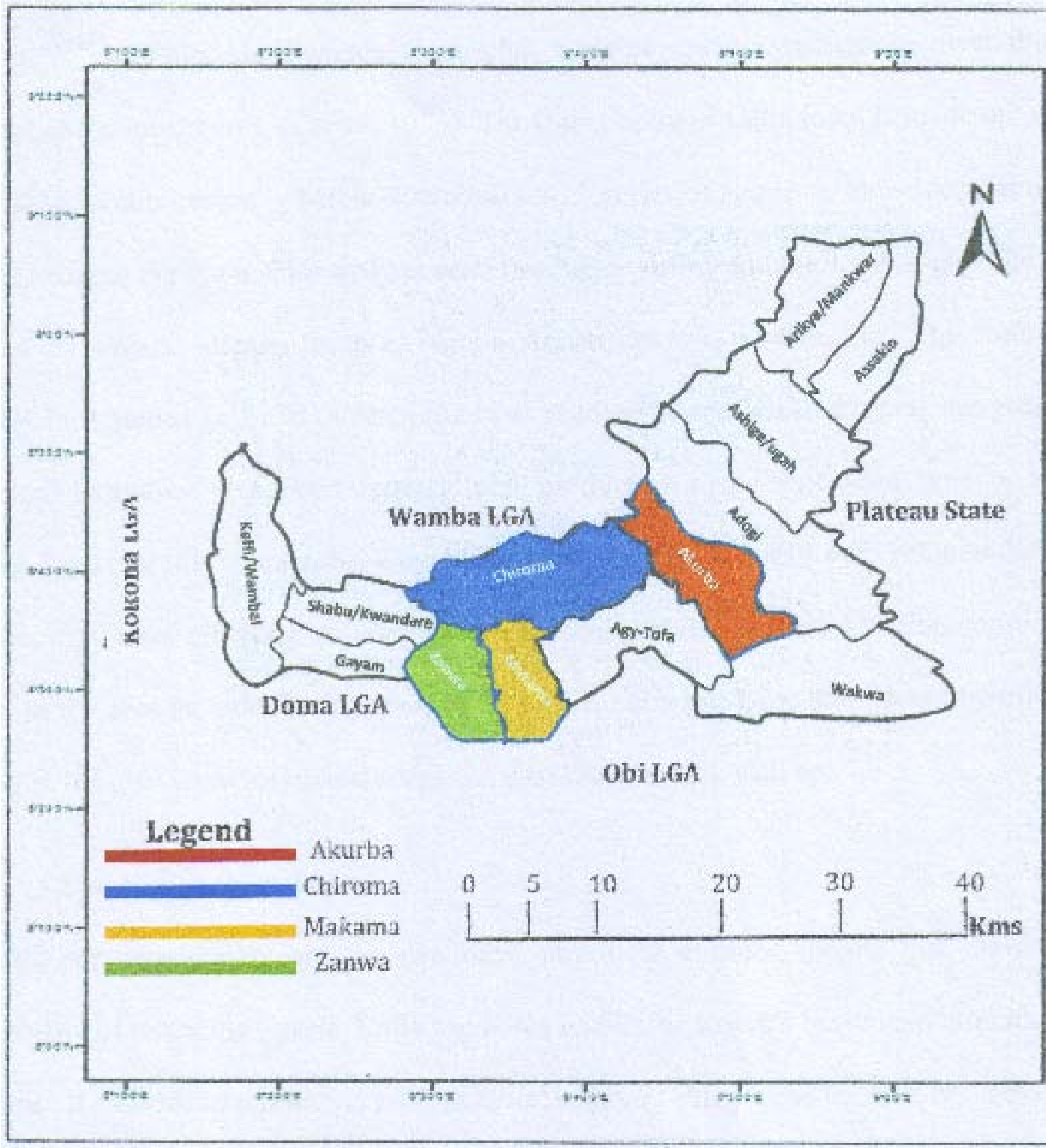


Figure 2: ?

1

Figure 3: Table 1

1

S/No	Water parameter	WHO Std	Sample water sources				
			Borehole well		Rain	Stream	Tap
1	Colour (pt/co)	5(pt/co)	6.0	6.4	2.0	10.5	4.0
2	Turbidity (NTU)	5NTU	3.0	4.5	1.4	8.5	2.9
3	Temperature (°C)	25°C	22.5	23.4	15.4	26.4	20.5
						Source: Field survey, 2019	

Figure 4: Table 1 :

2

S/No	Chemical parameter	WHO Std	Different Water sources				
			Borehole well		Rain	Stream	Tap
1	pH	7	6.2	7.5	6.9	6.8	6.3
2	Calcium (mg/1)	100(mg/1)	101	105	109	106	102
3	Nitrate (mg/1)	25(mg/1)	22	28	30	40.5	27
4	Chlorides (mg/1)	25(mg/1)	26.1	23.2	22	20.0	21.5
5	Sulphate (mg/1)	25(mg/1)	22.5	21.0	20.5	28.3	23
					Source: Field survey, 2019		

Figure 5: Table 2 :

Figure 6:

3

S/No	Chemical properties	WHO Std	Difference Water Sources				
			Borehole	Well	Rain	Stream	Tap
2	TDS(mh/1)	500	280	302	42	406	273
2	Hardness (mg/1)	100	134	140	105	136	107
						Source: Field survey, 2019.	

Figure 7: Table 3 :

3

Figure 8: Table 3

4

S/No	Chemical properties	WHO Std	Different Water Sources				
			Borehole	well	Rain	Stream	Tap
1	Lead (mg/1)	0.05	0.04	0.03	0.01	0.02	0.08
2	Copper (mg/1)	1.0	0.2	0.1	0.01	0.3	0.4
3	Iron (mg/1))	0.5	0.4	0.7	0.3	0.8	0.6
						Source: Field survey, 2019	

Figure 9: Table 4 :

4

Figure 10: Table 4

5

S/No	Microbiological parameter	WHO Std			Water sources		
			Borehole	Well	Rain	Stream	Tap
1	F.coli form (MPN/100ml)	0	0.03	0.04	0.01	0.05	0.02
2	T.coli form (MPN/100ml)	0.3	0.5	0.4	0.1	0.7	0.2
					Source: Field survey, 2019		

Figure 11: Table 5 :

5

shows the microbiological characteristics of sample water sources with reference to WHO permissible guide lines. The table values are further presented in bar graph to clearly illustrate the concentration level of the microbiological properties as shown in Figure 6 below.

Figure 12: Table 5

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