Groundwater Quality Assessment and Sanitary Surveillance of Boreholes in Rural Areas in Benue State Of Nigeria

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Abstract

Access to clean and potable water is a great challenge in most rural areas in Nigeria, resulting in Water borne illness. This study was aimed at evaluation the physico-chemical and bacteriological characteristics of ground water with the sanitary condition around the boreholes in rural areas (Vandeikya) of Benue State Nigeria. Water quality parameters wee determined using standard methods, while sanitary surveillance was accessed with the aid of standard questionnaires. All the parameters were examined in two seasons (Wet and Dry) and most of them increased in content during the wet season over the dry season, due to the surface run off from storm water. Coliform count, pH, turbidity copper and iron in most instances, exceeded the world health organization recommended standard for portable water. The result of the sanitary surveillance revealed that the effect was more pronounced on the total coliform count of the ground water. The ground water quality samples were not fit for human consumption without adequate treatment. Routine monitoring of the ground water quality and maintaining sanity around the water points were recommended.

Keywords: *Ground water, water quality, rural areas, Vandeikya, Sanitary surveillance*

1. Introduction

The increasing popularity of and use of ground water as the main source of potable water supply worldwide is probably due to its ready availability, cool temperature and ability to undergo natural purification which make it attractive (USGS, 1999; Asbolt and Veal, 1994). The quality of ground water is the resultant of all the processes and reactions that are on the water from the moment it condensed in the atmosphere to the time it is discharged by a well or spring and varies from place to place and with the depth of the water table (Jan *et al;* 1995). The direct contamination of ground water sources caused by poor sanitary completion has been noted in many countries (Olsen *et al;* 2002). In developing countries, the use of poorly protected ground water sources have been linked to acute diarrhea disease (Trivedi *et al*; 1997., Nasinyama *et al;* 2000). The effectiveness of well head sanitary completion in reducing risks of all pathogens is profound as it provides a barrier to direct contamination of the source (Robertson and Edberg, 1992).

Ground water is an important source of water in both the urban and rural areas of Nigeria, but in the cities, pipelines are also available. Rural dwellers rely basically on hand dug wells for portable water supply as the streams usually dry up during dry season. These resources are under threat from pollution either from human lifestyle manifested by low level of hygiene preached in the developing nations (Ikem *et al;* 2002 and Akulieze *et al;* 2003).

Environmental health involves all factors circumstances and conditions in the environment or surroundings of human that can influence health and well being. the neglect of rural areas in most developing countries in terms of basic infrastructures such as pipe borne water and sanitation facilities expose the rural dwellers to availability of health related problems such as water borne disease (Sridhar, 2000). This study is aimed at determining the physico-chemical parameters and

bacteriological quality as well as sanitation status of boreholes in rural communities in Benue State of Nigeria.

2. Materials and Methods

The study area, vandeikya is found in Benue Sate, North central Nigeria, situated on longitude 9.5° N and latitude 4.35^{0}N and has savanna vegetation. The area has a tropical wet and dry climate. Dry season lasts for a minimum of five mouths (November to march), while the wet season spans between April and October.

Water samples were collected from fifteen boreholes, whose depth varied from 20 - 35m, located within the residential homes twice a month for period of three months in the dry season and another period of three months in the wet season. Water quality parameters analyzed in accordance to standard methods of Examining water and waste waters (APHA, 1998), were pH, conductivity, total dissolved solids (TDS), total suspended solids (TSS), turbidity, nitrate (NO^-3),copper (Cu^{2+}) Fluoride (F^-), chloride (Cl^-) Iron (Fe^{2+}), Chromium (Cr^{6+}), Carbonate, Bicarbonate, Dissolved oxygen (DO) and total coliform count. Sanitary inspections were carried out with simple questionnaires (Lloyd and Helmet 1992, Howard *et al* .,2003).

3. Results and Discussion

The results for the various physico-chemical and bacteriological characteristic determined in the water samples from the boreholes in the rural areas in Benue state with the sanitary surveillance situation are presented in Tables1, 2, and3.

The pH of the water samples ranged from 6.29-8.20 during the wet season 6.35-8.57 from dry season. The mean pH value in all the samples during the wet season was 7.25 and it increased slightly to 7.36 during the dry season. Generally the pH values obtained were within the WHO standard of 6.3 to 8.5 (WHO, 2004). The results showed that the boreholes water samples pH values were satisfactory for drinking and domestic water usage. These findings are in accordance with that of Ayers *et al.,* (1985). Conductivity indicates the presence of dissolved solids and contaminates especially electrolytes but does not give inspiration about specific chemicals.

The conductivity of the water samples from the boreholes varied from69. 35- 916. 10 µS/cm during the wet season, while it varied from29.10- 714.00 µS/cm during the dry season. The mean conductivity during the wet season was 293.61µS/cm and reduced to 212.0µS/cm during the dry season. The conductivity of the water samples was within the acceptable standard for during water. The higher values obtained during the wet season could be ascribed to the surface run of leachetes into the ground water.

The TDS results obtained from the water pounds ranged from17.40- 671.00mg/L during the wet season and from 14.00- 343.00mg/L during the dry season .The total dissolved solids (TDS) are an indication of the degree of dissolved substances such as metal ions in the water. The mean TDS during the wet season was 157.09mg/L and 100.60mg/L during the dry season. The TDS was within the acceptable standard of 1000mg/L from all the water samples in the season (WHO, 2004). The higher values obtained during the wet season may be due to surface run off. The total suspended solid (TSS) measures the physical observable dirtiness of a water resource. The TSS varied from3.00- 64.11mg/L during the wet season and1.00- 110mg/L during the dry season was acceptable.

Turbidity stems from the reduction of transparently due to the presence of percolate matter such as clay silt, finely divided organic matter etc. The turbidity values obtained in this study ranged from1.00- 87.00NTU (WHO,2004). However the turbidity values were generally lower during the dry season. The increased values during the wet season could be attributed to surface ran off and erosion carrying soil/silt and partially dissolved/ un-dissolved organic matters (Morokov, 1987).

The concentration of fluoride varied from 0.03-1.20mg/L during the wet season and from0.00-0.12 mg/L during the dry season. Fluoride concentration was within the acceptable limit of 1.5mg/L (WHO 2004). Fluoride concentration of less than 0.5mg/L observed in some areas in this study is known to cause dental carries. This result conforms to the findings of a similar study carried out by (Dissanake 1991). He therefore proposed 1.00mg/L as the optimal concentration of fluoride in drinking water.

In the present study, chloride ion content of the ground water samples ranged from 47.37-200.21 mg/L during the wet season and from10.57- 198.00mg/L during the dry season. The chloride content was within the WHO recommended standard of 250mg/L (WHO,2004). Nitrate content of ground water samples in the study ranged from 2.00- 35.10-mg/L during the wet season and 3.00- 29.10mg/L during the dry season. The concentration of nitrate in the study area was within the recommended standard of 50mg/L (WHO, 2004).

The concentration of copper in the ground water varied from 3.40 - 6.03mg/L during the wet season and from 0.01-2.40mg/L during dry season. Chromium hexavalent content of the ground water samples varied from 0.01-0.47 mg/L during the wet season and from 0.01- 0.37 mg/L during the dry season. The results obtained for copper in some instances were beyond the WHO maximum value of 2.00mg/L(WHO, 2004). All the same chromium was within the recommended WHO value of 0.05mg/L (WHO, 2004).

The most significant health effect of copper beyond the recommended standard is gastro intestinal disorderness (WHO,2004).

The concentration of Iron in the ground water varied from0.01- 1.20mg/L during the wet season and from0.01- 1.0 mg/L during dry season. The values of Iron obtained in some of water points exceed the WHO standard of 0.3mg/L WHO, 2004).

Generally, there was an increase in the iron concentration during the wet season compared to dry season. Anthropogenic sources of iron in the environment could be washed into the ground water during wet season. Iron has no health significance but it affects the anesthetics of the water and causes the consumer to reject the supply.

The results of DO obtained ranged from0.01- 3.61 mg/L during the wet season and from0.01-2.40 mg/L during the dry season. The threshold value for DO is 5.0mg/L for drinking water and should not be more than 5mg/L for agricultural purpose (Cruise and Nuller, 1994).Very low DO may result in anaerobic conditions that cause bad odors. Some boreholes were found to here vary low DO while may affect the quality of water.

Bicarbonates are the dominant anion in most surface and ground waters. The weatherings of rocks contribute to bicarbonates content in water. Mostly bicarbonates are soluble in water and concentration in water is related to pH. Bicarbonates are usually less than 500mg/L in ground water (WHO,2004). In this study, bicarbonates ranged from 67.00- 369.00 mg/L during the wet season and from 75.00- 400.00 mg/L during dry season, while carbonate ranged from 80.00-360.00 mg/L during the wet season. The bicarbonate and carbonate content of the ground water were within the acceptable limit.

Feaca indicator bacteria have been used to indicate the water quality and personal hygiene standard in a variety of settings (Kaltenthaler *et al.* ,1996). In this study total coliform from ranged from 0- 12.00 CFU/ 100ml during the wet season and from1.0- 8.0 CFU/100ml during the dry season. Some of the water points had coliform bacteria higher than the WHO standard of absent of coliform forming units/ 100ml (WHO,2004). All the same some boreholes had no coliform and this results is in accordance with the findings of (Strains 2000). The presence of coliform bacteria and compromised sanitary standard (Gelinas *et al.*, 1996 and chidavaenzi *et a.l*, 2000).

4. Conclusion

The result of this study indicate that the characteristics of the ground water in the rural areas in Benue state were fit for consumption with respect to the WHO standard except for copper., iron

and total coliform that were found to exceed the standard in some instances. The result of study also revealed the sanitary surveillance around the ground water points was compromised and this is attributed to the presence of coliform in the water. There is therefore need for routine monitoring of the ground water quality and sanitary inspection so as to fore stall the outbreak of water related diseases.

Table1: Characteristics of boreholes in rural areas in Benue-state during wet season

Parameter	Range	Mean	Standard Deviation
pH	8.20-629	7.25	0.62
Conductivity (µS/cm)	916.10-69.33	293.61	263.37
TDS (mg/L)	671.0-17.40	157.09	183.39
TSS (mg/L)	64.11-3.00	23.25	17.42
Turbidity (NTU)	87.00-1.00	27.70	10.93
Flouride (mg/L)	1.20-0.03	0.38	0.41
Chloride (mg/L)	200.21-47.35	122.53	48.84
Nitrate (mg/L)	35.10-2.00	13.26	10.55
Copper (mg/L)	3.40-0.03	1.20	0.79
Chromium (mg/L)	0.47-0.01	0.11	0.14
Iron (mg/L)	1.20-0.01	0.14	0.29
DO (mg/L)	3.61-0.01	0.83	1.21
Carbonate (mg/L)	860-380	150.20	78.93
Bicarbonate (mg/L)	369-67	158, 07	87.25
Total Conform (Cful100m)	12-0	3.53	3.91

Table2: Characteristics of boreholes in rural areas in Benue-state during dry season

Parameter	Range	Mean	Standard Deviation
pH	8.57-6.35	7.36	0.76
Conductivity (Us/cm)	14.00-29.10	212.00	185.84
TDS (mg/L)	343.00-14.00	100.60	53.49
TSS (mg/L)	100.00-1.00	28.23	15.07
Turbidity (NTU)	47.00-1.00	18.60	13.60
Fluoride (mg/L)	0.12-0.06	0.08	0.02
Chloride (mg/L)	198.00-57.10	123.30	49.55
Nitrate (mg/L)	29.10-3.00	9.95	4.84
Copper (mg/L)	2.40-0.01	0.58	0.29
Chromium (mg/L)	0.37-0.01	0.16	0.10
Iron (mg/L)	1.0-0.01	0.25	0.09
DO (mg/L)	2.40-0.01	0.78	0.12
Bicarbonate (mg/L)	400.00-75.00	149.47	84.89
Carbonate (mg/L)	248.00-70.00	132.67	55.37
Total conform (Cful100m)	8-.0	3.07	2.96

Table3: Sanitary Surveillance risk factors observed boreholes in rural areas in Benue-state.

Risk Factors	Number Observed	Percentage Observed
Latrine within 10m of borehole	2	13.83
Latrine within 10m uphill of boreholes	1	6.66
Other polonium Sources within 10m	6	40.0
Faulty damage	8	53.33
Cradled/broken/dirty damage	11	73.33
Missing/faulty fence	14	93,35
Apron less than 1m in radius	3	20.0
Spilt water collection in Apron area	13	86.61
Cracked/ damaged Apron	12	80.0
Loosed Grandaunt at the base	1	6.61

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