International Journal of Development and Sustainability
ISSN: 2186-8662 – www.isdsnet.com/ijds
Volume 8 Number 11 (2019): Pages 755-767
ISDS Article ID: IJDS19091101

Rural water availability and quality for sustainable development

Ihejirika Chinedu Emeka [1*], Nwalieji Maduabuchi J [1], Nwoko Chris Obioma [1], Ihejirika Onyenonachi C [2], Njoku-Tony Roseline Feechi [1], Ebe Tochi E [2], Mbuka-Nwosu Mbuka-Nwosu Ihuoma [3], Chinakwe Etienne C [3], Bello Oluyemi Patience [1], Nwachukwu Michael A [2], Ogbulie Jude-Anthony N [3]

[1] *Department of Environmental Management, Federal University of Technology, Owerri, P.M.B. 1526, Owerri, Imo State, Nigeria*
[2] *Department of Public Health, Federal University of Technology, Owerri, P.M.B. 1526, Owerri, Imo State, Nigeria*
[3] *Department of Microbiology, Federal University of Technology, Owerri, P.M.B. 1526, Owerri, Imo State, Nigeria*

Abstract

Quality assessment of rural water supply is of great importance for good health of rural dwellers towards the Sustainable Development Goals (SDG). This study examined quality and availability of rural water supply from wells in twelve communities of Anambra State, Nigeria. Water samples were collected bimonthly for six months from each of the 12 wells and subjected to standard physicochemical and microbiological examinations. Result showed pH, total hardness, iron, total and faecal coliform counts exceeding acceptable limits for good drinking water. Based on Water Quality Index and Corresponding Water Quality Status, 5 out of the 12 community wells are producing water of poor quality. This negates the SDG about water for all and water quality. Further analysis revealed that SDG on water supply is about 58% achieved in Anambra State. Besides, excellent and good water quality provides good health, while poor water quality causes diseases, increased economic stress, and rise in morbidity and mortality rates. There is need to revise, expand and intensify the overall idea of SDG in some specific areas such as water supply. This is necessary because the initial driving force of SDG has gradually declined without the goals being significantly or fully achieved.

Keywords: Water Supply; Water Quality; Disease Burden; Economic Stress; SDG; Anambra State

Cite this article as: Emeka, I.C., J, N.M., Obioma, N.C., C, I.O., Feechi, N.R., E, E.T., Ihuoma, M.M., C, C.E., Patience, B.O., A, N.M. and N, O.J. (2019), “Rural water availability and quality for sustainable development”, *International Journal of Development and Sustainability*, Vol. 8 No. 11, pp. 755-767.

* Corresponding author. *E-mail address:* chinedu.ihejirika@futo.edu.ng

1. Introduction

The increasing demand for adequate water for the growing global population and the associated matching counter efforts by international organizations, regional and developing nations in water provision, are of great concern especially for rural dwellers in developing nations like Nigeria. According to a report on UNICEF support to Water Sanitation and Hygiene (WASH) sector in Nigeria in 2014, updated in 2017, Nigeria was ranked among the top 5 countries globally for having large population of people without access to safe water, improved sanitation and practicing defecation (UNICEF, 2012).

UNICEF (2012) reported that Nigeria had progressively lowered since 2010 than the regional average for sub-Saharan Africa in water and sanitation. NPC and ICF (2014) estimated 34% of the Nigerian population with access to improved sanitation and 59% with access to improved water sources. Nigeria therefore has not met the Millennium Development Goals for water (75%) and sanitation (65%) with greater differences in the rural areas of Nigeria.

Although, groundwater (borehole) is the global largest source of potable water (Howard, 1997), and provides water to approximately 1.5 billion people daily globally, studies have shown that borehole water sources are not completely safe for use except when properly treated. Presently, many people in developing countries especially in rural areas are having increased access to borehole water, but these groundwater sources are not devoid of contamination and poor quality (Palamuleni and Akoth, 2015). According to Palamuleni and Akoth (2015), groundwater quality varies from location to location, and might be influenced by the type of soils, rocks and surfaces through which it moves (Seth et al., 2014; Thivya et al., 2014). Groundwater can be contaminated through sediments and heavy metals which may dissolve in the water.

The efforts of intervention programs and projects embarked on by UNICEF/European Union sponsored groundwater development projects (boreholes) through the Rural Water Supply and Sanitation Agency (RUWASSA) under the Ministry of Power and Domestic Water Development in Anambra State, Nigeria, was targeted at providing adequate potable water for rural dwellers.

The challenge therefore remained on the quality of water provided by these international and national agencies because the water projects were not equipped with water treatment plants to ensure the quality of water for the growing population of Anambra State, especially in the rural areas of Anambra East and Aguata Local Government Areas (LGAs). The study therefore targeted at the establishment of borehole water quality of water projects established by UNICEF/European Union sponsored groundwater development projects (boreholes) through the Rural Water Supply and Sanitation Agency (RUWASSA) under the Ministry of Power and Domestic Water Development, Anambra State in Anambra East and Aguata LGAs of Anambra State, Nigeria, by establishing the Water Quality Index (WQI) and corresponding Water Quality Status (WQS) to prevent possible risks associated with water borne diseases.

2. Materials and methods

Study Area: The study areas are Aguleri and Umueri in Anambra East Local Government Area (LGA), and Ezinifite and Isuofia in Aguata LGA, as shown in Fig. 1 and 2 respectively. Aguleri and Umueri are neigbouring towns which share almost the same lifestyle, language, food, culture and tradition. They are bounded to the west by Nkwelle Ezunaka in Oyi LGA, Awkuzu and Umunya to the South (both in Oyi LGA), Ukwulu to the East (Dunukofia LGA), and Nando to the North (Anambra East LGA). The major occupation of the people in the area is fishing along Omambala River which with rainfall is the only source of water in the area before the recent UNICEF/European Union sponsored groundwater development projects (boreholes) through the Rural Water Supply and Sanitation Agency (RUWASSA) under the Ministry of Power and Domestic Water Development, Anambra State. According to National Population Commission population study in 2007 (National Population Census, 2007), the population of Aguata LGA stood at 370,172 persons, while the population of Anambra East LGA stood at 152,149 persons.

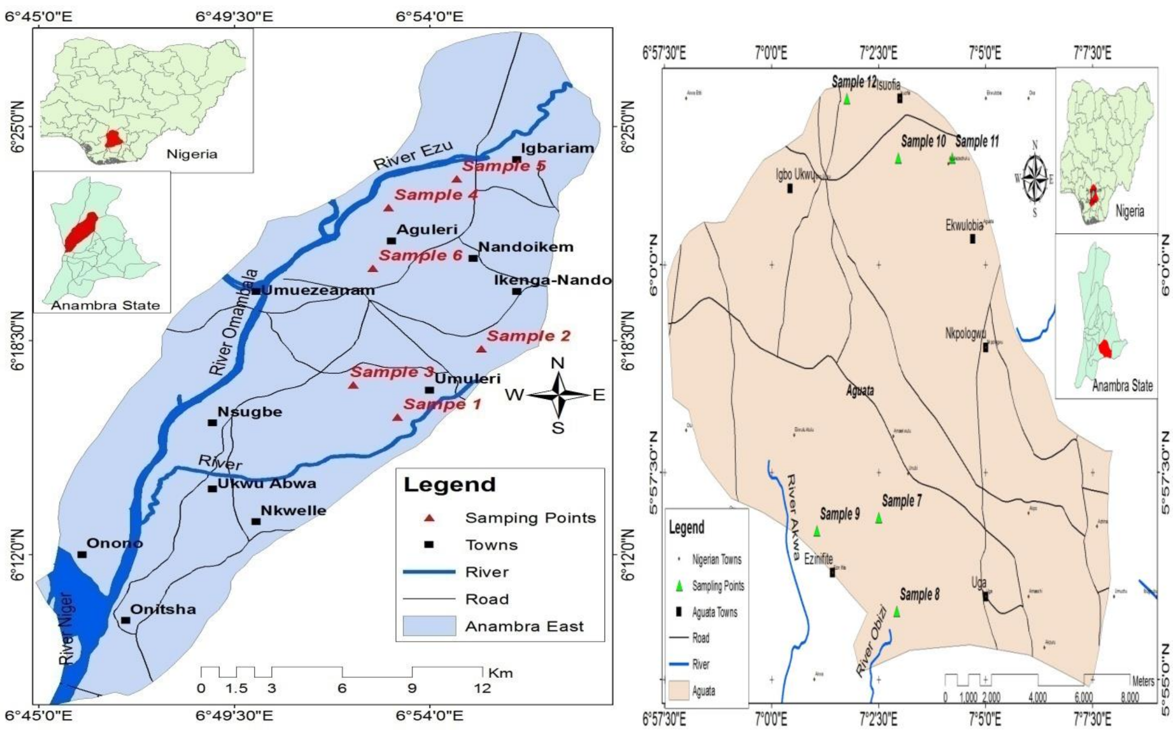

Figure 1a: Anambra East LGA and Fig1b: showing Aguata LGA showing the Sample Location Points

2.1. Sample collection

Groundwater samples from different areas in Anambra East (samples1-6) and Aguata (samples 7-12) LGAs of Anambra State were collected with the aid of two clean and sterilized one litre water sampling bottles, two for each sampling point. One sampling bottle was used for physicochemical analysis while the other sampling bottle was used for microbiological analysis. Water samples were collected from running taps. The taps were allowed to run for 3minutes before collection. The sampling bottles were aseptically used to collect water samples to prevent external contamination. The sampling bottles were corked and were immediately transported to the laboratory for standard physicochemical and microbiological analysis.

The sampling and analysis were repeated bimonthly for six months to enable the generation of reliable and dependable results.

2.2. Sample analysis

2.2.1. Physicochemical analysis

The collected water samples were analyzed for various physicochemical analyses. The samples were analyzed for the following; Temperature (^{0}C), pH, Electrical conductivity (EC) (μS/cm), Turbidity (NTU), Total Dissolved Solids (TDS) mg/l, Total hardness (mg/l), Salinity mg/l, Chloride (Cl^-) mg/l, Carbonate (CO_3^{-2}) mg/l, Bicarbonate (HCO_3^-) mg/l, Calcium (Ca^{2+}) mg/l, Magnesium (Mg^{2+}) mg/l, Potassium (K^+) mg/l, Sulphate (SO_4^{2-}) mg/l, Nitrite (NO_2^-) mg/l, Nitrate (NO_3^{-2}) mg/l, Iron (Fe^{+2}) mg/l, Manganese (Mn^{2+}) mg/l, Copper (Cu^{2+}) mg/l, Residual Chlorine (Cl_2) mg/l. were analyzed as described by APHA (1985), and a Perkin-Elmer Atomic Absorption Spectrophotometer (Model 303).

2.2.2. Bacteriological analysis

The media used was prepared according to manufacturer's specification. Sterilization of media was carried out by moist heat sterilization method using autoclave at 121^{0}C, 15psi and for 15 minutes. Heat stable materials were sterilized using hot air oven at 160^{0}C for 1 hour as described by Cruickshank et al. (1982). Heat labile materials were aseptically rinsed with alcohol and distilled water. The water samples were aseptically subjected to 10-fold serial dilutions to dilute the population of microorganisms sufficiently in sterile blanks of 9ml peptone water for easy enumeration. The media used include MacConkey agar and Eosin Methyline Blue agar.

The method of Dubey and Maheshwari (2004) was adopted for the inoculation of media. The samples were serially diluted using 10-fold serial dilution method. This was aimed at reducing the population of microorganisms for easy enumeration. The inoculated media were incubated at37^{0}C for 48 hours.

Statistical Analysis: The result was subjected to different statistical analyses and presentations ranging from T-test, Analysis of variance (ANOVA), Correlation, Tukey grouping and Line graph by method of Statistical Package for Social Sciences (SPSS).

2.2.3. Calculations of water quality index (WQI)

Water Quality Index was calculated using the model as applied by Horton (1965). WQI is calculated thus:

WQI = ∑QnWn / ∑Wn

Where,

Qn = the quality rating for the n^{th} Water quality parameter,

Wn = the unit weight for nth parameter,

Qn = 100 [Vn-Vio] / [Sn-Vio]

Where,

Vn = Estimated value of the n^{th} parameter at a given water sampling station

Sn = Standard permissible value of the n^{th} parameter

Vio = Ideal value of n^{th} parameter in pure water (i.e., 0 for all other parameters except the parameters pH and Dissolved oxygen [7.0 and 14.6 mg/l respectively])

Wn = K/Sn

Sn = standard permissible value for nth parameter

K = proportionality constant, where K = 0.286

3. results

The results of physicochemical and biological parameters across sampling locations, test of significance and comparison with established standards were as shown in tables 1, 2 and 3. The values of parameters at different locations showed that all were within the established WHO and NESREA drinking water standards except for pH (5.20-7.10), Total hardness (12-228mg/l), Iron (0.1-0.35mg/l), Total coliform count (0-4cfu/ml) and Faecal coliform count (0-2cfu/ml).

Also, the test of significance showed that the following parameters had significant variations ($P<0.05$) at different locations; pH (6.15±0.61), Electrical conductivity (49.89±36.79µs/cm), total dissolved solids (25.23±18.29mg/l), total coliforms (2.75±4.00cfu/ml) and faecal coliforms (1.17±1.75cfu/ml), but did not show significant ($P>0.05$) variation for salinity (4.73±15.68mg/l), chloride (2.83±9.50mg/l), bicarbonate (44.41±40.07mg/l), total hardness (44.25±61.66), calcium (11.80±9.76mg/l), nitrate (4.22±2.06mg/l), magnesium (13.18±11.80mg/l), sulphate (4.29±4.03mg/l), nitrite (0.02±0.02mg/l), iron (0.10±0.09mg/l) and manganese (0.03±0.03mg/l).

The pH values of water samples taken from the different areas of Anambra East and Aguata LGAs ranged from 5.20 to 7.10, while the WHO (2004) and NESREA (2009) standards for drinking water quality on pH lies within the range of 6.5 to 8.5. These studies showed that value of some of the water samples including sampling points 1,4,6,7,8,10,11 and 12 which are Iruozobia Umueri (5.80), Umuekete (6.35) and Umuaga (6.20) in Aguleri, Anambra East LGA, while Ononaku (6.00) and Ifite (6.20) in Ezinifite, Isiaku (5.20), Obinato Umueze (5.40) and Ozara (5.10) in Isuofia, in Aguata LGA, respectively, fall below the established standards and are therefore considered to be acidic. While, sampling points 2, 3, 5 and 9, which are Mgbede (7.10) and Akwete (6.80) in Umueri, Umuawunu (6.75) in Aguleri, in Anambra East LGA, and Ezeada (6.50) in Ezinifite in Aguata LGA respectively were within established standard.

The values of the total hardness of water samples taken from different study areas of Anambra east and Aguata LGAs ranged from 12 to 228mg/l. Total hardness of Akwete Umueri (228mg/l) sampling location was above WHO (2004) permissible limit of 100mg/l. All other locations were within WHO (2004) permissible limit for drinking water.

The values of iron concentration of the water samples range from 0.1 to 0.35mg/l, when compared to the established WHO and NESREA standard (0.3mg/l). Iron concentration at Umuawunu Aguleri (0.35mg/l) was above established standards of WHO (2004) and NESREA (2009).

The total coliform counts in the water samples analysed ranged from 0 – 13cfu/ml while, WHO (2004) drinking water standard is 0cfu/ml. This study showed that total coliform counts of some of the water samples from points 4,5,6,7 and 8, which were from Umuekete (2cfu/ml), Umuawunu (1cfu/ml) and Umuaga (1cfu/ml) in Aguleri, Anambra east LGA, and Ononaku (2cfu/ml) and Ifite (4cfu/ml) in Ezinifite, Aguata LGA, respectively, fall above the established standard limit.

The fecal coliform counts in the water samples ranged from 0 – 5cfu/ml while, WHO (2004) drinking water standard is 0cfu/ml. This study showed that feacal coliform counts of some of the water samples from points 4, 7 and 8, which were Umuekete (1cfu/ml) in Aguleri, Anambra east LGA and Ononaku (1cfu/ml) and Ifite (4cfu/ml) in Ezinifite, Aguata LGA respectively were not within the established standards.

The Water Quality Index (WQI) with some selected parameters for the different water sources in Anambra East Local Government Area (LGA) as shown in tables 5 were as follows: Iruozobia (48.70), Akwete (262.48), Mgbede (47.40), Umuekete (27.12), Umuawunu (84.72) and Umuaga (21.14).

While the WQI for the different water sources in Aguata LGA were as follows: Ononaku (75.22), Ifite (42.84), Ezeada (17.76), Isiaku (133.38), Obinato (133.90) and Ozara (8.60).

Table 5 showed the WQI and corresponding water quality status of water sources in the study areas. In Anambra East LGA, Umuaga water source is "excellent" and can be used for drinking, irrigation and industrial purposes. Water sources from Iruozobia, Mgbede and Umuekete had "good" water quality status with possible uses for domestic, irrigation and industrial purposes, Umuawunu had "poor" and can be used only for irrigation, while Akwete had an "unfit" drinking water status and can only be used if properly treated.

In Aguata LGA, water sources from Ezeada and Ozara had "excellent" water status and can be used for drinking, irrigation and industrial purposes. Ifite community water sources were classified to be "good" for domestic, irrigation and industrial purposes. Water sources from Ononaku were classified to be poor and can be used only for irrigation. Communities of Isiaku and Obinato water sources were classified to be "very poor" and can be restricted for irrigation purposes.

Table 2. Physicochemical and Bacteriological Parameters at Different Sampling Points

Sampling points	pH	EC µS/cm	TDS mg/l	Salinity %	Cl^- mg/l	CO_3^{2-} mg/l	Total Hardness mg/l	Ca mg/l	Mg mg/l	SO_4^{2-} mg/l	Fe mg/l	Mn mg/l	NO_3^- mg/l	NO_2^- mg/l	Total Coliform cfu/ml	Fecal Coliform cfu/ml
UMULERI																
1 (Iruozobia)	5.80	36.9	18.4	NIL	NIL	15	15	9.0	6.0	4.5	0.07	0.07	3.0	NIL	0	0
2 (Mgbede)	7.10	45.9	22.9	54.5	33	125	228	12.6	102	12	0.15	0.01	4.4	0.03	0	0
3 (Akwete)	6.80	48.3	20.2	20.0	11.0	17	18	10	22	10	0.04	0.05	3.5	0.05	0	0
AGULERI																
4 (Umuekete)	6.35	83.9	41.9	NIL	NIL	7.0	14	6.0	8.0	8.5	0.02	0.01	3.5	0.001	2	1
5(Umuawunu)	6.75	152.6	76.3	NIL	NIL	55	89	41	48	6.0	0.35	0.08	NIL	NIL	1	0
6 (Umuaga)	6.20	64.6	32.3	NIL	NIL	17	34	12	22	NIL	0.02	0.04	5.7	0.02	1	0
EZINIFITE														1		
7 (Ononaku)	6.0	39.9	19.9	NIL	NIL	10	12	3.0	9.0	NIL	0.09	NIL	4.4	0.07	2	1
8 (Ifite)	6.2	27.6	13.8	NIL	NIL	9.0	15	7.0	8.0	7.0	0.04	0.04	6.2	0.04	4	2
9 (Ezeada)	6.5	35.6	18.5	NIL	NIL	9.0	15	4.0	8.0	8.0	0.05	0.03	4.5		0	0
ISUOFIA																
10 (Isiaku)	5.2	26.2	13.1	NIL	NIL	9.0	27	13	14	1.0	0.2	0.03	8.0	0.01	0	0
11 (Obinato)	5.4	25.1	12.5	1.7	1.0	16	20	12	8.0	NIL	0.01	NIL	1.8	0.01	0	0
12 (Ozara)	5.10	28.4	8.30	NIL	NIL	17	22	15	10	NIL	0.1	NIL	1.4	0.01	0	0

Table 3. Comparison of Physicochemical and Bacteriological Characteristics of Water Samples with WHO (2008) and NESREA (2009) Standard Limits

Parameters	Units	Range	Minimum Range	Maximum Range	Mean Deviation	P-value	NESREA	WHO
pH		1.90	5.20	7.10	6.15±0.61	0.02	6.5-8.5	7-8.5
EC	µs/cm	127.50	25.10	125.60	49.89±36.79	0.02	1000	1000
TDS	NTU	63.80	12.10	76.30	25.23±18.29	0.02	500	500
Salinity	mg/l	54.50	0.00	54.50	4.73±15.68	0.45	-	-
Chloride	mg/l	33.00	0.00	33.00	2.83±9.50	0.45	250	200
Bicarbonate	mg/l	115.00	10.00	125.00	44.41±40.07	0.98	-	-
Total hardness	mg/l	216.00	12.00	228.00	44.25±61.66	0.43	-	100
Calcium	mg/l	38.00	3.00	41.00	11.80±9.76	0.37	-	75
Nitrate	mg/l	8.00	0.00	8.00	4.22±2.06	0.65	50	50
Magnesium	mg/l	42.00	6.00	48.00	13.18±11.80	0.18	-	50
Suphate	mg/l	12.00	0.00	12.00	4.29±4.03	0.14	100	200
Nitrite	mg/l	0.070	0.00	0.070	0.02±0.02	0.37	-	50

Iron	mg/l	0.34	0.00	0.35	0.10±0.09	0.87	0.3	0.3
Manganese	mg/l	0.08	0.1	0.08	0.03±0.03	0.46	0.05	0.1
Total coliforms	cfu/ml	4.00	0.00	4.00	2.75±4.00	0.01	0	0
Fecal coliforms	cfu/ml	2.00	0.00	2.00	1.17±1.75	0.003	0	0

Table 4. Quality Rating and Water Quality Index of Samples

LGA	Sample Location	Qn_{pH}	Qn_{TDS}	Qn_{NO3^-}	$Qn_{Total\ Hardness}$	$Qn_{SO4^{2-}}$	WQI
Anambra East	Iruozobia	-120	45.8	6.0	15.0	4.5	48.70
	Akwete	10	3.68	8.8	228	12	262.48
	Mgbede	-20	4.4	13.0	36	14	47.40
	Umuekete	-65	8.38	7.0	14	8.5	27.12
	Umuawunu	-25	14.72	0.0	89	6.0	84.72
	Umuaga	-80	6.46	11.4	34	7.0	21.14
Aguata	Ononaku	-100	3.98	8.8	12	0.0	75.22
	Ifite	-80	2.76	12.4	15	7.0	42.84
	Ezeada	-20	4.76	13.0	13	7.0	17.76
	Isiaku	-180	2.62	16.0	27	1.0	133.38
	Obinato	-160	2.50	3.6	20	0.0	133.90
	Ozara	-50	15	6.4	17	3.0	8.6

Table 5. Water Quality Index and Corresponding Water Quality Status of Samples

LGA	Sample Location	WQI	Status	Possible Usage
Anambra East	Iruozobia	48.70	Good	Domestic, Irrigation and Industrial
	Akwete	262.48	Unfit for Drinking	Proper treatment required
	Mgbede	47.40	Good	Domestic, Irrigation and Industrial
	Umuekete	27.12	Good	Domestic, Irrigation and Industrial
	Umuawunu	84.72	Poor	Irrigation
	Umuaga	21.14	Excellent	Drinking, Irrigation and Industrial

Aguata	Ononaku	75.22	Poor	Irrigation
	Ifite	42.84	Good	Domestic, Irrigation and Industrial
	Ezeada	17.76	Excellent	Drinking, Irrigation and Industrial
	Isiaku	133.38	Very Poor	Restricted use for Irrigation
	Obinato	133.90	Very Poor	Restricted use for Irrigation
	Ozara	8.60	Excellent	Drinking, Irrigation and Industrial

4. discussion

Acidic pH values of drinking water sources from Iruozobia Umueri; Umuekete and Umuaga in Aguleri; Anambra East LGA; Ononaku and Ifite in Ezinifite; Isiaku, Obinato Umueze and Ozara in Isuofia, Aguata LGA, implied that the water sources are unsafe for drinking and did not meet United Nations (UN) set goal of safe drinking water by the year 2015 (UN, 2000; Kirkwood, 1998).

Furthermore, the deleterious effects of acidic pH are too numerous to mention. Acidic water may cause corrosion of water reticulation structures, leading to a gradual release of piping materials like iron, copper, lead or PVC in the drinking water (Swistock et al., 2001). Acidic pH also can discolour drinking water and impact a metallic taste on it. According to UNICEF (2008), acidic pH which may lead to the release of metals in water may also cause the staining of laundry materials, generation or impaction of “blue-green” colour stains on wash hand basins and sinks in homes.

According to WHO (2003), if the communities indulged in agricultural irrigation, the danger of applying acidic water might include increased absorption and assimilation of sulphur and nitric compounds through the roots and plant systems. This might lead to toxic effects, slowing of planting growth and resultant death of plants.

The total hardness of water is one of the major parameters considered when treating water for domestic use. It is a characteristic of water that affects lather formation with soap and cause scale formation in kettles and other hot water boiling appliances. Akwete Umueri community with value of total hardness of 228mg/l above established standards will be experiencing difficulties in laundry activities. This might lead to increased use of soap and other detergents and eventual high cost of laundry. Hard water also can cause clogging and physical damage of plumbing pipes especially during the hot seasons and damage water reticulation systems and physically contaminate water distribution in the community (WHO, 2014). These will further impose economic hardship on the community in managing water distribution systems and maintenance of home appliances.

Umuawunu Aguleri had iron concentration slightly above established standards. It demands for caution in the use of water from such community especially on aesthetic values and health issues. Iron in water impacts a reddish colour as well as a metallic taste in water. Excess iron in water may lead to "iron overload". According to FAO/WHO (1988), though iron is an essential element in the nutrition of humans, its minimum daily requirement is related to age, sex, physiological status and bioavailability and ranges from 10 to 50 mg/L. According to WHO (2003), iron overload results from mutation of the gene that is responsible for coding for digestion of iron. This may lead to hemochromatis, renal, heart and pancreatic damage, it might also cause diabetes. Furthermore, WHO (2003) stated that increased iron in drinking water may lead to stomach upset, nausea and vomiting.

Fecal coliforms were detected in water sources from Umuekete in Aguleri, Ononaku and Ifite. This is against the establishment and goal of UN (2000) on safe drinking water. The presence of coliforms (faecal) in the drinking water sources confirmed contamination of the water sources with sewage from humans, rodents or farm animals, which are the principal sources of faecal coliforms. This is in accordance with the reports of Figueras and Borrego (2010). Accordingly, Ihejirika et al. (2011) stated that water is a reliable source of faecal contamination and consequently is associated with pathogens. Coliforms include members of the family Enterobacteriaceae. These organisms include *Escherichia coli*, *Salmonella typhi*, *Shigella dysenteriae* and *Serratia marcescens* (Prescott et al., 2005). The presence of these organisms in drinking water portends possible cases of enteric diseases like diarrhea, typhoid fever and dysentery, for users (Das et al., 2009). These water sources, if not properly treated before use, definitely will cause high morbidity and mortality rates in the affected communities.

The classification of WQI and corresponding quality status for different uses as was established by Asuquo and Etim (2012) implied that among the twelve (12) communities studied, 58.33% of the communities had suitable water source for drinking and domestic purposes, while 41.67% had no suitable water sources for drinking and domestic purposes. This result is similar to the report of African Ministers' Council on Water (AMCOW) (2015) which stated the reports on rural access to water and sanitation by Water Supply and Sanitation Baseline Survey (WSSBS) as 59.6% in 2007, and that of Joint Monitoring Programme (JMP) of UNICEF/WHO as 28% in 2008, which is below the 36% earlier recorded in 1990. This data implies very serious challenge in the achievement of Millennium Development Goals (MDGs) of 65% on the provision of safe drinking water sources for human consumption.

The poor ground water quality may pose serious challenge on the health and economy of developing countries like Nigeria. There is therefore great need to consider and implement policies that not only will provide water for rural dwellers or in developing countries but also will tackle challenges of water quality and potability. This concern should be louder and most prominent in developing countries and their communities because they habour the global most indigent and poorest population of people.

Millions of dollars are spent by international agencies like; WHO,UN, UNESCO, etc to provide adequate supply of water for rural dwellers with great emphasis on adequacy and sanitation, but issues of consistent leadership, political and governance crisis with increasing corruption in developing countries have led to serious water sanitation crisis in developing countries like Nigeria. Boreholes are dug, adequate water is supplied, but there are not enough water treatment facilities attached to this. According to Akpabio and

Ekanem (2009), different communities do not have same water quality due to varying degrees of over pumping of the aquifers, falling water tables and sharp deterioration of the aquatic ecosystem. These present situations have made it risky to accept every ground water source as suitable for drinking and have also exposed the human population in those communities to varying degrees of water borne diseases.

According to AMCOW (2015), the responsibility of potable water supply was traditionally entrusted to agencies of the state governments (state water agencies), however, in some states, this responsibility has been returned back to a state government department, while state rural water and sanitation agencies have been set up mostly to actualize the FGN/UNICEF rural water supply and sanitation program. Under this program, the LGAs are responsible for the provision of rural water supplies and sanitation facilities in their localities or areas. The challenge therefore is that majority of the LGAs have a few resources and skills to contain this challenge.

In the face of these water and sanitation challenges in rural areas of Anambra, Nigeria, the suggestions of AMCOW (2015) of establishing rural water and sanitation agencies in states where this has not been done and their roles substantially limited to facilitate and build capacity of LGAs, and increasing the pace of the implementation of the frame work for rural water delivery with emphases on community ownership and management of the program.

5. conclusion

Provision of rural water in rural areas of Anambra State of Nigeria did not meet the standards for water and sanitation as specified in United Nations' MDGs. United Nations Water, Sanitation and Hygiene (WASH) program should be made a major consideration in rural water provision especially in developing countries to forestall possible outbreak in waterborne diseases and for a sustainable development.

References

African Ministers' Council on Water (AMCOW). (2015), *Water Supply and Sanitation in Nigeria: Turning finance into services for 2015 and beyond.* African Ministers' Council on Water.

Akpabio, E.M. and Ekanem, E.M. (2009), "Water Uncertainties in Southeastern Nigeria: Why Government should be interested in Management", *International Journal of Sociology and Anthropology*, Vol. 1 No. 2, pp. 038-046.

APHA/AWWA/W/WPCF. (1985), *Standard Methods for the Examination of Water and Wastewater*. 16th ed. American Public Health Association Washington D.C. pp. 76-538

Asuquo J.E. and Etim E.E. (2012), "Water quality index for assessment of borehole water quality in Uyo metropolis, Akwa Ibom state, Nigeria", *International Journal of Modern Chemistry*, Vol. 1 No. 3, pp. 102-108

Cruickshank, R., Dugauid, J.P., Marmoin, B.P. and Swain, R.H.A. (1982), "*Medical Microbiology". The practice of Medical Microbiology 13th ed. Churchill Livingstone, Edinburgh.* 2, pp. 273-284.

Das, A., Manickam, P., Hutin, Y., Pal, B.B., Chhotray, S.K. and Gupte, M.D. (2009), "An outbreak of cholera associated with an unprotected well in Parbatia, Orissa, eastern India", *J Health Popul Nutr*, Vol. 27 No. 5, pp. 646-51.

Dubey, R.C. and Maheshwari, D.K. (2004), *Methods for study of microorganisms. Practical Microbiology (2nd Ed.) S. Chaud and Company Ltd. Ram Nagar, New Delhi.* pp. 19-301.

FAO/WHO. (1988), *Requirements of vitamin A, iron, folate and vitamin B12. Report of a Joint FAO/WHO Expert Consultation. Rome, Food and Agriculture Organization of the United Nations*, (FAO Food and Nutrition Series, No. 23).

Figueras, M.J. and Borrego, J.J. (2010), New perspectives in monitoring drinking water microbial quality.

Horton, R.K. (1965), "An index number system for rating water quality", *Journal - Water Pollution Control Federation*, Vol. 37, pp. 300 -305.

Howard, K.W.F. (1997), "Impacts of urban development on groundwater*", In: Eyles E., editor. Environmental Geology of Urban Areas. Volume 3. Special Publication of the Geological Association of Canada; St. John's, Nfld, Canada*: Geotext., pp. 93-104.

Ihejirika, C.E., Ogbulie, J.N., Nwabueze, R.N., Orji, J.C., Ihejirika, O.C., Adieze, I.E., Azuwike, O.C. and Ibe, I.J. (2011), "Seasonal influences on the distribution of bacterial pathogens and waterborne diseases transmission potentials of Imo River, Nigeria", *Journal of Research in Biology*, Vol 3. pp. 163-172

Kirkwood, T. and Westendorp, R. (1998), "Disinfection of water distribution systems for *Legionella*", *Semin. Respir. Infect.,* Vol.13, pp. 147-159.

National Environmental Standards and Regulations Enforcement Agency (NESREA) (2009), National Environmental Standards and Regulation Enforcement Agency. Regulations Vol. 96, 65; the Federal Government Printer, Abuja, Nigeria.

National Population Commission (NPC) [Nigeria] and ICF International. (2014), *Nigeria Demographic and Health Survey 2013. Abuja, Nigeria, and Rockville, Maryland, USA*: NPC and ICF International.

Palamuleni, L. and Akoth, M. (2015), "Physicochemical and microbiological analysis of selected borehole water in Mahikeng, South Africa", *Int J Environ Res Public Health,* Vol. 12 No. 8, pp. 8619-8630.

Prescott, L.M., Harley J.P. and Klein, D.A. (2005), *Microbiology*. 6th edition. McGraw Hill.

Seth, O.N., Tagbor, T.A. and Bernard, O. (2014), "Assessment of chemical quality of groundwater over some rock types in Ashanti region, Ghana", *Am. J. Sci. Ind. Res*., Vol. 5, pp. 1–6.

Swistock, B.R., Sharpe, W.E. and Dickison, J. (2001), "Educating Rural Private Water System Owners in Pennsylvania Using Satellite vs. Traditional Programs", *Journal of Extension*, Vol. 39 No. 3.

Thivya, C., Chidambaram, S., Thilagavathi, R., Nepolian, M. and Adithya, V.S. (2014), "Evaluation of drinking water quality index (DWQI) and its seasonal variations in hard rock aquifers of Madurai District, Tamilnadu", *Int. J. Adv. Geosci*., Vol. 2, pp. 8–52.

UNICEF (2008), *UNICEF Hand Book on water quality. Water, Environment and Sanitation Section, Programme Division.* UNICEF New York.

UNICEF (2012). UNICEF Annual Report. UNICEF

United Nations. (2000). "Millennium Development Goals No. 7, To Ensure Access to drinking water and sanitation for all by 2015". United Nations

WHO (2004), *Guideline for Drinking Water Quality*, 2nd Edition, Volume 2, Health Criteria and Other Supporting International Programme on Chemical Safety, World Health Organization, Geneva.

WHO (2008), *Guidelines for drinking water quality*, Third edition, incorporating the first and second addenda, Vol.1, Geneva.

World Health Organization (WHO) (2014), "Water Safety in Distribution Systems". *Public Health, Environmental and Social Determinants, Water, Sanitation, Hygiene and Health.* World Health Organizatiosn, Geneva.

WHO. (2003). "Iron in Drinking-water. Background document for development of WHO Guidelines for Drinking-water Quality". Originally published in Guidelines for drinking-water quality 2nd ed. Vol. 2. Health criteria and other supporting information. World Health Organization, Geneva, 1996.