International Journal of Science and Research Archive
eISSN: 2582-8185
Cross Ref DOI: 10.30574/ijsra
Journal homepage: https://ijsra.net/

(RESEARCH ARTICLE)

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Analysis of the physical chemistry of domestic water supply sources in choba, Port Harcourt, rivers state

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International Journal of Science and Research Archive, 2024, 11(01), 1658–1672

Publication history: Received on 14 November 2023; revised on 04 February 2024; accepted on 07 February 2024

Article DOI: https://doi.org/10.30574/ijsra.2024.11.1.1084

Abstract

Water are used for several important purposes but the most essential use considered on the basis of social and economic significance as it relates to the health of the population is human consumption and sanitation. Man needs constant and accessible supply of water to provide necessary prerequisite for important physiological and biochemical processes. On account of the general contention that water is more basic than all other critical stuff to life and in its pure state is commended key to health. This study aimed at to examine the physical characteristics of the water supply sources in Choba as a crucial factor for development and upon which the quality of life depends. Thus, water samples were collected from borehole and well water sources being the only available major sources of water supply in Rumuokocha, Rumuchakara, Igbogo, Owhipa, Ndudor and Rumualoghu communities that make Choba and the parameters investigated include pH, Temperature, Dissolved oxygen (DO), Conductivity, Total Dissolved Solid (TDS) and Salinity. The results of the analyses for temperature was t= 0.751 and t= 0.547 both at $p<0.05$ for borehole and well water sources implying no significant difference from the allowable limit by WHO whereas for DO, pH, salinity, TDS and conductivity, t= -51.966; -24.027; -24.796, -19.546 ;2.321and t= -51.966; -24.027; -16.966, -20.024; 2.272 for borehole and well water sources respectively indicating a statistically significant difference between the parameters investigated and the allowable limits. Similarly, the ANOVA result shows F= 400.384; 23.262; 19.997; 8502.215at $p<0.05$ for parameters like temperature, salinity, TDS and conductivity of the available water sources do not vary significantly in the area. Therefore, constant monitoring and assessment of physical water quality parameters, water treatment and assessment of bacteriological content and other relevant water parameters to holistically ascertain it suitability for adequate human use were recommended.

Keywords: Physical Chemistry; Suitability; Borehole; Well water; Assessment

1. Introduction

Water is a precious resource which is of fundamental importance and according to Bibi, Khan and Nazir (2016); it is commonly used in various aspects of life particularly drinking and other developmental purposes. Domestic water supplies are one of the essential requirements for human life. Without water, life cannot be sustained beyond a few days and the lack of access to adequate water supplies leads to the spread of disease. Children bear the greatest health burden associated with poor water quality and sanitation. Diarrheal diseases attributed to poor water supply, sanitation and hygiene account for 1.73 million deaths each year and contribute over 54 million disability adjusted life years, a total equivalent to 3.7% of the global burden of disease (WHO, 2010). Water is one of the essential elements naturally abundant and readily available. It is a vital natural resource and essential constituent of plants, animal's life, vegetable matter of earth's crust. It covers approximately three quarter of the earth's surface. Over 97% of the total supply is contained in the oceans and other saline bodies. Of the remaining three percent (3%), over two percent (2%) is tied up

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in the ice caps and glaciers alongside with atmospheric and soil moisture. Thus, humans for their general livelihood and the support of their varied technical and agricultural activities must depend upon the remaining 0.62% found in the fresh water lakes, rivers and groundwater supplies (Eja, 2002).The importance of adequate water quantity for human health cannot be overemphasized as an extensive debate about the relative importance of water quantity, water quality, sanitation and hygiene in protecting and improving health is asserted in studies such as (United Nation Children Emergency Fund, UNICEF(2012); Wasike, 2010; Batmanghelid, 2009). However, the problem of drinking water ranges from exposure to toxic inorganic substances, heavy metals, microbial pollutants, increasing nutrients concentration and other traced elements of chemicals that are found in water resources. It is obvious that potable water is essential for life but human activities interfere in many ways with natural water cycle and affect the society-water relationship due to constantly increasing human population and its expectations in respect to the standard of living which causes increase demands on exploitation of existing water sources. Water demand already exceeds supply in many part of the world, and as world population continues to rise at an unprecedented rate, many more areas are expected to experience this imbalance in the near future (Udoh & Etim, 2007; Chowdhury, 2013).

Although safe drinking water does not provide calories or organic nutrients, water is essential to humans and other life forms. Meanwhile, access to safe drinking water has definitely improved over the last decades in almost every part of the world; however, approximately one billion people still lack access to safe drinking water and this is a major problem in developing countries particularly within Africa where most people rely largely on local ground water source such as borehole water for consumption purposes and other domestic needs. Water from these sources can be contaminated resulting in fatal consequences when unwanted materials that enter into water, changes the quality of the water (Briggs, 2003). Water pollution is a global problem and constitutes serious threat to survival and is considered to have taken place when a body of water becomes contaminated by physical debris such as plastic, water bottles or rubber tires or chemicals such as runoffs from factories, cars, sewage treatment facilities, cars etc. Also, industrial, agricultural, domestic and commercial activities or processes release substances (wastes) into the environment, which ultimately find their way into natural waters, thus rendering them unsuitable for the intended purpose (Ahmad, Yusafzai, Bari & Ullah , 2014; Onojake, Sikoki, Omokheyeke&Akpiri, 2017).Apart from the World Health Organization (WHO) report that unsafe drinking water contribute significantly to many health issues among which is diarrhea, which has cause millions of deaths annually particularly in developing countries. It can be specifically stated that 52% of Nigerian homes don't have access to safe drinking water which also includes the absence of good water from Government utilities (Adetunji&Odetokun, 2011; Ezekwe*et al*, 2013). The importance of adequate water quantity for human health has been recognized for many years and there has been an extensive debate about the relative importance of water quantity, water quality, sanitation and hygiene in protecting and improving health (Esrey*et al*., 1985; lawford*et al*., 2003; Nwidu *et al*., 2008). Access to safe drinking water is a major problem in developing countries irrespective of the fact that access to safe drinking water is key to sustainable development and indispensable to food production, quality health and poverty reduction and above all central to life and a satisfactory safe supply must be made available to consumers (Ackah , Gyamfi, Acquah & Nyarko, 2012). Accordingly potable water is the water that has sufficient quality to serve as drinking water. Thus good drinking water is not a luxury but one of the most essential requirements of life itself needed for good health and the socio-economic development of man (Ajewole, 2005).Therefore, water intended for human consumption must not contain pathogens or harmful chemicals; because water contaminated with microorganisms is the cause of epidemics and lack of access to safe drinking water from improved sources and adequate sanitation services is a major challenge in most developing countries including Nigeria ((Balbus and Embrey, 2002; WHO, 2006).Thus, this paper aimed at examining the sources of domestic water supply in Choba, Rivers State with a view of analyzing and comparing the physico-chemical characteristics of the different sources of domestic water supply within the area with specified water quality standards based on the influx of people into the area, students and business minded individuals alike as a result of the Presence of University of Port Harcourt.

2. Material and methods

The study area is located between latitudes $04^{0}51'30"$N and $04^{0}53'0"$N, and longitudes $006^{0}54'0"$E and $006^{0}55'30"$ E comprising ofRumuchakara, Ndudor, Rumuokocha, Igbogo, Rumualoghu and Owhipa communities that houses the University of Port-Harcourt. Choba is a semi-urban Centre where the majority of the populace depends on private boreholes and few depends on well water as the main source of water supply. Water samples were purposively collected from each of the identified sources of domestic water supplies across the respective communities based on accessibility. The water samples were put in a properly rinsed water bottle and adequately labelled and in-situ readings of parameters such as pH, Temperature, Dissolved oxygen (DO), Conductivity, Total Dissolved Solid (TDS) and Salinity of water samples from the various boreholes and well siteswas immediately recorded using the Extech Water Quality Reader. The depth of well water within the study area was measured using a localized made depth Metre and the various elevation points (Rumuokocha-21m, Rumuchakara -14 m, Igbogo- 13 m, Owhipa-13 m, Ndudor-16 m and Rumualoghu-17 m) were accurately recorded and used to produce a contour map of the area. The water Parameters results obtained

from the field together with other geologic data was displayed in a GIS environment using Arc-GIS10.0 software to produce an IDW (Inverse Distance Weighted) interpolation map as displayed in figure 2-7.

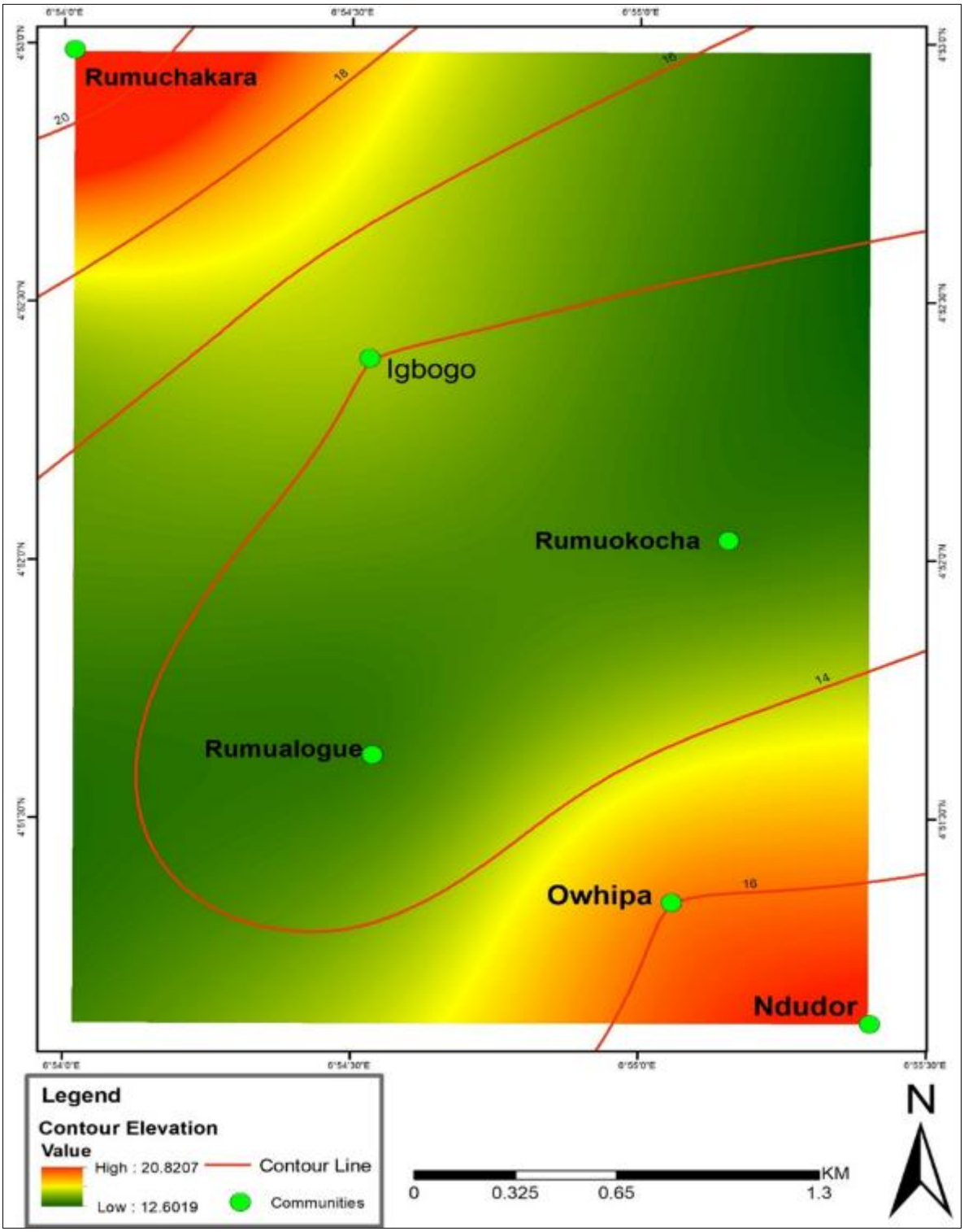

Figure 1 Elevation contour of the Study Area

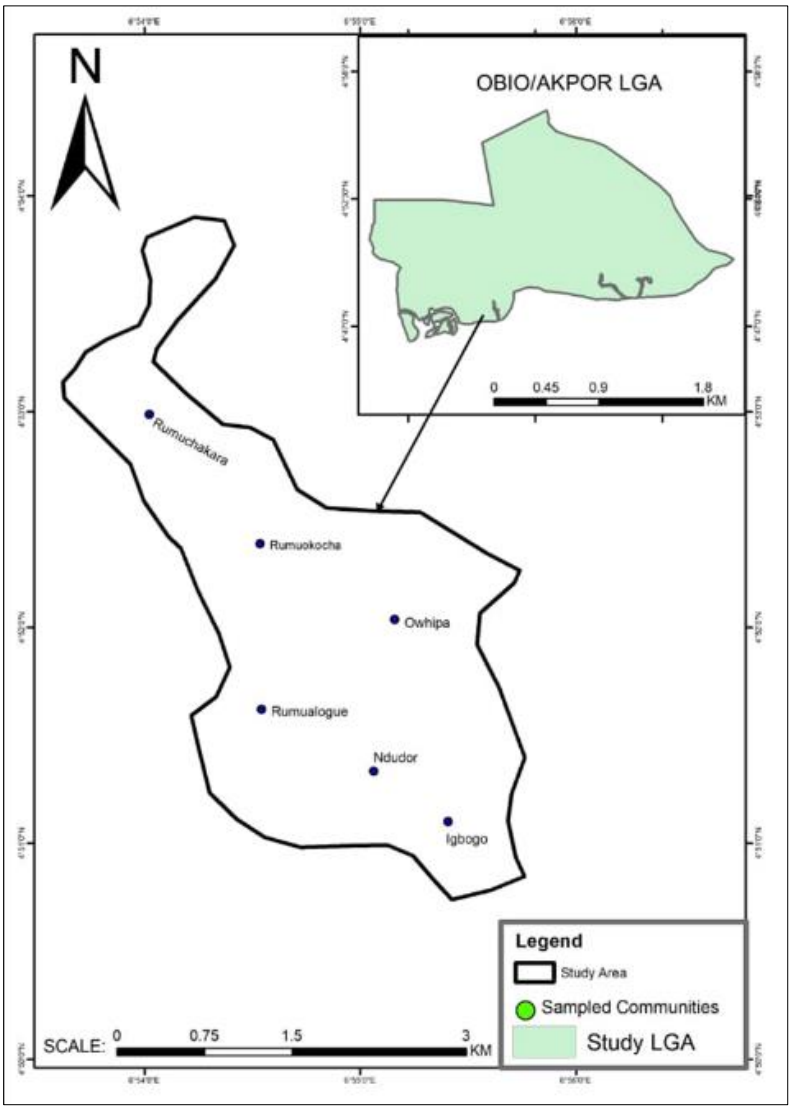

Figure 2 Communities in the Study Area

3. Results and discussion

The physico-Chemical parameters of the borehole water investigated are shown in Table 1and it is observed that Temperature is highly indicated in borehole water from Owhipa with value of 77.6 °C which is higher than all other sampled sites including the WHO standard. Again, water samples from the other communities (Rumuokocha, Rumuchakara, Igbogo and Rumualoghu) having values less than 30 °C which is the permissible limit for drinking water according to WHO means that water from these communities are safe for consumption without any human health implications. The temperature ranged between 27.4°C as lowest at Ndudor and 77.6 °C as the highest at Rumualoghu. In all the communities Dissolved Oxygen (DO) was abysmally low compared to the specified limits as the readings fluctuates between 1.52 mg/l and 2.57 mg/l. While borehole water from Rumuokocha recorded the highest Dissolved Oxygen of 2.57 mg/l in relation to other communities, the least was observed in water sample collected from Rumualoghu and the reading was 1.52 mg/l. The good thing is that DO in all the communities are within the permissible limit set up by WHO for drinking water. Furthermore, pH recorded 5.67 mg/l at Igbogo which is highest in the entire communities in the area. Technically all the health challenges that could possibly arise from consuming water with high pH might not be experienced in the area since all the readings were all within the allowable limits set by the WHO. However, the lowest pH value of 4.72 mg/l was indicated by water sample from Owhipa. Also, Salinity which expresses the salt content of water from the studied water sources in the area is only considerably higher than all other communities in the area with a value of 307 ppm at Rumualoghu while all the readings shown are far less than the specified standard as shown in Table 1with the least recorded as 77.0ppm against the borehole water from Rumuokocha. On the other hand, TDS readings ranges between 118.7mg/l as lowest at Rumuokocha and 448 mg/l as

highest at Rumualoghu against 1200 mg/l specified WHO standard. This implies clearly that water from all the boreholes in the communities under investigation are all within the permissible limit for drinking water. In a related vein, Conductivity which is another important physical parameter was considered and in line with the specified value of 0.05 -200 µS/cm, it was observed that conductivity readings fall between 164.7 µS/cm as the least and 695 µS/cm as the highest. In more specific terms, Rumuokocha recorded the least reading of 164.7µS/cm while 354 µS/cm was recorded in the sample collected from Rumuchakara, Igbogo borehole water was reported to contain 220µS/cm whereas Owhipa, Ndudor and Rumualoghu recorded 434 µS/cm, 396 µS/cm and 695 µS/cm respectively as against the permissible limit set by WHO. A cursory study of table 1 shows that borehole water from all the Communities in the area except Rumuokocha exceeded the conductivity specified limit to guarantee good water quality. Although, conductivity is described not to have any significant impact on human health, high conductivity may result in lowering the aesthetics of the water by producing mineral taste to the water. Water with high conductivity may also cause corrosion of metal surface of equipment such as boiler and home appliances like water heater system and faucets. This simply means that people within Rumuchakara, Igbogo, Owhipa, Ndudor and Rumualoghu may experience serious corrosion of their metal home appliances such as water heater and boiler as the conductivity level of the water is significantly high.

Table 1 Physico-Chemical Characteristics of Borehole Water

Parameters	**Rumuokocha**	**Rumuchakara**	**Igbogo**	**Owhipa**	**Ndudor**	**Rumualoghu**	**WHO Standard**
Temperature	28.1	27.9	29.0	77.6	27.4	27.3	30 °C
Dissolved Oxygen	2.57	1.87	1.77	1.72	1.9	1.52	6.5-9.5 mg/l
pH	5.26	4.86	5.67	4.72	5.11	4.86	6.5-8.5 mg/l
Salinity	77.0ppm	165ppm	102ppm	203ppm	186ppm	307ppm	5OO-1000 ppm
TDS	118.7 mg/l	247 mg/l	150 mg/l	305 mg/l	275 mg/l	448 mg/l	1200mg/l
Conductivity	164.7 µS/cm	354 µS/cm	220 µS/cm	434 µS/cm	396 µS/cm	695 µS/cm	00.5-200µS/cm

Table 2 Physico-Chemical Characteristics of Well Water

Parameters	**Rumuokocha**	**Rumuchakara**	**Igbogo**	**Owhipa**	**Ndudor**	**Rumualoghu**	**WHO Standard**
Temperature	25.1	23.9	29.0	77.6	28.4	24.3	30 °C
Dissolved Oxygen	2.57	1.87	1.77	1.72	1.9	1.52	6.5-9.5 mg/l
pH	5.26	4.86	5.67	4.72	5.11	4.86	6.5-8.5 mg/l
Salinity	76.0ppm	165ppm	106ppm	209ppm	186ppm	407ppm	5OO-1000 ppm
TDS	128.7 mg/l	247 mg/l	150 mg/l	305 mg/l	252 mg/l	448 mg/l	1200mg/l
Conductivity	154.7 µS/cm	354 µS/cm	220 µS/cm	434 µS/cm	396 µS/cm	695 µS/cm	0.05-200 µS/cm

The presentation shown in Table 2 is the physico-Chemical properties of well water tested which includes; Temperature, Dissolved oxygen, pH, Salinity, TDS and Conductivity. It is observed as shown that the Temperature of the well water in the area ranged between is 23.9 °C and 77.6 °C whereas the smallest reading is 23.9 °C and obtained from water sample gotten from Rumuchakara while Owhipa had the highest of 77.6 °C which is considerably higher than the 30 °C permissible limit for drinking water. Therefore, making the water unsafe for consumption as the water is capable

of yielding other health consequences. Dissolved Oxygen (DO) in well water obtained from Rumuokocha with a value of 2.57 mg/l was the highest while that from Rumualoghu has the lowest value of 1.52 mg/l against WHO standard of 6.5-9.5 mg/l and this expressly show that DO readings of well water in all the Communities is within the permissible limit. On the other hand, pH values are all within the permissible limit with a value ranging between 4.72- 5.67 mg/l compared to WHO standard of 6.5-8.5 mg/l. Notwithstanding, the lowest value of 4.72 mg/l is confirmed from water collected from Owhipa while the highest which is 5.67 is recorded at Igbogo. Although, salinity recorded 402mg/l in well water from Rumualoghu which was significantly high compared to the readings recorded from other Communities. It was further revealed that salinity of well water in all the Communities were within the permissible limit for drinking water set by WHO as it doesn't exceed 1000 mg/l benchmarked as the tolerable limit for safe domestic water consumption. The TDS was found to record 128.4 mg/l as the lowest in Rumuoocha on one hand and on the other hand recorded 448mg/l as the highest at Rumualoghu. Even though, 448 mg/l recorded in well water from Rumualoghu was the highest amongst readings obtained from other Communities, it was undoubtedly revealed that they all spanned within the acceptable limit for drinking water since the values were still lower than 1200 mg/l in all the Communities. The well water samples from the different Communities indicated that the least value for conductivity was 154.7 µS/cm recorded at Rumuokocha while the highest value of 695 µS/cm was recorded at Rumualoghu. It was discovered that conductivity was considerably higher in well water from Rumuchakara, Igbogo, Owhipa, Ndudor and Rumualoghuwith values higher than WHO standard of (0.05 µS/cm-200 µS/cm) except in Rumuokocha where the value of 164.7 µS/cm falls within the permissible limit.

Table 3 Physico-Chemical Characteristics of Water Supply Sources in the Area

Parameters	**Sources of Water**	**Rumuokocha**	**Rumuchakara**	**Igbogo**	**Owhipa**	**Ndudor**	**Rumualoghu**
Temperature	Borehole	28.1	27.9	29.0	77.6	27.4	24.3
	Well	25.1	23.9	29.0	77.6	28.4	24.3
Dissolved Oxygen	Borehole	2.57	1.87	1.77	1.72	1.9	1.52
	Well	2.57	1.87	1.77	1.72	1.9	1.52
pH	Borehole	5.26	4.86	5.67	4.72	5.11	4.86
	Well	5.26	4.86	5.67	4.72	5.11	4.86
Salinity(ppm)	Borehole	77.0	165	102	203	186	307
	Well	76.0	165	106	209	186	407
TDS (mg/l)	Borehole	118.7	247	150	305	275	448
	Well	128.7	247	150	305	252	448
Conductivity (µS/cm)	Borehole	164.7	354	220	434	396	695
	Well	154.7	354	220	434	396	695

The physico-Chemical characteristics of the water supply sources is presented in Table 3 and it clearly shows that Temperature readings of the water supply sources identified in the area are all within WHO permissible limit. The temperature of water in the area irrespective of the sources fluctuates between 23.9 °C and 77.6 °C. However, it was observed that the least temperature reading for the water sources were 23.9 °C for well water at Rumuchakara and 24.3 °C for borehole water at Rumualoghu while 77.6 °C is the highest temperature value for both water sources at Owhipa. On the other hand, it is indicated that 23.4 °C is the least temperature reading for borehole water from Rumualoghu while well water from Rumuloghu has same temperature reading, it stands as second least in the area. Furthermore, temperature values for borehole water samples from communities like Rumuokocha (28.1 °C),Rumuchakara (27.9 °C) are higher than that of well water from the same communities reading 25.1 °C and 23.9 °C respectively. Igbogo and Owhipa had same reading of 29 °C and 77.6 °C for both water sources across the area, it was only in Ndudor that the temperature reading of 28.4 °C for well water is higher than that of borehole water which recorded 27.4 °C. Nevertheless, all the temperature readings for both water sources in the different communities are not higher than 30°C which is the permissible limit for drinking water specified by WHO implying that the communities sources of domestic water supply are undoubtedly safe for consumption without any consequences. The Dissolved Oxygen (DO) readings from all the communities in the area were found to be very low compared to the specified limits and the readings were the same in all the communities recording 1.52 mg/l as the least for both sources of water supply at Rumualoghu and

2.57 mg/l as the highest for both sources as well at Rumuokocha. The DO values in all the communities as shown in Table 3 are within the permissible limit for drinking water specified by the World Health Organization. Also the pH values recorded across the area for both water sources ranged between 4.72 mg/l as the lowest and 5.67 mg/l as the highest. The pH values were exactly the same in all the communities with Owhipa recording the lowest of 4.72 mg/l and Igbogo recording the highest of 5.67 mg/l which simply reveals that all the readings were within the allowable limits set by WHO and consumption from the water supply sources in the area are without any health implications . The salinity values of water from the water supply sources in the area ranged between 76 ppm and 407 ppm although this reading is specifically connected to well water. It is evident from the readings as displayed in Table 3 that the salinity content of well water is considerably higher in Igbogo and Owhipa communities than borehole with a value of 407 ppm at Rumualoghu been the overall highest while Rumuchakara and Ndudor recorded the same readings. It was also observed as shown in Table 3 that borehole water in Rumuokocha recorded 77.0ppm whereas well water from the same community recorded 76ppm which was not significantly different. Although, in Rumualoghu 307ppm was seen as the highest reading for borehole water salinity, it was second to the highest on overall basis while Igbogu and Owhipa well water shows 106 ppm and 209 ppm against borehole water of 102 ppm and 203 ppm in the same communities.Rumuokocha and Rumualoghu is seen to record both the lowest and highest values of salinity for both borehole and well water amongst other communities and the values are 77ppm for borehole water and 76ppm for well water at the lowest end and 307ppm and 407ppm at the highest end. The respective readings of salinity for both water sources in all the communities fall within allowable limits as they are all less than the specified values of 500-1000 ppm. TDS readings ranges between 118.7 mg/l and 448 mg/l with Rumuokocha recording 118.7mg/l as the least for borehole water and 448 mg/l for both water sources as the highest at Rumualoghu while Rumuokocha recorded 128.7 mg/l for well water, Rumuchakara, Igbogo, Owhipa and Rumualoghu has the same readings 247mg/l, 150mg/l, 305mg/l and 448 mg/l respectively and they were all within the 1200 mg/l WHO specified limit which points to the fact that water from all the sources of domestic supply sources in the communities are all within the permissible limit which guarantee that consuming water from these sources was not harmful. Table 3 also revealed on the other hand the readings of conductivity which was another important physical parameter been the ability of water as a medium to carry electric current that was investigated and in accordance with 0.05 -200 µS/cm tolerable limit, it was affirmed that conductivity readings in all the communities where water samples were collected from the water supply sources were above the limits except in Rumuokocha. The readings ranged between 154.7 µS/cm as the least and 695 µS/cm as the highest. However, it seen that only Rumuokocha recorded a slight difference in reading where borehole water recorded 164.7µS/cm and well water 154.7 µS/cm while the readings were exactly the same for both sources in the rest of the communities; Rumuchakara, Igbogo, Owhipa, Ndudor and Rumualoghu 354 µS/cm, 220 µS/cm, 434µS/cm, 396µS/cm, and 695 µS/cm respectively. Even though, conductivity does not have direct impact on human health, it is determined for several purposes such as determination of mineralization rate (existence of minerals such as potassium, calcium, and sodium) and estimating the amount of chemical reagents used to treat this water (Cidu *et al.*, 2011). Due to high conductivity in water samples from Rumuchakara, Igbogo, Owhipa, Ndudor and Rumualoghu the area will suffer corrosion of metal surface of equipment such as boiler, water heater system and faucets from time to time.

Table 4 Test of Mean Difference for Borehole Water Quality and WHO Standard

Water Quality Parameters	**T**	**Df**	**Sig. (2-tailed)**	**Mean Difference**	**95% Confidence Interval of the Difference**	
					Lower	**Upper**
Temperature	0.751	5	0.487	6.21667	-15.0688	27.5021
DO	-51.966	5	0.000	-7.60833	-7.9847	-7.2320
pH	-24.027	5	0.000	-3.42000	-3.7859	-3.0541
Salinity	-24.796	5	-.000	-826.66667	-912.3681	-740.9652
TDS	-19.546	5	0.000	-942.71667	-1066.6962	-818.7371
Conductivity	2.321	5	0.0018	177.28333	-19.0385	373.6051

The result of the analysis of the borehole water quality parameters tested against the WHO standard is displayed in Table 4. From the table it is revealed that temperature is the only physical characteristics of borehole water quality in the area which do not show any statistically significant difference from the WHO specified standard at t= 0.751, $p<0.05$whereas DO, pH, salinity, TDS and conductivity, t= -51.966; -24.027; -24.796, -19.546 and 2.321 indicate a statistically significant difference in comparison to the allowable limits. Hence, H_1 is retained.

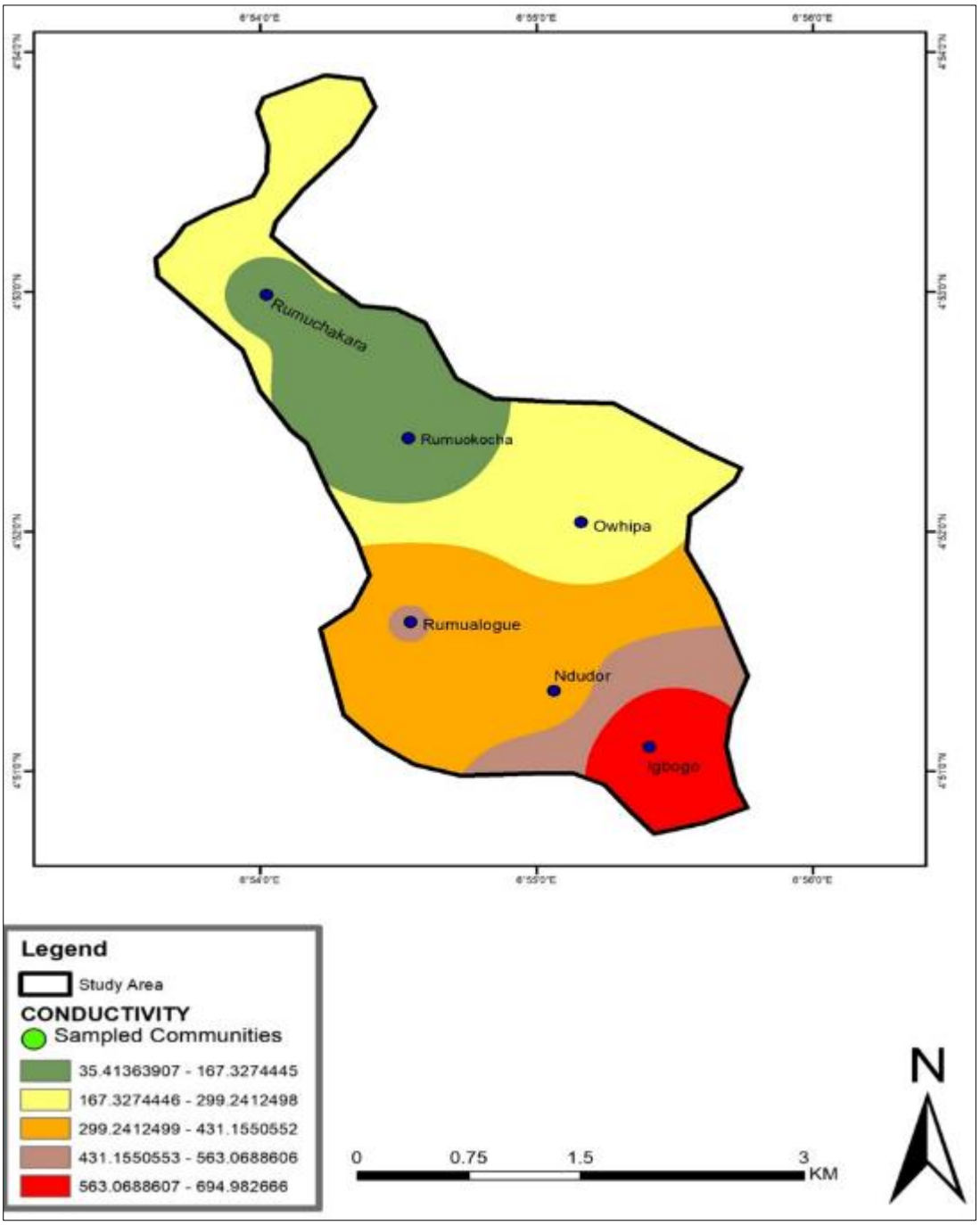

Figure 3 Interpolation Map of Conductivity

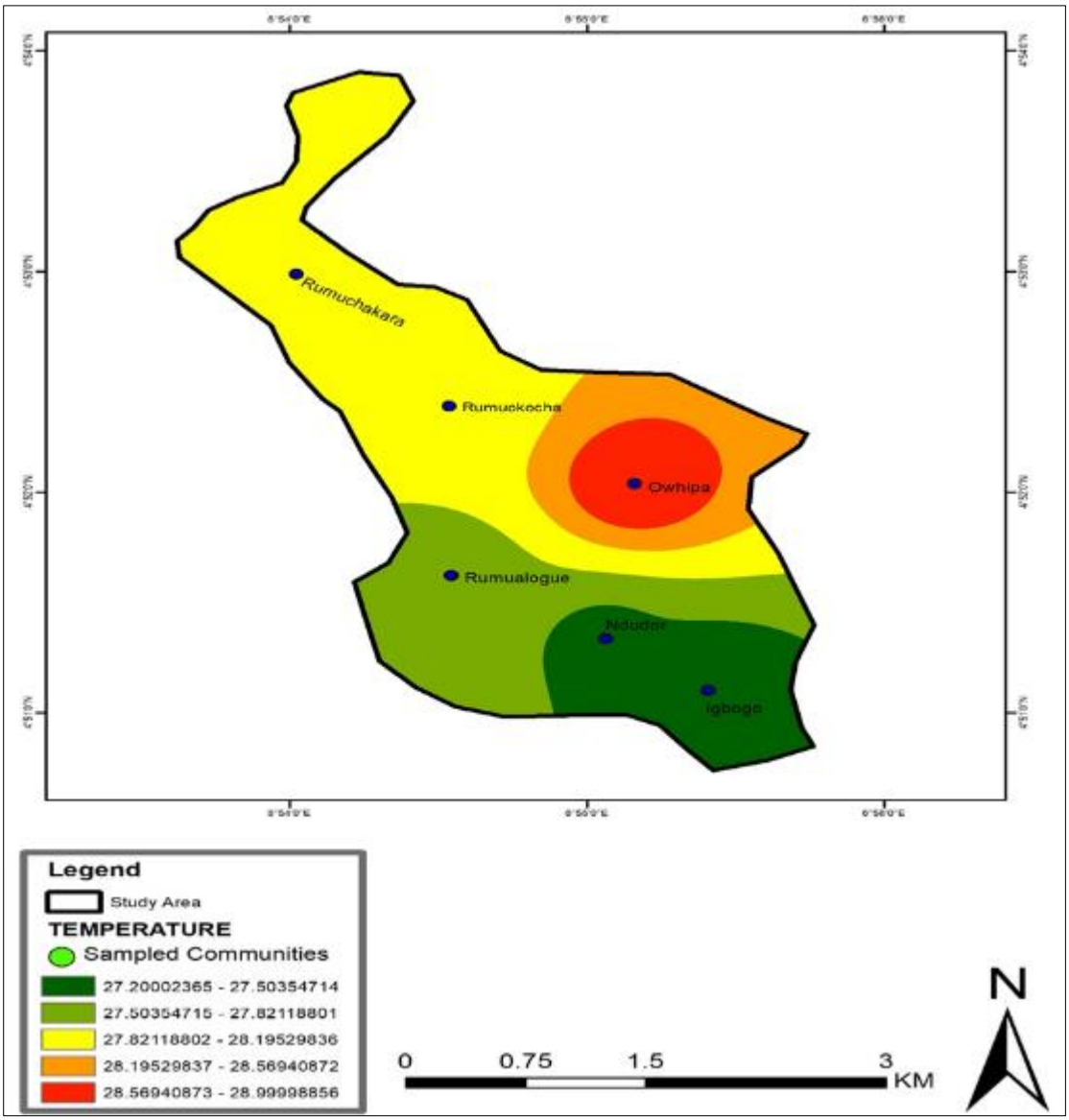

Figure 4 Interpolation Map of Temperature

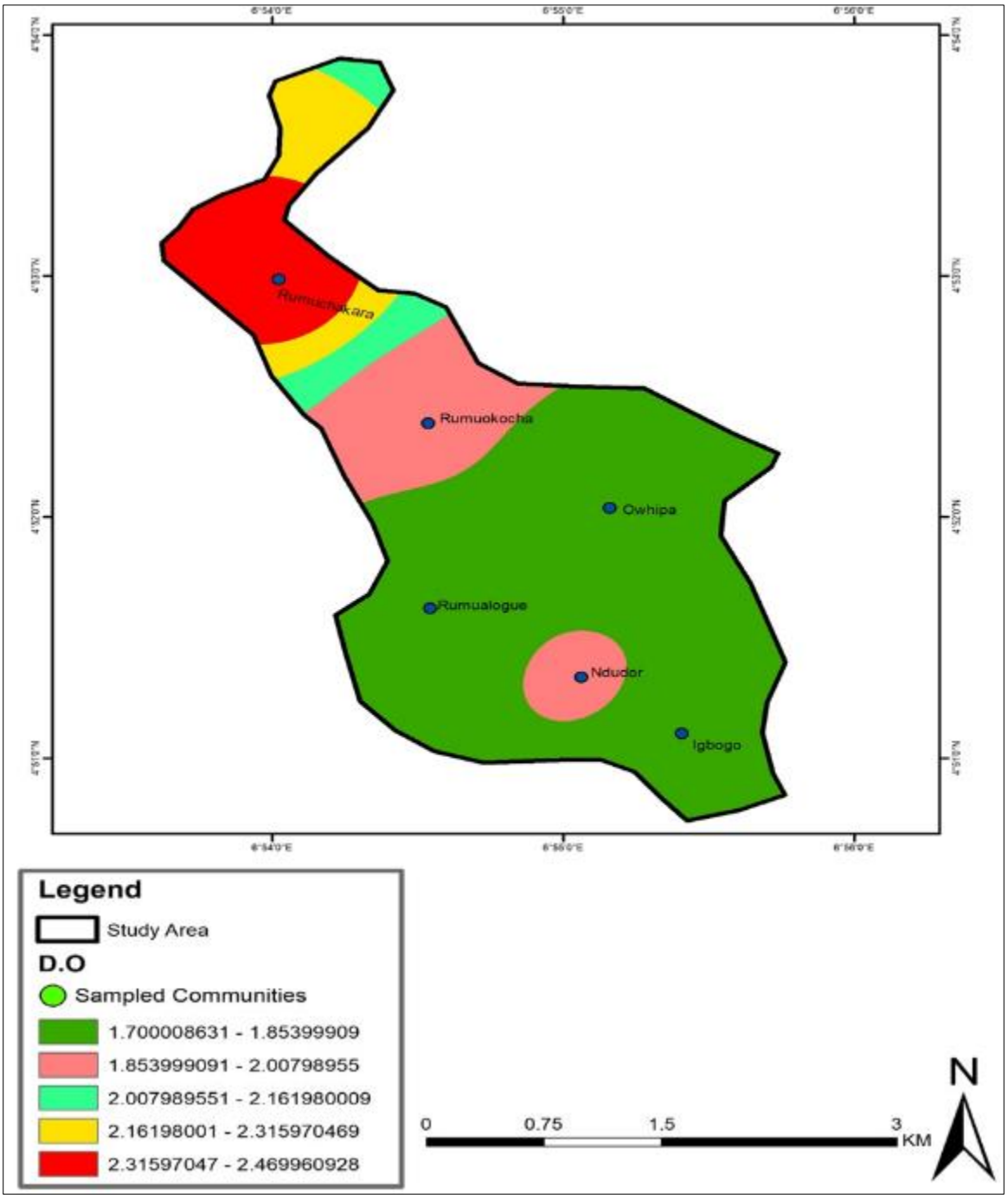

Figure 5 Interpolation Map of Dissolved oxygen

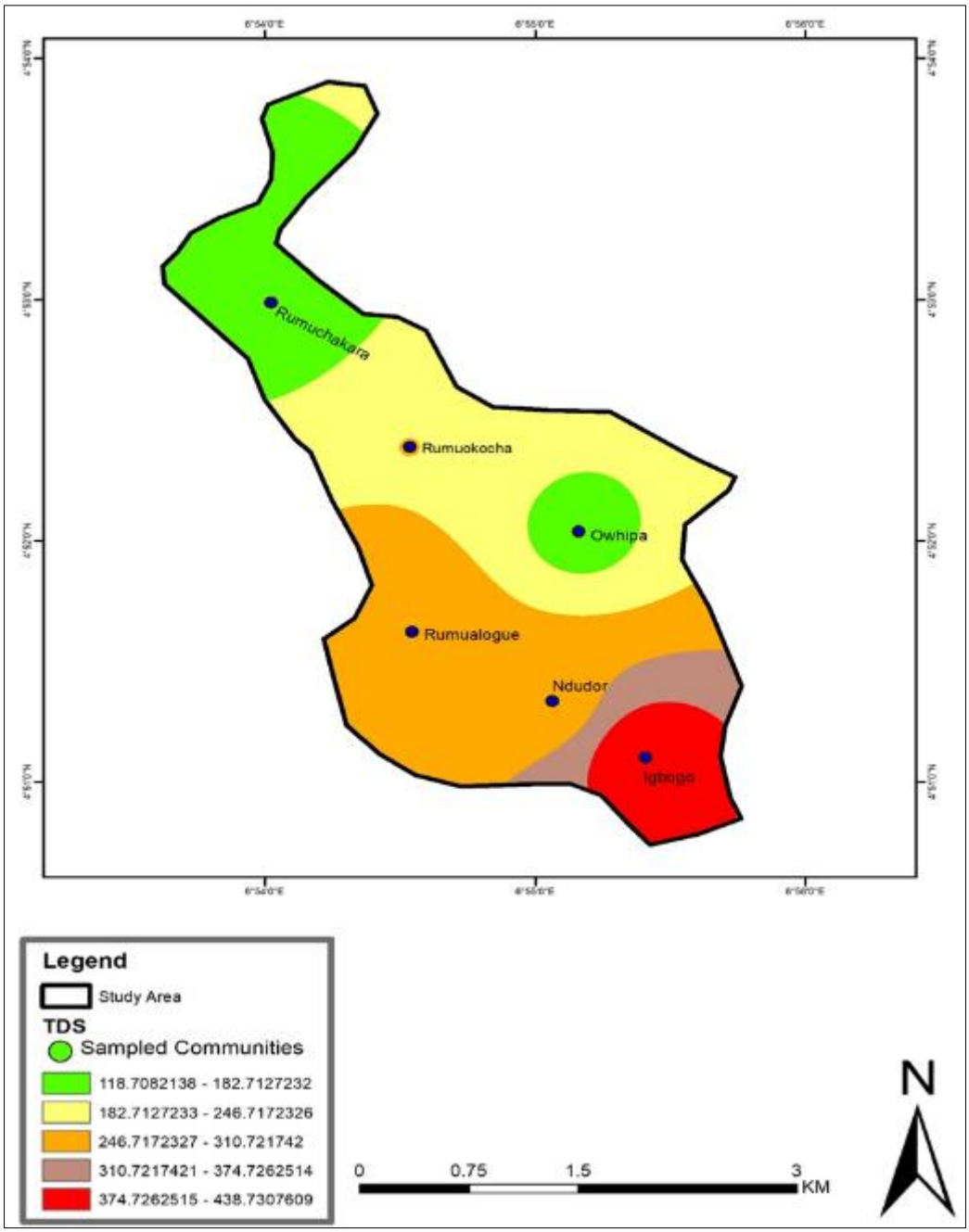

Figure 6 Interpolation Map of Total Dissolved Solids

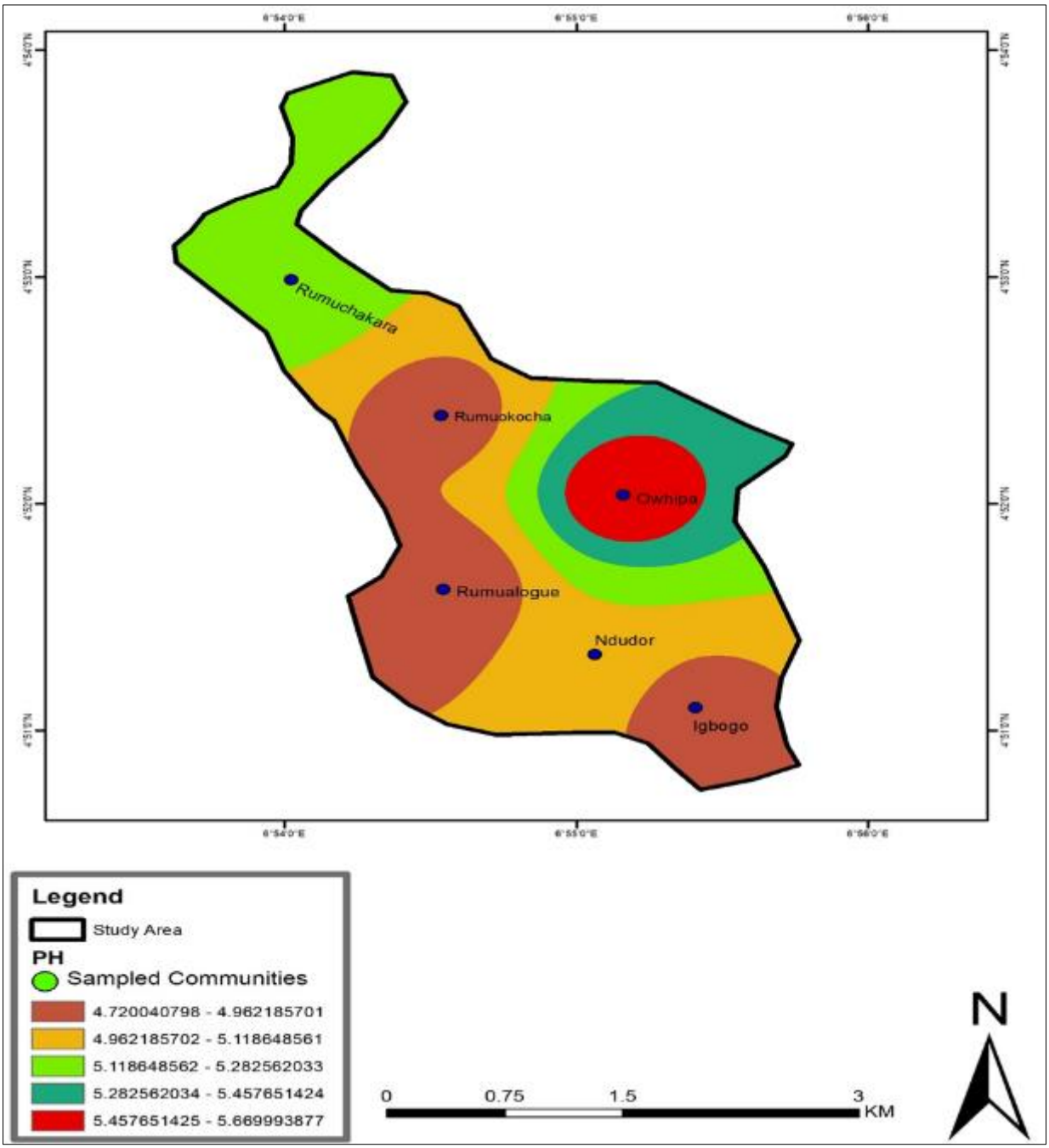

Figure 7 Interpolation Map of pH

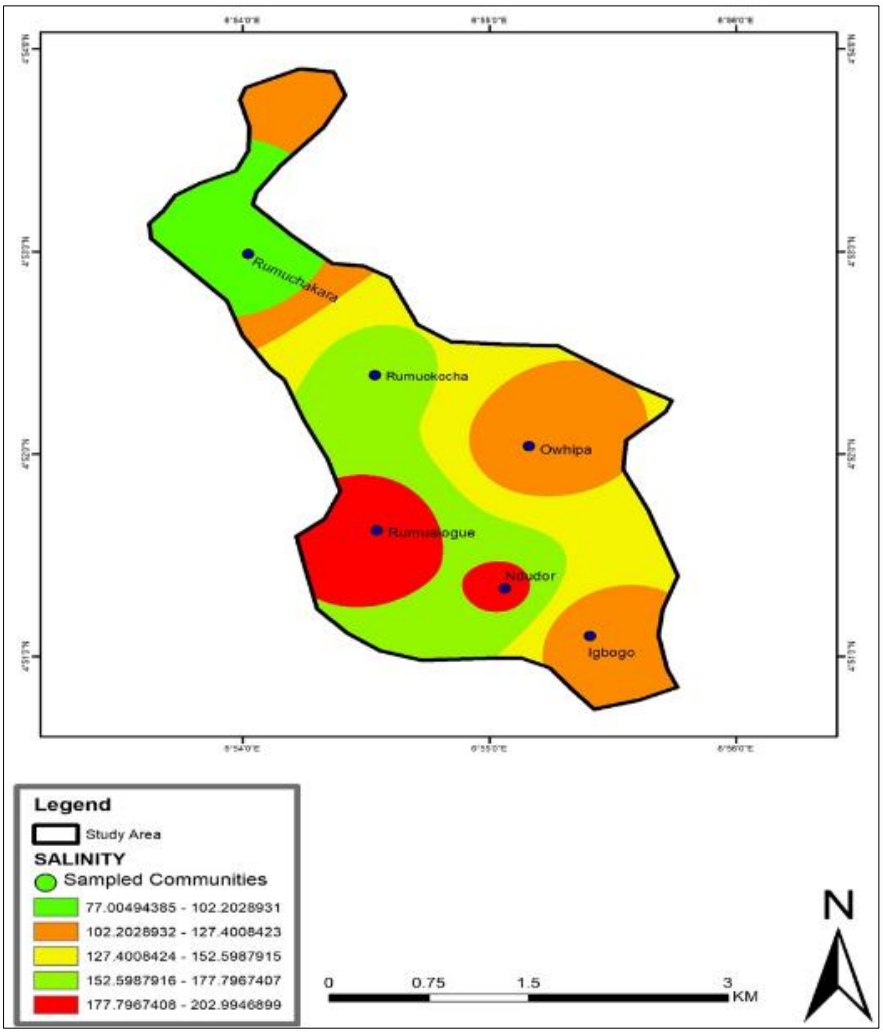

Figure 8 Interpolation Map of Salinity

Table 5 Test of Mean Difference for Well Water Quality and WHO Standard

Water Quality Parameters	T	Df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Temperature	0.547	5	0.608	4.71667	-17.4438	26.8772
Dissolved Oxygen	-51.966	5	0.000	-7.60833	-7.9847	-7.2320
pH	-24.027	5	0.000	-3.42000	-3.7859	-3.0541
Salinity	-16.966	5	0.000	-808.50000	-931.0007	-685.9993
TDS	-20.024	5	0.000	-944.88333	-1066.1816	-823.5851
Conductivity	2.272	5	0.0027	175.61667	-23.1221	374.3554

The result of the analysis of the well water quality parameters tested against the WHO standard is displayed in Table 5. From the table it is revealed that temperature is the only physical characteristics of well water in the area which do not show any statistically significant difference from the WHO specified standard at t= 0.547, $p<0.05$ whereas for DO, pH, salinity, TDS and conductivity, t= -51.966; -24.027; -16.966, -20.024 and 2.272 shows a statistically significant difference compared to the allowable limits. Hence, H_1 is retained.

Table 6 Analysis of Variation in Water Supply Sources

Parameters	Source of Variation	Sum of Squares	df	Mean Square	F	Sig.
Temperature	Between Groups	4337.497	5	867.499	400.384	.000
	Within Groups	13.000	6	2.167		
	Total	4350.497	11			
Dissolved Oxygen	Between Groups	1.286	5	0.257	-.	-.
	Within Groups	.000	6	0.000		
	Total	1.286	11			
pH	Between Groups	1.216	5	0.243	-.	-.
	Within Groups	0.000	6	0.000		
	Total	1.216	11			
Salinity	Between Groups	97438.417	5	19487.683	23.262	0.001
	Within Groups	5026.500	6	837.750		
	Total	102464.917	11			
TDS	Between Groups	136282.600	5	27256.520	519.997	0.000
	Within Groups	314.500	6	52.417		
	Total	136597.100	11			
Conductivity	Between Groups	354258.950	5	70851.790	8502.215	0.000
	Within Groups	50.000	6	8.333		
	Total	354308.950	11			

The only two major sources of domestic water supply in the area are borehole and well water and Table 6 shows the analysis of the variation in water supply sources in the area. The analysis clearly shows that at F= 400.384; 23.262; 19.997; 8502.215, $p<0.05$, there is no statistically significant variation in the water quality parameters such as temperature, salinity, TDS and conductivity of the available water sources investigated. However, the major sources of water supply in an area can be contaminated by many man-made pollutants such as leaching of nitrates and pesticides into surface and ground water arising from rainfall, soil infiltration and surface run off from agricultural land thereby causing considerable variations in the contaminant load of water over time (Fawell & Nieuwenhuijsen, 2003).

4. Conclusion

Groundwater is widely used in Nigeria through wells and boreholes as major sources of providing drinking water for homes and communities. Unfortunately borehole water like water from other sources is to a greater extent not completely pure and its purity level varies from place to place and from location to location depending on several factors like the geological conditions of the soil through which the ground water flows and some anthropogenic activities. The problem of water scarcity keeps increasing in scope, frequency, and severity because the demand for water continues to grow due to population growth, rapid urbanization, increasing agriculture and industrial activities, and lack of adequate capacity to manage freshwater resources whereas supply of renewable water remains fixed. Unsafe drinking water causes a lot of health issues and millions have suffered all manner of water borne diseases, with common being diarrhea which has cause millions of deaths yearly, especially in developing countries. Hence, the need to ascertain the quality of water sources in the area in line with regulatory standard for purposes of safe human consumption and sanitation as movement of people especially students into the area increases because of the presence of the University of Port Harcourt. On account of the findings, the study prescribes the following recommendations;

- Constant monitoring and assessment of physical characteristics of water quality in the area
- Bacteriological and other necessary water assessment parameters is required to ascertain it suitability for human consumption and other domestic purposes.
- General water treatment to maintain acceptable water quality over time.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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