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Assessment of Underground Water Quality from Wash Boreholes in Some Selected Wards of Jere L.G.A. Borno State, Nigeria

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Abstract: *The study assessment of underground water quality from wash boreholes in some selecte ward of Jere Local Government Area, Borno State and the objectives of the study are: 1. to identify and examine the characteristics of wash boreholes in the study area, 2. To assess the quality of water from wash boreholes consumed by residents.The methodology involved sampling water from Wash Boreholes. Water samples were collected from Wash Boreholes from the selected wards. The five (5) wards were purposively sampled, taking into cognizance location of residential density and other periphery. Water samples were collected from 10 different wash boreholes, six (6) from commercial and 4 from private for the analyses of the physicochemical and microbial. Analysis will be conducted on ten (10) water samples and six (6) physical parameters and eight (8) cations and anions were analyzed in the samples. E-Coli a bacteria resulting from feacal contamination will be analyzed in all the ten samples while total coliform count was investigated in four samples. Water samples will be collected from 10 different Wash boreholes located from different geographical zones within the Jere local area of Borno state using sterile plastic bottle. Each of the Wash Borehole water samples will be analyzed for the following parameters; pH, Electrical conductivity, Manganese, Iron, Calcium, Bicarbonate, Sodium, Chloride, Nitrite, Sulphate, magnesium, potassium, Total Dissolved Solids, and Hardness. The Physiochemical and Bacteriological analyses were conducted at the Microbiology Laboratory of the Faculty Veterinary Medicine, University of Maiduguri. It is therefore recommended that Water quality analysis shouldbe carried out on all the boreholes in the area at least once in every two years to ensure that incidences of contamination are noticed earlier for remedial action to be taken. The communities should be educated on the need to keep their surroundings clean most especially around the boreholes.*

1.1 INTRODUCTION

Groundwater is the water located beneath the ground surface in soil pore spaces and in the fractures of rock formation (United States Geological Survey (USGS), 2009). Groundwater is the largest available source of fresh water as two thirds of global fresh water is found underground (Annenberg, 2012). About 2 billion people worldwide use groundwater and up to 80% of drinking water in Europe and Russia is groundwater (Earth Sciences for Society Foundation, 2005). In Africa including Nigeria, majority of the population rely on ground water supplies for drinking and other household uses. The intensity of human activities has led to increasing environmental pollution, which impacts negatively on environmental and human health. The pathways through which humans and other ecological entities are exposed to environmental pollutants include water, air, soil and plants. The mode of exposure is either by ingestion, inhalation, through the skin (dermal exposure) or a combination of two or all. Human activities which contaminate groundwater include landfill, mining, accidental spills of chemicals or waste materials, placement of septic and other tanks in hydrological and geological unstable locations, underground pipeline leakage, improper application of fertilizers and pesticides, among others (Lehr, 2002). Because groundwater is part of the hydrologic cycle, contaminants in other parts of the cycle, such as surface water, can be transferred into groundwater supplies (Groundwater Foundation, 2012). In the same vein, groundwater might contain some impurities, even if it is unaffected by human activities; the composition depends on the prevailing geology including the mineralogy of the rock materials through which the groundwater migrates (Lenntech, 2011). Further, groundwater being part of the hydrologic cycle also plays a significant role in maintaining the surface water systems through flows into lakes and base flow into rivers; thereby, supporting the inflow needs of the surface water. These flows are often crucial for maintaining the biodiversity and habitats of sensitive ecosystems (Tharme, 2003).Contaminated groundwater is unsafe for human consumption. The effects on any exposed populations can include sub-chronic toxicity, chronic toxicity and carcinogenicity, depending on the type of contaminants, leading to higher public expenditure on health care. In addition, surface water quality and the health of the aquatic organisms can be negatively affected when groundwater transfers contaminants to surface water through the hydrologic cycle. This study therefore seeks to assess groundwater quality from wash boreholes in some selected wards of Jere L.GA of Borno State.

1.2 Statement of Research Problem

The quality of groundwater in the aquifers of Nigeria has been little documented (British Geologic Survey, 2004). From the limited information available, groundwater compositions appear to be spatially variable and highly dependent on aquifer lithology (BGS, 2004). A large proportion of the population of Nigerian's relies on groundwater for domestic use. However treated borehole water supplies for natural chemicals by accredited water utilities are not available (Pritchard *et al;.,* 2007). There is health problems associated with intake of water with high concentrations of chemical compounds from groundwater (EPA, 2008). Due to the fact that fluoride levels of drinking water sources have not been adequately done it has caused dental fluorosis to children of primary school age and in extreme cases death (Sajidu *et al;.,* 2007). EPA (2008) observes that the short-term problems associated with excessive levels of nitrate in drinking water are serious illness and sometimes death especially in infants. These problems range from an acute condition in which health deteriorates rapidly over a period of days. Long-term intake of nitrates and nitrites has the potential to cause diuresis, increased starchy deposits and hemorrhaging of the spleen (EPA, 2008). In recent times, due to the unreliable sources of water and convenience, most well to do individuals in the study area sunk

Wash Boreholes within their compounds for domestic consumption and others for commercial purposes. Some of the Wash Boreholes are either close to Septic Tanks, Solid Waste Dumpsites, Soak away and drainage system. The Wash Boreholes Several studies were conducted on water contamination (Bukar, 2012, Kagu *et al,* 2013). Kagu *et a,l* assessed waste water from households, while Bukar, 2014 assessed rain water for their quality and majority of other studies concentrated on deep Boreholes, but assessment of wash borehole water for its quality was not conducted in this area. It is against this backdrop that this study assessed groundwater quality from wash boreholes in some selected wards of Jere L.G.A, of Borno State.

1.3 Objectives of the Study

i. identify and examine the characteristics of wash boreholes in the study area,
ii. assess the quality of water from wash borehole consumed by residents,
iii. determine the relative distance of wash boreholes to the source of contamination and
iv. identify and examine water contamination related diseases and infections.

2.0 CONCEPTUAL FRAME AND LITERATURE REVIEW

2.1 Concept of Ground Water

The quality of water available from underground aquifers may be superior in many respects to the quality of surface water. For instance, if a stream is located in a gravel stratum, a supply of suitable drinking water might be obtained by drilling or digging a well into the aquifer that recharges the river. Ground water contains higher dissolved solids concentrations than surface waters of the same local environment. Majority of the minerals contribute to hardness (calcium and magnesium) and alkalinity (bicarbonate, carbonate, and hydroxide) due to increased concentration of carbon dioxide in the ground water. Hydrogen sulphide may be found in some well waters in populous urban centres like Onitsha, Lagos, Kano, Enugu, Ibadan, etc. Although, groundwater is less subject to contamination as compared to surface water, it is still contaminated by salt intrusion, domestic and industrial effluents, seepage of agricultural chemicals coupled with flooding by runoff water, all contribute to contamination. Ground water can be extracted at any point in the geological formation but the depth and type of cover over the groundwater determine feasibility of constructing a well for water supply. Borehole is a well drilled into the sub-surface aquifer for the purpose of exploiting ground water. Aquifer is a porous and permeable rock hosting water or a water saturated geological unit or formation that may be exploited for water for economic use. It is solely drilled to provide water for drinking, domestic and industrial uses. Boreholes are situated in unconfined sedimentary basin that exceeds 2000m. Hand dug-wells are between 16-45m deep, there is seasonal fluctuation, the water column rises in rainy season but decreases or may dry up in dry season.

2.2 Groundwater uses

Over 1.5 billion people worldwide depend on groundwater for drinking and of the world's water that is usable by humans, 98% is stored in aquifers (www.groundwater.org). The chemical constituents of the ground water determine its usefulness for drinking and domestic use, industry and agriculture (Fetter, 1994). Principally water is used at household level for drinking, hygiene and sanitation. Many studies on the multiple use of water have identified and quantified the livelihoods benefits from using water (Van Koppen, *et al;.,* 2006). In the developed world groundwater has been used as a pivot for development. As groundwater is an integral component of the hydrological cycle, the health of the streams, lakes, wetlands, and associated ecosystems depends upon groundwater. Groundwater also sustains economic activities by providing significant water supplies for industries involved in manufacturing, mining and petroleum (Van Koppen *et al;.*, 2006). Although groundwater is a renewable resource, it is not limitless and requires wise management to protect its integrity, security and sustainability.

2.3 Groundwater Quality

Water is formed by the union of two hydrogen atoms with one oxygen atom in an asymmetry bonding (Freeze and Cherry, 1979). This asymmetrical arrangement gives rise to an unbalanced electrical charge that imparts a polar characteristic to the molecule. This means that water in liquid state is composed of molecular groups with the molecules in each group held together by hydrogen bonding. Groundwater chemistry changes as water moves along its paths, increasing the ion concentrations with distance and time. Water drawn from boreholes in rural areas is perceived to be of good quality as such no treatment for chemical constituents is done before use. Fetter (1994), argue that, natural waters are never pure and contain some amounts of dissolved gases, solids, and suspended materials.

Generally both surface water and groundwater are acceptable for human consumption (Kundell, 2008). However, due to recently increased agricultural activities, there has been considerable degradation of water resources as a result of increased siltation in rivers and reservoirs. This is most severe in areas that are under immense population pressure, resulting in serious deforestation and cultivation of marginal and other fragile areas (Aquastat, 2006). Groundwater is more mineralized in alluvial aquifers than in the weathered basement aquifers (Kundell, 2008).

2.4 Groundwater Contamination

The sources of groundwater contamination are many and the contaminants numerous (Fetter 1994). While industrial effluent may find its way into the groundwater, suburban areas have its groundwater with high levels of nitrate due to use of lawn fertilizers and septic tank discharge while agricultural areas, have high levels of fertilizers found in groundwater and also specialized synthetic organic and inorganic chemicals as well (Fetter, 1994). Landfills in urban and rural areas are known sources of groundwater contamination. While most of the elements are actually necessary to support healthy ecosystems such as, nitrates, and phosphorous associated with groundwater, it is not the simple presence of these items that is problematic, but the excess amounts that pollutes groundwater resources for both human use and natural ecosystems (TWDB, 2002).

2.5 Contaminants/Pollutants Affecting Groundwater Quality

The degree of pollution of a given water resource system is a function of its water quality characteristics. The usefulness of water to serve a required purpose is determined mainly by the effects of concentration levels of the constituents.

Some of these contaminants/pollutants are those emanating from:-

(i) Agricultural contamination
(ii) Sanitary landfills and garbage dumps
(iii) Biological contamination
(iv) Heavy metal contamination

Table 2.1 Sources and Health Effects of some Heavy Metals

Metals	Sources	Effects
Cadmium (Cd)	Coal, petroleum, mining and smelting operations, fossils fuel combustion, sewage sludge disposal, fertilizer application, paint pigment etc.	Kidney dysfunctions, hypertension, anaemia, lever damage, vomiting carcinogenic, diarrhea, muscle scramps, nausea.
Copper (Cu)	Natural deposits, plumbing materials	Essential nutrients, high doses causes gastrointestinal disturbance, nausea and vomiting, lever and kidney damage
Lead (Pb)	Volcanic erruptions, sea salt sprays, forest fire, mining and smelting operation, leaded gasoline, batteries	Enzym inhibition, kidney impairment, neurological disorders, teratogenic effect birth defects
Mercury (Hg)	Coal, mining and smelting operations, fossils fuel combustion, electrical appliances, insecticides, fungicides, pharmaceutical	Kidney malfunctions, renal effect, teratogenic effect, neurological disorders, enzyme inhibition, carcinogenic
Iron (Fe)	Natural deposits, industrial wastes, domestic wastes	Essential nutrients at high doses causes gastrointestinal disturbances, brown stains in laundry
Manganese	Occurs mostly with Fe deposits	As with Iron

Source: Field Survey, 2021

3.0 Methodology

3.1 Nature of Data: The study assessed the groundwater quality from Wash Boreholes in some selected wards of Jere L.G.A. The study is mixed experimental and mapping. It involved collection of water samples and laboratory analysis for quality, as well as prevalence of water borne diseases. The generated data included information on the characteristics of wash boreholes in the study area, quality of water from wash borehole consumed by residents, the relative distance of wash boreholes to the source of contamination and the nature of water contamination related diseases and infections.

3.2 Sources of Data: The data used in the study are essentially from primary sources, which were generated through laboratory analysis of water samples. Therefore, data used involved interval/ratio (values from the laboratory tests). These include values of parameters considered in the water quality analysis which were given in mg/l or coliform count/100ml of sample; type and frequency of waterborne diseases/illnesses reported in households. Data from documentary sources were also used. These are mandatory standard limit values of water quality constituents of WHO Water Quality Guidelines 2008 and that of Standards Organization of Nigeria 2007; and hospital records of frequency of waterborne diseases for the study area from the epidemiological unit, Borno State Ministry of Health. Equally, the secondary sources of data were also used which included journals, publications, review of some literatures and the internet.

3.3 Water Sampling Procedure

The study involved sampling water from Wash Boreholes. Water samples were collected from Wash Boreholes from the selected wards. The five (5) wards were purposively sampled, taking into cognizance location of residential density and other periphery. Water samples were collected from 10 different wash boreholes, six (6) from commercial and 4 from private for the analyses of the physicochemical and microbial.

Taking the water samples and analysis procedure were guided by the standard method for water analysis (APHA, 1989), and were done with the assistance of two graduates. They were trained and pre-brief before the actual sampling, thus they were acquainted with the technicalities of water sampling procedure, handling and conveyance of samples. The necessary resources for smooth sampling exercise were also mobilized at that point. All water samples were collected using plastic bottles, which were washed with the samples water in addition to the earlier sterilization by boiling. All samples were appropriately labeled with the respective wards.

3.4 Sample Collection

Analysis was conducted on ten (10) water samples and six (6) physical parameters and eight (8) cations and anions were analyzed in the samples. E-Coli a bacteria resulting from feacal contamination were analyzed in all the ten samples while total coliform count was investigated in four samples. Water samples were collected from 10 different Wash boreholes located from different geographical zones within the Jere local area of Borno state using sterile plastic bottle. Each of the Wash Borehole water samples was analyzed for the following parameters; pH, Electrical conductivity, Manganese, Iron, Calcium, Bicarbonate, Sodium, Chloride, Nitrite, Sulphate, magnesium, potassium, Total Dissolved Solids, and Hardness. The Physiochemical and Bacteriological analyses were conducted at the Microbiology Laboratory of the Faculty Veterinary Medicine, University of Maiduguri.

3.5 Laboratory Analysis

The analysis covered the interpretation of the laboratory analysis of the obtained samples from Wash Boreholes. The equipment used for the analysis of water samples included the Inductively Coupled Plasma – Optical Emission Spectrometer ICP – OES, monochromator, UV/V Spectrometer, evaporating dish and spectrophotometer, MacConkey agar plate and a 10-15X microscope. The statistical tools used are essentially descriptive, where means, percentages as well as tabulations were applied in the presentation of results.

Table 4.1 Results for water analysis

Sample Wards	pH	Ec	TDS	Na	K	Ca	Mg	NO_3	E-Coli	DO %	BOD_5	Mn	Fe
Ngomari WBH A	7.07	323	168.0	30.0	6.350	10.66	21.36	7.46	3.0	11.0	8.0	0.021	0.068
Ngomari WBH B	7.02	318	167.0	28.6	7.000	9.95	17.42	8.43	3.0	11.0	8.0	0.022	0.066
Bale Gal. WBH 1	7.65	198	100.0	30.8	5.000	20.03	13.83	3.59	5.0	14.0	9.5	0.042	0.043
Bale Gal. WBH 2	7.72	198	102.0	37.5	5.000	14.62	11.60	2.83	5.0	14.0	9.5	0.042	0.043
Old Maid. WBH 1	7.60	908	405.0	90.0	10.00	24.82	15.00	2.48	ND	14.0	6.5	0.063	0.055
Old Maid WBH 2	7.72	911	427.0	93.7	10.00	26.03	14.11	2.69	ND	14.0	6.5	0.065	0.054
Mashamari WBH 1	6.74	1367	683.0	240.7	5.930	45.95	19.33	7.45	5.0	8.0	7.5	0.022	0.022
Mashamari WBH 2	6.68	1431	715.0	230.0	5.220	42.88	22.46	6.90	5.0	8.0	7.5	0.020	0.022
Goni Kachallari WBH1	7.01	1237	196.0	51.82	3.21	2.65	2.89	2.77				2.01	3.01
Goni Kachallari WBH2	7.15	2620	425.0	57.32	3.63	3.05	2.72	2.21				1.92	2.86

Table 4.2 Bacteriological Results of Some selected water samples

Sample ID	Total coliform count/ml	Fecal coliform count	Bacterial Isolation
Old Maiduguri 1	80.0	1.0	Cognebacteria species, bacillus subtilis
Old Maiduguri 2	60.0	0.0	No bacteria growth
Goni Kachallari 1	47.0	0.2	Cognebacteria species, bacillus subtilis
Goni Kachallari 2	55.0	0.0	No bacteria growth
WHO	10	-	Nill
NSDW	10	-	Nill

The results of water samples indicate that the concentration of the Cations and the Anions are all within the recommended values for domestic applications as stipulated by the World Health Organization (WHO) guidelines. Na, K, Ca, Mg values for all the locations are within the WHO recommended guidelines. This may be as a result of the seepage of the water to the subsurface carrying along dissolve particles. The same was the case with the dissolved solids measured 750mg/l in Mashamari Wash Borehole 2 while the highest TDS value of 715mg/l was also recorded at Mashamari Was Borehole 2. Other variations in the chemical and bacteriological concentration are basically due to the general geology of the area and the nature of subsurface formations. Most wash boreholes that are shallow show a tendency of contamination due to the closeness of the water to human activities. The results indicate that Fe, Zn, Cu and Mn has a very low amount of these metals in some locations while in some locations it was not detected at all.

E-coli were also observed in Wash Boreholes of Mashamari, Bale Galtimari and Ngomari. This might not be separated from their proximity to the earth surface. Heavy metal concentration seems to be very low in all the locations. Mn, Cu,Zn and Fe were analyzed and a high value of 0.100 Mg/l and 0.080 Mg/l of Mn, and Cu were observed in Mashamari and Ngomari Airport Wash boreholes respectively. These elements were however not detected in twelve (12) other locations. Most high concentrations were measured from Wash Boreholes because the Wash Bore holes collects infiltrated water and with less distance from the ground surface, natural filtration of the water is not effective, thereby allowing these metals to settle easily.

Bacteriological data indicated that the E-coli value obtained from some locations are insignificant. They are also mostly from Wash Boreholes. The proximity of the Wash Boreholes to pit latrines may be responsible for the E-coli presence in some wash boreholes. Findings by (Bashir and Adebayo,2003), on seasonal variation in water quality and outbreak of water borne diseases in Yola, indicates that the distribution of diarrhea and typhoid fever is considered high in the nine months of dry season, the record suggests that 34.9% of the diarrhea cases were reported in the three rainy months, while 65.1% of cases in the nine dry months which were attributed to increasing pollution of water sources with diarrhea causing pathogens. In the case of typhoid fever 79.9% of the cases were reported in the nine dry months. There is no doubt some of the water sources get contamination from microbial pathogens during the rainy season but however, cases during the dry season may not be ruled out.

5.0 Conclusion and Recommendations

5.1 Conclusion

The analysis centered on the results of laboratory analysis of Wash boreholes water samples collected in the five selected wards of Jere LGA. The results portrayed the physical, chemical and microbial qualities of the water samples against the standards of the WHO and the Nigerian Standard Organization. The differences of quality between water samples were highlighted. All the three physical parameters analyzed are within the permissible limits of the standards; as for chemical quality, most parameters tested are within the permissible limit, only the concentration of chromium exceeded the permissible limits. The two microbial parameters tested shows different results. The total coliform counts in all samples are less than the 10 cfu/100ml of sample recommended by both standards. But for the e.coli count, the 0cfu/100ml of sample is not attained in many samples. The quality of wash boreholes water consumed by residents is confirmed by the study to be of low quality. This is attributed to the shallowness of the Wash boreholes and the non-compliance to the recommended guidelines to distance specification between boreholes and point pollution sources, urbanization, improper waste disposal and management, erection of pit latrines, septic tanks and soak away.

5.2 Recommendations

Based on the findings, the study recommended the following:-

- ✓ Water quality analysis should be carried out on all the boreholes in the area at least once in every two years to ensure that incidences of contamination are noticed earlier for remedial action to be taken.
- ✓ The communities should be educated on the need to keep their surroundings clean most especially around the boreholes.
- ✓ The main policies and guidelines relating to the management of groundwater quality should be strictly enforced.
- ✓ The communities should be educated on the dangers associated with sighting of Wash Boreholes near pollution points.
- ✓ Proper solid and liquid waste disposal methods should be enforced by the agencies responsible.

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