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EVALUATION OF TEMPORAL CHANGES IN BOREHOLES WATER QUALITY IN IGABI LOCAL GOVERNMENT AREA, KADUNA STATE

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ABSTRACT

With a view to ascertaining the quality of water in selected boreholes in Igabi local Government area of Kaduna state, twenty water samples were randomly collected within major towns (Danfili, Kwarau, Saminaka and Rigachikun) of the Local Government from November to April (Dry), and from May to October (Rainy season) of year 2012. The samples were analyzed for physical, chemical, and bacteriological parameters (Calcium, Fluoride, Magnesium, Nitrate, Sodium, Chloride and Bicarbonates) to observe any changes in the ground water quality of the area. Analysis of variance (ANOVA) and Pearson Correlation were performed on the data obtained using SPSS 10.0 for significant variations and inter-element relationship. High mean turbidity were recorded in boreholes in Danfili (12.2NTU), Kwarau (6.2NTU). A mean turbidity of 4.3 NTU was recorded in Dry season for wells with Rigachikun having 5.1NTU. It was observed that a negative correlation exist between well depth and heavy metal concentration. There was also a linear relationship of 0.686 between well distance and nitrate (faecal contaminant). Mean value for Flouride (0.22mg/l), Sodium (20.78mg/l), Calcium (15.7mg/l), Iron (.013mg/l), Nitrate (3.69mg/l), Cadmium (0.00102mg/l) Chloride (22.107mg/l) recorded for sampled wells were all within WHO standard. A high value of 24mg/l and 25mg/l for Nitrate was recorded in Saminaka Road and Danfili an indication of contamination during the rainy season indicating surface- ground water intrusion (influx). The results of bacteriological analysis indicated that most wells sampled have range of 1cfu/100ml to 7cfu/100ml with Danfili Mani having the highest values (7cfu/100ml) which make it unsaved for consumption.

Keywords: Temporal change, analysis, groundwater, physiochemical, bacteriological, quality

1.0 INTRODUCTION

Urbanization and population growth without commensurate facilities can seriously degrade groundwater quality, particularly in shallow aquifers. This can also be understood from the fact that groundwater quality reflects an interplay between natural hydro-geology and human activities (Broers and Grift, 2004).. The neglect of rural areas in most developing countries in terms of basic infrastructures such as pipe-borne water and sanitation facilities, expose the villagers to a variety of health related problems such as water-borne diseases. However, the large scale industrial growth has caused serious concerns regarding the susceptibility of groundwater contamination due to discharge of waste materials.

The usual source of drinking water is the streams, rivers, wells and boreholes which are mostly untreated and associated with various health risks (Agbarie and Obi, 2009). One of the targets of the millennium development goals (MDG) in terms of healthy living for the masses can be achieved through the supply of safe and convenient water (Orewole *et al.*, 2007).he Nationwide Rapid Assessment of Drinking Water Quality (RADWQ) conducted in 2004/05 by the Federal Ministry of Water Resources showed that some groundwater sources were contaminated by variety of pollutants across the country. It has been realized also that poor water quality could hinder the realization of the Millennium Development Goals (MDGS) target of having the proportion of people without sustainable access to safe water by 2015.

In most rural settlements in Nigeria, (Igabi Local Government inclusive) access to clean and potable water is a great challenge, resulting in water borne diseases. The out brake of water-borned diseases (like cholera, dysentery, and typhoid fever) recently in 2013 in some parts of Kaduna state may not be unconnected with the Portability of their sources of drinking water.

An Evaluation of Temporal Changes in Groundwater Quality in Igabi Local Government Area of Kaduna State, Nigeria was to determine the quality of water, in selected boreholes. This study investigated the hygienic sources of groundwater in Igabi Local Government area of Kaduna state used for domestic purposes and its quality parameters to ascertain the quality of groundwater delivered to the various houses.

MATERIALS AND METHODS

Study Areas and Locations

Kaduna state with a total land mass of 46,053 km² and is located on longitude 10° 20′ 0″ N and latitude 7° 45′ 0″ E. According to NPC (2006), the state is located in the North Western part of Nigeria with its capital in Kaduna town. The bedrock geology is predominantly metamorphic rocks of Nigerian basement complex consisting of Biotite Gneisses and older Granites. Kaduna State experiences a typical tropical continental climate of wet and dry type of season. The population of the residents in the state is totalled 6,113,503 as at 2006 National population count. Igabi local government is bounded by Kaduna South and Kaduna north to the south, and Birnin Gwari and Zaria local governments to the North. Figure 3.1 shows the map of Igabi Local Government Area indicating the points where samples were collected for this study.

Sample Collection Process

Thirty samples (boreholes) were collected for the study starting from November to April (Dry season) and May through October (Wet Season) of the year 2013 and 2014. Sample collection was done in the morning and evening basis to take care of any temporal changes in quality as a result of drawdown, recharge and depth of the well. Water samples were collected separately for each analytical parameter in different container of 250ml, 500ml and 500 for parameters of physicochemical analysis, heavy metals and bacteriological analysis respectively. Samples were taken to National Water Resource Institute laboratory and Heavy metals were analyzed at Kaduna State Environmental Protection Agency Laboratory according to the NSDWQ standard of 2007.

RESULTS AND DISCUSSIONS

The results of physical parameter for the various types of boreholes under consideration are presented in Table 1 below.

Table 1: Results of Physical parameter for Boreholes

Location		pH	Turbidity (NTU)	TDS (mg/l)	Elect. Cond. (us/cm)	Temp ^{0}C
1B	Wet	7.31	0.49	35.6	30.4	
	Dry	7.4	0.98	16.6	43	31.3
2B	Wet	7.18	3.8	157	120	30.4
	Dry	7.7	2.9	140	134	
3B	Wet	7.31	4.02	173	267	30.2
	Dry	6.56	5.3	278	46	
4B	Wet	7.34	3.72	40.9	37.9	30.3
	Dry	7.3	2.2	27	340	
5B	Wet	6.69	2.1	22.5	97.1	30.1
	Dry	7.9	2.7	40.3	75	
6B	Wet	7.42	4.7	90.3	123	318
	Dry	7.1	6.3	83.7	167	
7B	Wet	7.64	5	65	134	30.8
	Dry	7.3	4.2	42	192	
8B	Wet	7.18	4.45	82.2	120	31.4
	Dry	7.2	4.09	63	132	
9B	Wet	7.17	5.1	204	21.2	31.2
	Dry	7.18	4.7	123	11.6	
10B	Wet	7.92	5	165	267	30.2
	Dry	7.4	4	88	156.7	
WHO		6.5-8.5	5	150	1000	

The results of physical parameter of boreholes sampled are presented in table 2 above. The results show that the mean turbidity (3.34 NTU) for wet season was within the WHO and NSDWQ. This result agreed with previous work carried out in 2009 in some part of Kaduna State by the National Water Resources Institute, Kaduna to assess the drinking water quality.

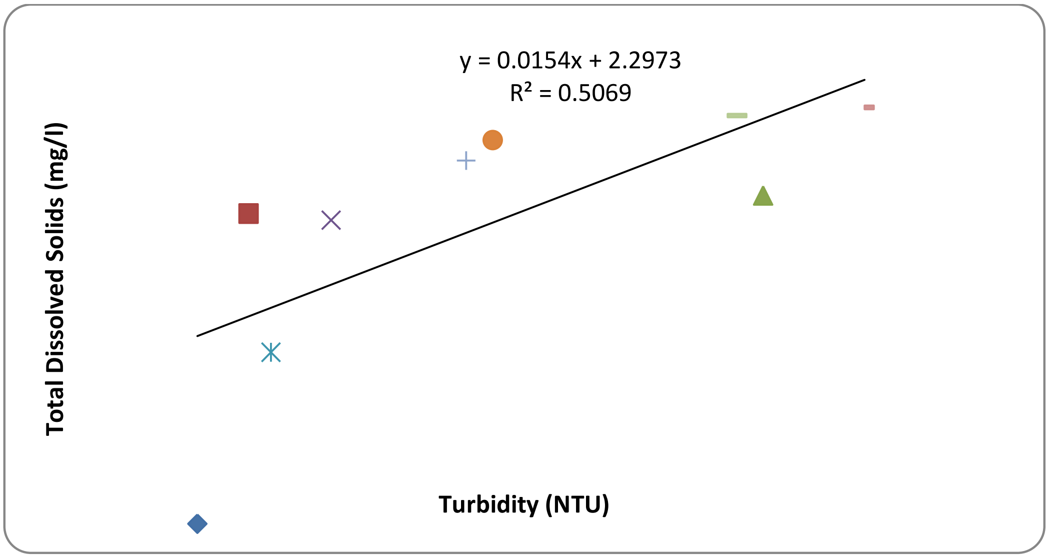

Fig. 1: Plot of TDS against Turbidity boreholes

The result showed that most boreholes water may be clear but contain some traces of manganese, (shiny tiny black particles). This is attributed to geological formation and aquifer characteristics of area. The mean turbidity for dry season (4.09 and 4.8 NTU) conform with both the WHO (2009) and the NSDWQ (2005) standard. This result indicated that with lower volume of water or dilution, lower turbidity values were obtained. Higher correlation of 0.894 exists between turbidity in wet season and that of dry season. However, higher turbidity was recorded in Dan fili (6.3), Rigachikun (6.0) and Igabi with 5.1 NTU. This result is similar to that obtained by Musa, *et., al* (2011), in their study of Physicochemical Assessment of Ground water use in some selected settlements in Minna, Niger State. They concluded that most wells get contaminated because of their closeness to pollution source. The results also agreed with that of Musa (2014) work on the Effect of Domestic Waste Leachates on Quality Parameters of Ground water, and that of Abdulbaki, *et al*., (2014) that concluded that the closer (within 8m) a shallow well`s location to an open dumpsite , the higher the value of physicochemical parameter it will contain.

The mean Total Dissolved Solid of 130.62mg/l for boreholes was high but falls within the WHO and the NSDWQ standard of 150mg/l with a standard error of 46.66. .On the other hand, the pH, and, Electrical conductivity are within the range of the set standard with the mean of 7.08 and 157.31us/cm respectively. Total Suspended Solids in the samples fall within the 500 mg/l of the set standard. This may be due to absence of serious construction activities around the studied areas that will allow for quick influx of sediment into groundwater via overland flow as observed by Drake,(2005). The suspended particles clouding the water may be due to such inorganic substances as clay, rock flour, silt, calcium carbonate, silica, iron, manganese. This result was affirmed by Ehinola, (2002) that concluded that groundwater characteristics are greatly affected by geological formation of the area.

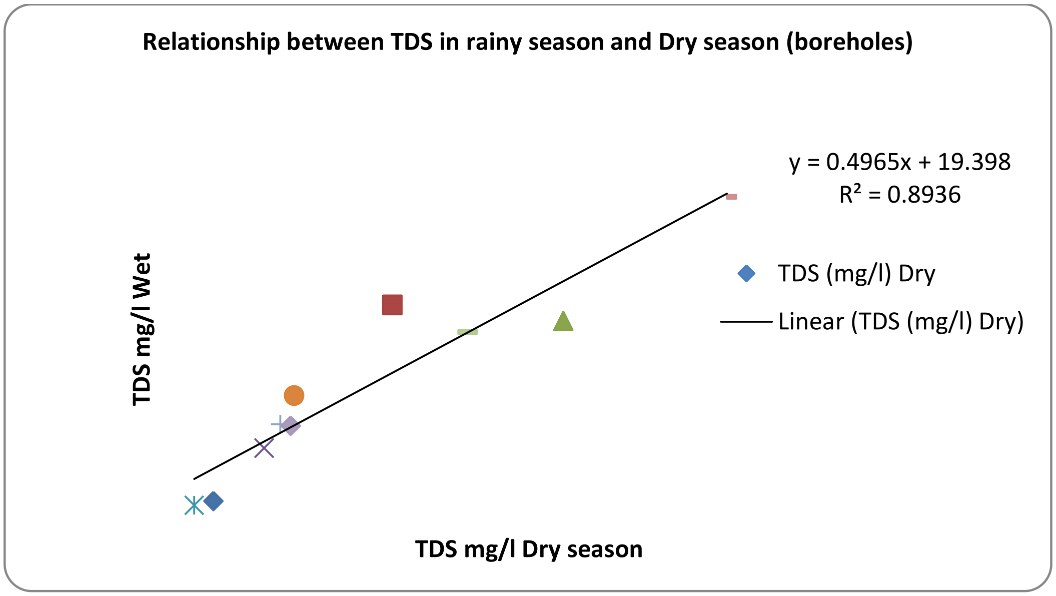

Fig. 2: Relationship between TDS in wet season and dry season in boreholes

The Total Dissolved Solid results show that during the wet season the mean value (164.03 mg/l) was above the WHO standard of 150mg/l with a standard deviation of 28.7mg/l. Total Dissolved Solid was also observed to be high in Abuja Road (260mg/l) and 379mg/l was recorded in Saminaka Road, Rigasa. These results conformed to that of Adeoye *et al.,* (2011) work on Evaluation of Water Quality Standards and Sanitary Conditions in Moniya Abattoir, Ibadan. This may be as a result of higher recharge during the wet season which encourages lateral influx of contaminants and other unwanted materials through the aquifer. On the other hand, the pH, and, Electrical conductivity are within the range of the set standard with a mean of 6.88 and 201us/cm respectively.

It was observed that chloride concentration is very low in Kwarau (a mean value of 6.3mg/l) and Igabi with a mean value of 12.97mg/l as compared with mean value of 22.07mg/l during the period of study. This result indicated that Chloride concentration is low where there is less urban and suburban development. This result is conformity with previous work carried by Federal Ministry of Water Resources in 2009 in some parts of Kaduna State.

Table 2: Results of Chemical Parameters (Boreholes)

S	Calcium	Fluoride	Magnesium	Nitrate	Sodium	Chloride	Bicarbonate
1B Wet	6.2	0.22	7.06	2.12	9.7	14.49	10
Dry	7.5	0.01	8.0	1.6	3.5	10.2	18
2B Wet	19	0.22	31.8	3.52	18.2	28	22
Dry	24	0.3	42.7	1.05	10.2	10	38
3B Wet	45	0.12	28	4.3	34	62.9	12.31
Dry	49	0.10	55	1.9	12.9	26.1	38
4B Wet	28	0.33	19.9	3.92	15.4	22.8	9.4
Dry	17	0.23	30	3.2	11.1	12.5	29.2
5B Wet	26	0.41	15	3.7	5.84	18.9	15
Dry	30	0.38	26	1.4	5.1	8	23
6B Wet	5.15	0.44	10.9	1.9	28	12	9.5
Dry	7	0.25	14	0.1	13	7.4	18.2
7B Wet	10.1	0.26	15	30	9.2	20.1	11.8
Dry	14	0.1	18	16	19.3	12.85	38
8B Wet	32	0.13	8.1	12	17.3	15.13	21
Dry	57	0.10	18	7	25.1	4.96	32
9B Wet	9	0.34	12.1	27	18.6	32.61	18
Dry	15	0.23	18	5.8	8	12.3	29
10B Wet	10.9	0.02	5	18	8.5	13	19
Dry	12.1	0.01	8.06	8.4	7.5	8.2	23
WHO	200	1.5	150	50	200	250	NGV

The result shows that the values of fluoride (0.189mg/l), Magnesium (15.704mg/l), Nitrates (6.35mg/l), Sodium (12.979mg/l), and Chloride (22.107mg/l) fall within the national and WHO standards of 1.5 mg/l, 50 mg/l, 200 mg/l and 250 mg/l accordingly. These results are related to that of National Water Resources Institute of 2009 on the Assessment of Drinking Water Quality in Kaduna and Taraba State.

Results of the analysis of the heavy metals (Table 3) in the sampled boreholes indicated most of them exist in a trace form and this called for continuous ground water monitoring and assessment in the area. Zinc had a mean value of 1.5517mg/l during the wet season, though within acceptable limit but still high and with a mean of 1.38 during the period of study. Cadmium in the sampled boreholes water has a value of 0.002mg/l in the same period which is slightly high though within the maximum permissible limit (0.003mg/l) of WHO Standard. This result shows that frequent water surveillance need to be undertaken in the area. On the other hand the mean value of Chromium, (0.00016mg/l), Lead (0.00003mg/l), Iron (0.132mg/l) are within the NSDWQ 2009 and the WHO 2011 standard. Manganese had a mean value of 0.00175mg/ which is very close to the maximum limit of 0.2mg/l of the

National standard. These results are in line with previous work carried out by National Water Resources Institute Kaduna on the Assessment of Ground water Quality in Kaduna State.

Table 3: Results of Heavy Metals

Location	Lead	Iron	Manganese	Zinc	Cadmium	Chromium
1B	0.004	0.1	0.03	0.18	0.004	0
	0.001.	0.11	0.02	0.17	0.002	0
2B	0.002	0.23	0.34	1.4	0.003	0
	0.005	0.18	0.25	1.3	0.002	0
3B	0.002	0.11	0.18	2.05	0.002	0
	0.001	0.09	0.14	2	0.001	0
4B	0.001	0.11	0.02	1.21	0.003	0
	0.001	0.1	0.03	1.18	0.002	0
5B	0.002	0.2	0.06	2.19	0.002	0
	0.001	0.18	0.04	2.01	0.001	0
6B	0.003	0.12	0.04	2.11	0.002	0
	0.001	0.1	0.03	2.01	0.001	0
7B	0.004	0.12	0.08	1.5	0.002	0.01
	0.001	0.06	0.04	1.1	0.001	0
8B	0.003	0.2	0.07	1.3	0.002	0.001
	0.002	0.18	0.05	1.15	0.001	0
9B	0.001	0.25	0.015	121	0.002	0
	0.001	0.21	0.09	1.18	0.001	0
10B	0.003	0.23	0.25	2.07	0.001	0.01
	0.001	0.19	0.16	2	0.002	0
WHO/NSD WQ	0,01	0.3	0.2	3	0.003	0.05

CONCLUSION

This study clearly showed that location of the wells may influence their quality as observed from the results. Any well within 2.4 meter will contain high nitrate concentration above the WHO standard and well sited within 9 meter to dumpsite or pollution source will be liable to faecal contamination.

The borehole located on Saminaka road, Rigasa, was discovered to have high turbidity, and a faecal coliform of 1cfu/100ml which is above the national and international standard of 0cfu/100m. In this location the Zinc level was high (1.395mg/ml) and iron was 0.23mg/ml though within the limit of the set standard but still high .The discoveries at this location may be connected to the location of the borehole to a drainage channel and its proximity to an old dumpsite. Boreholes located in Igabi and Rigachukun area have turbidity of 3.81 and

5.32NTU respectively which is slightly higher than the WHO/NSDWQ of 5 and 3 NTU respectively. In Rigachukun town the iron level in boreholes were slightly high (0.365mg/l and3.67mg/l). This result is above the National Standard of Drinking Water Quality (NSDWQ) of 0.3mg/l but it is portable when compare with the World Health Organisation (WHO) and standard of 1.0mg/l. It can be concluded that iron is an issue of concern in boreholes and groundwater in most part of the study area. It was observed in literatures that coloration that comes with water having high iron content, stained containers and fixtures make it objectionable. The results of the heavy metals indicated a mean value of 1.566 for Zinc, 0.00267mg/l for Cadmium, and 0.087 for Manganese which are close to the maximum acceptable limit of WHO standard of 3mg/l for Zinc, 0.003 for Cadmium and 0.1 for Manganese. The slightly high level of Manganese and Iron during April and July period make the water slightly turbid during this period. Water samples from Danfili and Saminaka Road are found not to be safe for drinking and higher iron found in Rigachikun make the water objectionable.

RECOMMENDATIONS

The following recommendations were suggested based on the result of the study. It is recommended that increased campaign be carried out for improved household and community sanitation in Rigasa and Danmani in particular and rural areas in the developing countries in general.

- Wells located within 9 meters from pollution source and wells less than 2.4 meters depth should be abandoned and future wells should be constructed beyond 15 meters from pollution source.
- Apron (cap) should be provided to protect inflow of surface waste into the wells.
- Proper lining should be provided to serve as additional sieve and protect against lateral flow of contaminants.
- Proper solid waste disposal method should be adopted, phasing out open dumpsites to safeguard public health from water borne diseases.

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