Groundwater Contamination from Septic Tanks in Selected Part of Kaduna, Nigeria

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Abstract: The groundwater of Kudenda and Nasarawa areas of Kaduna, in northern Nigeria, were assessed through chemical and bacteriological analyses of water samples obtained from shallow wells located in the study area. The essence of the study was to investigate the quality and the portability of the groundwater using the World Health Organization (WHO) standards for drinking water. The results showed potential contamination of the water in these areas as evidenced by the high concentrations of sodium, coliform count, calcium and magnesium values as compared to W.H.O. standards for safe drinking water. This result suggests that the water might have been contaminated due to human activities and closeness to pit latrines/septic tanks and domestic refuse dumps.
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1.0 Introduction

Groundwater is one of the most valuable sources of drinking water, and is also very important for many agricultural purposes. Since it is filtered through the ground, it is often fresh and cold and usually cleaner than surface water. Unfortunately, ground water quality is threatened every day by people who do not even realize the implications of their activities or how the extent of damage they are causing to it (Christine, 1993). The looming water crisis is becoming a major issue on the world agenda for the twenty-first century. The world water council presented the world water vision during the second world water forum and ministerial conference at The Hague in March, 2000 (Cosgroved and Rijsberman, 2000) as reported by Zaporozec (2002).

The vision document emanating from the conference reported that 1.2 billion people, or one-fifth of the world population, do not have access to safe drinking water, while half of the world population lack adequate sanitation. The vision document further stated that rapidly growing cities like ours, burgeoning industries and rapidly rising use of chemicals in agriculture have undermined the quality of many rivers, lakes and aquifers and also emphasizes that the impacts of agriculture on water quality are less visible over time but at least as dangerous as industrial, because many of the fertilizers, pesticides and herbicides used to improve agricultural productivity slowly accumulate in groundwater aquifers and natural ecosystems. Sources of groundwater contamination are usually associated with human activities. Through these activities, materials or waste may come into contact with groundwater, which may become contaminated (Larry, 2006).

According to Larner and Barrett (2001), solid wastes generated by private homes, businesses, industries and public buildings can be disposed of in the direct vicinity of these places or be collected and deposited at solid waste disposal sites. In many cases, these disposal sites may just be pieces of open land that have been fenced off, excavations and old mining areas or isolated ravines and valleys. In the case that no proper sanitary measures have been taken at the site, leachate may form and infiltrate into the subsoil. The leachate usually contains inorganic components including chloride, sulfates, carbonates, nitrogen compounds and metals and a wide range of organic compounds.

In many urban areas like Kaduna, the disposal of liquid waste, by septic tanks, cesspits and latrines is still practiced. The discharge of human waste more or less directly from latrines into pits is still common in many parts of the world. Poorly functioning septic tanks in the ground may overflow and discharge nitrogen-rich liquids into the unsaturated zone (Olaniyan et al, 2009).

Another worrisome development is the installation of cesspits to prevent nuisance at the land surface which carries liquid wastes like urine and human excrements, washing water e.t.c. which may contaminate wells where water table is high. In populated urban areas where their density is high, septic tanks, cesspits and latrines may seriously contaminate local groundwater resources beyond easy repairs. According to Shagari (2003), Niger Delta's groundwater contamination resulted from effluent of septic tanks. Lawal (2004) opined that the neglect of government in the provision of portable drinking water to local communities have compelled them to rely on well water for drinking despite the inherent risk.

The purpose of the study is to examine the physical and chemical properties of the water taken from shallow wells in the study area, since wells are the major sources of water in the area.

2.0 Materials and methods

Kudenda-Nasarawa area of Kaduna is located within latitude 10^0 28.765', longitude $07^0$23.028' and latitude $10^0$28. 820', longitude $07^0$22.500 both in Kaduna metropolis of Kaduna state. The water samples were taken from shallow wells used in homes for domestic water supply between the months of January and March when the water table is considered lowest. The samples were taken in plastic containers each of 1.5-litre capacity after being properly washed, cleaned and sterilized using sulphuric acid, and again rinsed with distilled water. At the point of collection, each bottle was half-filled with the water sample, shaken and poured away in order to stimulate the containers before being later filled up and covered. A total number of six samples were taken from randomly located wells and properly labeled to indicate the sample number and point of collection. The laboratory analyses conducted on the water samples include the PH, temperature, electrical conductivity, turbidity, odour, taste, hardness, carbonate, bicarbonates, chloride and bacteriological examination.

3.0 Results and Discussion

The results of the chemical and bacteriological analyses are presented in Table 1 below:

Electrical conductivity

The values obtained for all the samples were range between 29µs/cm and 60µmhos/cm. These values are within the W.H.O. standard for drinking water as shown in Table 2, and they also satisfied the Nigeria drinking water standard as shown in Table 3. This implied that electrical conductivity test does not reveal any health hazard in using water from these wells as drinking water.

Total dissolved solids

The total dissolved solids test showed 1800mg/l, 200mg/l, 1800mg/l, 400mg/l, 1600mg/l and 1000mg/l respectively for samples A to F. The W.H.O. standard allows between 500 and 1500. This then means that water samples taken from wells A, C and E are not suitable for drinking and pose health hazard in these areas.

Bicarbonate

The results obtained gave these values, 38.8mg/l, 16.8mg/l, 32.4mg/l, 31.2mg/l, 36mg/l and 108.4 mg/l for samples A to F respectively. These are within the W.H.O. standard of 90-160 mg/l. Water taken from these wells are free from excessive bicarbonates.

pH

As can be seen in Table 1, the pH values range from 6.56 to 6.92. The W.H.O. standard recommended a value range of 6.5-8.5. The values obtained fell within this range and hence considered suitable for drinking with respect to pH values.

Sulphate

Samples A to F, after analysis, gave the values 36.9mg/l, 17.9mg/l, 153.7mg/l, 248.3mg/l, 168.7mg/l and 257.9 mg/l respectively. The W.H.O. recommended a minimum value of 200mg/l and a maximum value of 400mg/l. Since the values obtained are all within the safe limits, there appeared to be no sulphate contamination threat for drinking from the wells.

Iron

The water sample results showed range of values from 0.09mg/l to 0.20mg/l for samples A to F. The W.H.O. standard gave range of 0.1mg/l to 1mg/l, suggesting that the results obtained are within safe limits for iron.

Table 1: Results of chemical and bacteriological analyses on water samples

Parameters	Units	A	B	C	D	E	F
PH		6.92	6.56	6.61	6.75	6.65	6.79
Temperature	^{0}C	31.4	31.1	31.4	31.2	31.3	31.3
Turbidity	NTU	10.4	5.1	8.4	3.7	2.2	4.9
Electrical conductivity	µmhos/cm	60	34	29	0.47	32	49
Calcium Ca^{2+}	mg/l	220	396	316	228	324	220
Magnesium Mg^{2+}	mg/l	128	144	250	220	240	144
Sodium Na^{+}	mg/l	100	188	198	180	200	106
Potassium K^{+}	mg/l	100	100	98	90	94	102
Bicarbornate HCO_3^-	mg/l	38.8	16.8	32.4	31.2	36.8	108.4
Chloride Cl^-	mg/l	92.3	92.3	92.3	149.1	120.7	120.1
Sulphate SO_4^{2-}	mg/l	316.9	179.7	153.7	248.3	168.7	257.9
Boron	mg/l	1.7	2.5	1.5	0.90	1.3	1.1
Total hardness	mg/l	372	296	240	260	208	328
Iron Fe	mg/l	0.09	0.15	0.11	0.08	0.08	0.02
Total dissolved solids	mg/l	1800	200	1800	400	1600	1000
Total suspended solids	mg/l	600	600	400	1000	1000	800
Total solids	mg/l	2400	1200	2200	1800	2600	1800
B.O.D	mg/l	45	55	40	5.6	3.8	52
C.O.D	mg/l	84.60	106.4	75.20	105.28	71.44	97.76
Coliform count	cfu/ml	8	17	10	2	14	24

Table 2: World Health Organization Drinking Water Standard

Substances	W.H.O. Maximum Guideline Value
$B.O.D_5$ (mg/l)	6.0
C.O.D (mg/l)	10.0
pH	6.5 – 8.5
T.D.S. (mg/l)	500
Elect. Conduct. (us/cm) Total Hardness as	-
C_aCO_3 (mg/l)	100
Acidity (mg/l)	500
Alkalinity(mg/l)	500
Sulphate (mg/l)	250
Chloride (mg/l)	250
Fluoride (mg/l)	1.4
Nitrate (mg/l)	10 as N; 45 as NO_3^-
Bicarbonate (mg/l)	500
Carbonate (mg/l)	500
Calcium (mg/l)	200
Magnesium (mg/l)	150
Iron as Fe^{2+}(mg/l)	0.3
Manganese (mg/l)	0.1
Chromium(mg/l)	0.05
Sodium (mg/l)	200
Potassium (mg/l)	15
Zinc (mg/l)	5.0
Copper (mg/l)	1.0
Mercury (mg/l)	0.001
Arsenic (mg/l)	0.05
Lead (mg/l)	0.05

Source: World Health Organization International Standards, 1971

Table 3: Nigerian Parameters and Maximum Allowable Limits for Drinking Water

Parameter	**Unit**	**Maximum Permitted**	**Health Impact**
Aluminum (Al)	mg/L	0.2	Potential Neuro-degenerative disorders
Arsenic (As)	mg/L	0.01	Cancer,
Barium	mg/L	0.7	Hypertension
Cadmium (Cd)	mg/L	0.003	Toxic to the kidney
Chloride (Cl)	mg/L	250	None
Chromium (Cr6+)	mg/L	0.05	Cancer
Conductivity	µS/cm	1000	None
Copper (Cu+2)	mg/L	1	Gastrointestinal disorder,
Cyanide (CN-)	mg/L	0.01	Very toxic to the thyroid and the nervous system
Fluoride (F-)	mg/L	1.5	Fluorosis, Skeletal tissue (bones and teeth) morbidity
Hardness (as CaCO3)	mg/L	150	None
Hydrogen Sulphide (H2S)	mg/L	0.05	None
Iron (Fe+2)	mg/L	0.3	None
Lead (Pb)	mg/L	0.01	Cancer, interference with Vitamin D metabolism, affect mental development in infants, toxic to the central and peripheral nervous systems
Magnesium (Mg+2)	mg/L	0.20	Consumer acceptability
Manganese (Mn+2)	mg/L	0.2	Neurological disorder
Mercury (Hg)	mg/L	0.001	Affects the kidney and central nervous system
Nickel (Ni)	mg/L	0.02	Possible carcinogenic
Nitrate (NO3)	mg/L	50	Cyanosis, and asphyxia („blue-baby syndrome") in infants under 3 months syndrome") in infants under 3 months
Nitrite (NO2)	mg/L	0.2	Cyanosis, and asphyxia („blue-baby syndrome") in infants under 3 months
pH	-	6.5-8.5	None
Sodium (Na)	mg/L	200	None
Sulphate	mg/L	100	None
Total Dissolved Solids	mg/L	500	None
Zinc (Zn)	mg/L	3	None
Total Coliform count	cfu/ml	10	Indication of faecal contamination

BOD

Samples A to F have B.O.D. values of 4.5mg/l, 5.5mg/l, 4.0mg/l,5.6mg/l, 3.8mg/l and 5.2mg/l respectively. These compare well with the W.H.O. standard of 5 to 7 and hence the water is free for drinking.

Coliform count

The coliform count for the sampled wells gave values of 8cfu/ml, 17cfu/ml, 10cfu/ml, 2cfu/ml, 14cfu/ml and 24cfu/ml for samples A to F respectively. W.H.O. standard gives a range 1 to 10 cfu/ml. Samples B, E and F values fall outside of the given range and therefore water from these wells are not suitable for drinking.

Sodium

Samples A to F give values of 100mg/l, 188mg/l, 198mg/l, 180mg/l, 200mg/l, and 106mg/l respectively. However, the W.H.O. standard recommended a sodium value of between 20mg/l to 150mg/l. It therefore shows that samples B, C, D and E whose values are found higher than the recommended values are not suitable for drinking.

Magnesium

Sample test results for samples A to F showed 128mg/l,144mg/l, 256mg/l, 220mg/l, 240mg/l and 144mg/l. W.H.O. recommended a range of 30mg/l to 150 mg/l. It then follows that samples C, D and E are not suitable for drinking.

4.0 Conclusion and Recommendation

The groundwater in Kudenda and Nasarawa area of Kaduna, in northern Nigeria, were investigated with a view to determining the suitability of water from shallow wells in the area for drinking, following the proliferation of cesspit/pit latrines in the area. The concern has been proved by the presence of excessive concentrations of sodium, magnesium and calcium and high coliform count in some of the sampled areas. This agrees with USEPA (1980) that septic tanks contaminate 1% of a nation's usable aquifers. It is recommended that the State Environmental Protection Agency should keep monitoring this situation before hazardous substances accumulate and cause outbreak of water-related diseases of epidemic dimension.

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