International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 3 Number 5 (2014) pp. 644-649**
http://www.ijcmas.com

Original Research Article

An Assessment of Some Water Quality Properties of Groundwater in Dutsin - Ma Metropolis, Nigeria

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A B S T R A C T

Keywords

Water quality; Ground water; Dutsin-ma

Problems of water borne diseases are expected wherever water quality has been compromised. This is the case with many Nigerian rural and urban settlements where, in the recent past, many water-borne diseases epidemics were reported. Hydro-chemical assessment of the ground water quality in borehole, and hand-dug-wells of Dutsin-ma metropolis, Katsina state, Nigeria was carried-out. This was aimed at establishing the hydro-chemical facies and determining their suitability for drinking and other domestic chores. Water samples collected from the sources were analyzed for Electrical conductivity, Turbidity and pH levels by the use of conductivity meter, turbid meter and pH meter respectively while total dissolved solids (TDS) were measured by evaporation and calculation methods (Hem, 1991). The results of the analyses were compared with FAO (1954), WHO, (1993) and EU, (1998) International Standards for drinking water and revealed that the means of all the parameters studied were within recommended standard values (RSV) for safe drinking water.

Introduction

Water pollution is any physical, biological, or chemical change in water qualities that adversely effects living organisms or makes water unsuitable for desired uses. Most of the groundwater is clean and pure but it can become polluted by resultant natural and human activities. Such pollutants may originate from leaky underground tanks that store gasoline, leaky landfills, or over application of fertilizers or other agro-chemicals on fields or lawns. When pollutants leak, spill, or are carelessly dumped on the ground, they move through the soil. Because it is deep into ground, groundwater pollution is generally difficult and expensive to clean-up. At times completely new wells have to be dug where the ones in use become contaminated by pollutants. Furthermore, the quality of groundwater is determined by geochemical reactions between the water and rock matrix as the water moves along flow paths from an area of recharge to area of discharge. The quality of groundwater can also change as a result of mixing of water from different aquifers. The natural sources of water contamination are poison springs, soil seeps or sedimentation from aeration. Although some kinds of water pollution can occur through natural process, they are mostly a result of human activities. Human beings use water daily in their homes and industries. The water they use is taken from lakes, rivers and underground. After use, most of it returns to its primary source. Water pollution also occurs when storm water run-off from urban and industrial areas and from agricultural land and mining operations makes its way back to receiving waters (river, lake or ocean) into the ground (Burger, 2004). Due to the increasing anthropogenic and natural activities, water pollution has become a topical subject of discussion the world over (Asiwaju-Bello and Akande, 2004; and Ige *et al*, 2008*)*. This study intends to focus primarily on changes that effect water quality.

Not many studies on groundwater quality had been carried-out previously in the study area. Abdulhadi, (2010) studied some parameters of water quality in the area where he determined the levels of phosphates and nitrates, while Zango, (2010) determined the levels of sodium and potassium in borehole water of the area. Most of the previous works emphasized on the determination and estimation of the levels of some elements found in borehole water rather than assessing the comprehensive chemical and physical quality determinants such as pH, turbidity and electrical conductivity.

This work is aimed at assessing the groundwater quality in Dutsin-ma metropolis, Katsina state, Nigeria. Specifically the objectives are to determine the pH, electrical conductivity (EC) and total dissolve solids (TDS) values; analyze the turbidity of the water samples and make recommendations based on the findings. Results from the study may give a picture of the current ground water quality status of the area, thus, serving as a guide to planners, decision makers and the general public alike in arriving at a decision as to how groundwater pollution may be controlled. It may also serve as reference material for future studies in the area.

Materials and Methods

Location

Dutsin-ma is a Local Government Area, LGA in Katsina State, Nigeria. It's headquarter is the town of Dutsin-ma. The Local Government has an area of about 527 KM^2. The coordinates of Dutsin-ma town lie between $12^0 27' 18''$ N and $7^0 29' 29''$ E (Oguntoyimbo, 1983). Dutsin-ma LGA share its borders with Kurfi to the north, Charanchi to the northeast, Kankia to the east, Matazu to the southeast, Dan-musa to southwest and Safana to the west.

Sampling technique

Random sampling technique used in selecting hand-dug-wells. The town was divided into four administrative council wards. In each ward, one hand-dug-well (7.5 – 12.0M) was selected accidentally. All the boreholes were considered, as only five boreholes were functional among nine in the town as at the time of the study.

Sample Collection and Analyses

The samples were collected on 26th March, 2011 between 6:00am and 6:30am, in HDPE bottles dry-washed with dilute hydrochloric acid and rinsed three times with the water samples before filling them to capacity and labeling them accordingly

(B_1, B_2, B_3, B_4 and B_5 for boreholes and W_1, W_2, W_3 and W_4 for hand-dug-wells). These were then stored in a temperature of -4^{0}C in the laboratory for analysis. For collection, preservation and analyses of the samples, the standard method (APHA, 1995) was followed. EC and pH were measured in the field immediately after collecting of the samples using portable field pH and electrical conductivity meters. Total dissolved solids (TDS) were measured following evaporation and calculation methods, (Hem, 1991) while Turbidity was measured using turbidity stand tube.

Results and Discussion

EC:

The mean EC for water samples from the boreholes was 575.4µS/cm while that of the hand-dug-wells was 540.0µS/cm. Table 2 shows that samples B_2 and W_1 were out-of-range of the Recommended Standard Values, RSV. For all other samples, the values were within the ranges of all the 3 standards compared in Table 1. Thus, except for sampling points B_2 and W_1, all other points may be said to be safe for human consumption. At high levels of Electricity conductivity, drinking water may have an unpleasant taste or odor, or may even cause gastrointestinal distress in humans.

pH:

The mean pH for the borehole collecting points was 6.91 (Table 2). The values were rather high (7.14 and 6.98) for points B_1 and B_5. This implies pH value differences of drinking water in Dutsin-ma metropolis between points. In the same vein, the mean content for the hand-dug-wells was 6.60, with slightly higher values of 6.9 and 6.7 for sample points W_1 and W_4 respectively and slightly lower values of 6.2 and 6.5 for samples W_3 and W_2 respectively. Sample W_3 was a little out-of-range of the recommended standard values for safe drinking water. Arthur *et al*, (1976) stated that pH of water can be influenced by various chemical and biological processes, geological and environmental processes. It may thus be concluded that drinking water from boreholes and hand-dug-wells in Dutsin-ma metropolis is suitable for drinking and other domestic chores, as it fell within the recommended standard values except for sample point W_3 which fell below the recommended threshold limit values (TLV's).

TDS:

High specific conductance indicates high solids concentrations and high temperatures of water. Furthermore, high dissolved solids concentrations can cause deterioration of plumbing fixtures and appliances. The mean TDS for all the boreholes recorded was 368.26mg/l, while that of the hand-dug-wells stood at 345.6mg/l (Table 2). Only samples B_5 and W_1 were out of range of the recommended standard values. Relatively expensive water treatment processes, such as reverse osmosis, are needed to remove excessive dissolve solids from water.

Turbidity:

The mean value for borehole samples was 5.0NTU which falls within the recommended standards, while the mean value for hand-dug-wells was 7.5NTU (Table 2) which is also within the recommended standards (Table 1). This suggests that the geology of the area is safe enough and does not harbor high quantities of particulate matter such as microscopic organisms, soluble colored organic compounds, silt, clay, etc, and the amount of finely divided organic and inorganic matter suspended in the water are very low.

This work was carried out on two common sources of water, borehole and hand-dug-well, to determine 4 essential parameters of EC, pH, TDS and Turbidity and compare them with international standard values.

Hand-dug-wells show lower pH than boreholes, the average mean values of pH for the boreholes and hand-dug-wells were 6.91 and 6.6 respectively. The average mean values of turbidity for the boreholes and hand-dug-wells were 5 and 7.5 respectively, implying that both fell within the international standard recommendations. For electrical conductivity, (EC) the boreholes had 575.4 µS/cm while the hand-dug-wells had 537.5 µS/cm, these were also within the acceptable ranges. In summary, all the average values of the parameters studied fell within the recommended threshold limit values, (TLVs) suggesting that the quality of the water from the two main sources in Dutsin-ma town is comparable to the internationally accepted levels of FAO, (1954) WHO, (1993) and EU, (1998).

Table.1 Recommended Standard Values for Safe Drinking Water

Parameter	**(EU, 1998) Standard**	**(WHO, 1993) Standard**	**(FAO, 1954) Standard**
pH	NA	6.5 – 8.5	6.5- 8.5
Turbidity (NTU)	<30	<30	<30
EC (µS/cm)	250-750	250-750	250-750
TDS (mg/l)	<450	NA	<450

Table.2 Results of the Parameters Studied from the Various Sampling Points

Boreholes					**Hand-dug-wells**				
Sampling Point	EC (µS/cm)	TDS (mg/l)	Turbidity (NTU)	pH	**Sampling Point**	EC (µS/cm)	TDS (mg/l)	Turbidity (NTU)	pH
$\mathbf{B_1}$	491	314.25	5	7.14	$\mathbf{W_1}$	901	576.64	5	6.9
$\mathbf{B_2}$	795	508.80	5	6.88	$\mathbf{W_2}$	300	192	5	6.5
$\mathbf{B_3}$	361	231.04	5	6.64	$\mathbf{W_3}$	266	170.24	10	6.2
$\mathbf{B_4}$	489	312.95	5	6.91	$\mathbf{W_4}$	693	443.52	10	6.7
$\mathbf{B_5}$	741	474.24	5	6.98	**Mean**	540.0	345.60	7.50	6.60
Mean	575.40	368.26	5	6.91					

Fig.1:Map of Katsina State Showing Dutsinma L.G.A. and the Study Location.
Source:- Gnes/Spot Image 2014.

Fig. 1: Map of Katsina State Showing Dutsin-ma LGA.

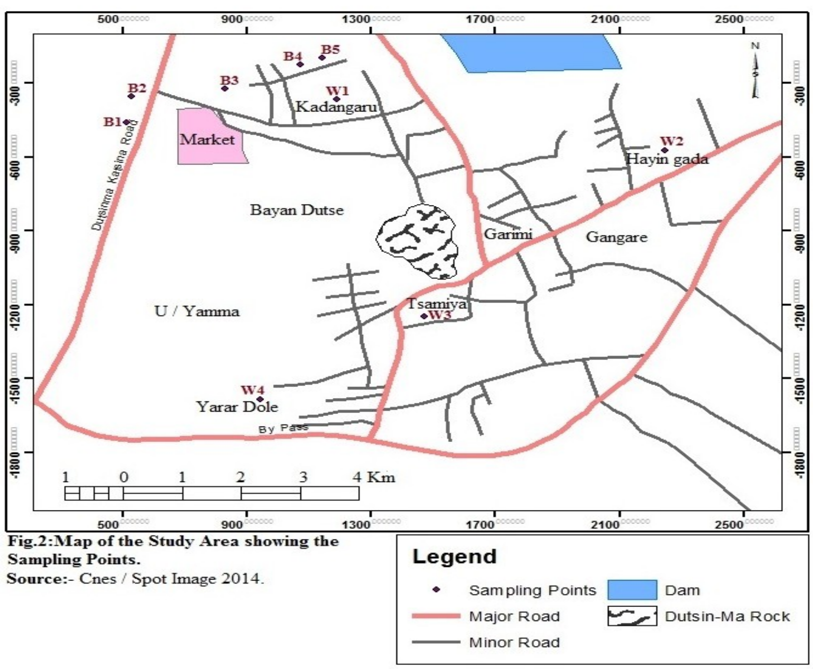

Fig.2:Map of the Study Area showing the Sampling Points.
Source:- Cnes / Spot Image 2014.

Fig. 2: Map of Dutsin-ma town showing the sampling points.

From the results obtained in this study, it is recommended that consumers around the sampling points whose values of results were outside the recommended threshold limits should be cautioned of the associated dangers that may manifest in future as a result of excessive accumulation in the body. Water from such sources may therefore be used for other purposes than drinking. Frequent monitoring of water quality from these sources should also be considered in order to detect early signs of hazards, just as there is the need for further studies to be carried out to investigate the levels of other parameters.

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