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ASSESSMENT OF GEOGRAPHICAL DETERMINATS OF WATER QUALITY IN SOME SELECTED URBAN RESIDENTIAL ESTATES IN IBADAN

Jimoh Usman Umar[A]

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ABSTRACT: *The study assessed water quality in the residential estates of Ibadan North Local Government Area, Oyo state, Nigeria. A purposive sampling technique was used to select 7 estates (Aerodrome, Aare (one of the estates in Bodija), Basorun, Ashi, OLuwokekere, Oluwonla and Ikolaba, because of the high concentration of boreholes there. Consequently, a copy of household pretested questionnaire was systematically administered to 326 respondents in every 5th building, drawn from the selected estates. Issues that raised include the socioeconomic characteristics of respondents, dominant sources of water, water analysis was carried out on the physiochemical (iron, lead and zinc) characteristics, temperature and pH of the water on site and the perceived effect of metals on health of the respondents. Both descriptive and inferential statistics were carried out at p<0.05. The study revealed the water quality in estates are acidic as the pH scale of estates water was between 4.0, and 5.5. the study also revealed Physiochemical parameters to be iron (0.634), lead (0,058) and zinc (0.073). It was revealed that more than 90% of respondents that went for medical checkup were diagnosed with diabetics. Conclusively, the quality of water in the area fell below the acceptable standard. therefore, prospective borehole sinker should carry out water treatment and also follow appropriate planning guideline in the sinking of boreholes.*

Keywords: *Water quality, Water, Residential Estates*

BACKGROUND TO THE STUDY, CONCEPTUAL FRAMEWORK AND LITERATURE REVIEW

Water is a common solvent essential to man for various such as industrial and agricultural processes, waste disposal, drinking, cooking, and human recreation. Man contends with two main problems, which are the quantity (source and amount) and quality of water in Nigeria (Adeniyi, 2004). In view of its occurrence and distribution pattern., water is not effortlessly available to man in the anticipated amount and quality. This is a difficult experienced in most towns and cities in the emerging countries let alone in their rural settings. These factors have led to the increasing rate of water borne diseases like Typhoid fever and Cholera experienced in such part of the world (Edwards, 1993). In the advanced nations like the United States of America in

[A] Department of urban and regional planning, Faculty of environmental design and Management, University of Ibadan, Oyo State, Nigeria; Contact: jimoluadams@gmail.com

particular, cases of outbreaks of diseases associated with contaminated portable water have been documented (Moore et al., 1993).

Water quality is a term that is most recurrently used, but seldom distinct, perhaps because it has no stable description, but apparently well understood by users. Conversely, the required properties of potable water should include adequate amount of dissolved oxygen at all time, a relatively low organic content, pH value near neutrality, moderate temperature, and freedom from excessive amount of infectious agents, toxic substances and mineral matter (Adeniyi, 2004). Water quality is most commonly used with particular locus to a set of standards against which acquiescence can be assessed. In 2015 the World Health Organisation (WHO) estimated that 30% of the people in West Africa still lack access to safe and clean drinking water. Historically, surface and groundwater have remained the major sources of water supply in African cities. Nonetheless, owing to increase in urbanisation and industrialisation coupled with high cost of developing new dams, the quality and quantity of surface water decline given room to urban groundwater as a better option (Adelana et al., 2008). This merit notwithstanding, urbanisation has noteworthy overall implications for freshwater use and waste management, specifically for the development, fortification and management of sub-surface water in an urban environment (Eni et al., 2011).

Several elements are accountable for water pollution, which makes it quite detrimental for portability. Such factors include sewage discharge, which contributes to oxygen demand and nutrient loading to a destabilised aquatic ecosystem, agricultural practices and industrialisation (DWAF and WRC, 1995; WRC, 2000). One of the outcome of inadequate urban planning process is evident in inability of population growth to match the available portable water. It is the world's poor that are mostly affected by 'ecological poverty' in form of inadequate supplies of good quality water (Agarwal and Narain, 2004). Therefore, enlightening management of water resources in poorer, emerging nations is vital for the improvement of quality of life and for further expansion in these regions. Accessibility and availability of fresh clean water is a strategic to sustainable growth and critical constituent in food production, health, and poverty declination. In the initial period, an estimated 1.2 billion people around the world lack access to safe water and near to 2.5 billion are not provided with suitable sanitation (Third World Water Forum on Water, 2003). Global estimate revealed that, over 50,000 people die daily due to water borne diseases (Herschy, 1999), while mortality in children between the ages of zero to five years according to USAID, (1990) and Warner, (1998) were attributed to water related diseases which annually is estimated to be about 4 million in developing countries. For instance, in Nigeria, particularly in Ibadan metropolis, portable water has been insufficient, in terms of quantity and quality. Countless studies have been undertaken to examine and evaluate the quality of drinking water. For example, it was discovered in a study carried out in Pakistan's biggest city, Karachi, that, out of hundreds of water samples tested, not a single was found safe for drinking (Ihsanullah, 20090). Additional study showed that, in district Kohat (KPK), 18 samples were collected from multiple sites to test the physiochemical parameters (pH, TDS, Alkalinity, Electrical conductivity, etc). it was revealed that most of the samples were contaminated (Ahmed et al., 2012). Adebo and Adetoyinbo (2009) assessed the groundwater quality in an unconsolidated coastal aquifer of Lagos, and documented that of all the parameters considered, chloride concentration surpassed WHO expected standard for drinking water, which was traceable to saltwater incursion. In Warri town, the study carried out by Akunobi and Chibuzor (2012) on the quality of groundwater revealed it to be slightly acidic, showing a heavy metal such as Pb, Cr, Zn, Cd and Cu. Water type delineated are Ca-Mg-HCO_3, $NaHCO_3$, NaCl. The occurrence of alkali and alkali earth metallic ion and chloride are a major attribute of seawater intrusion, while heavy metal reflect the increasing impact of anthropogenic activities.

Many theories have been used in solving water quality challenges. One of such theories is referred to as 'SPARROW' (Spatially Referenced Regressions on Watershed attributes) (Smith et al., 1997). It is a watershed modelling procedure that uses process-based and a crossbreed statistical approach to appraise pollutant causes and contaminant transport in watersheds and surface waters. Its estimation is done in a nonlinear regression model by processing components and contaminant supply, including surface-water flow paths, mass-balance constraints non-conservative transport progressions. Factors of the regression equation are estimated by correlating generally available stream water-quality records, such as those from State and Federal monitoring programs, with GIS (Geographical Information system) data on pollutant sources (e.g. atmospheric deposition, fertilizers, human and animal wastes), hydrological and climatic properties (precipitation, topography, vegetation, soils, and water routing) which affect contaminant transportation.

Meanwhile, literature have demonstrated that groundwater from the boreholes analysed in Gwagwalada area of Abuja Metropolitan City, had turbidity, total dissolved solids, magnesium, total hardness concentrations beyond the WHO approved limit for drinking water in some of the wells while nitrate was though found to be within WHO acceptable manual limit for drinking water (Ishaya and Abaje 2009). Danmo et al. (2013) carried out a study in both Bama and Kondga towns in Bornu State and observed that nitrate, manganese, faecal coliform concentrations in both hands dug wells and boreholes were above the WHO permissible limit for drinking water. Similarly, Idris-Nda et al. (2011) appraised the chemical quality of groundwater quality in Minna Metropolis and established the presence of heavy metals with high concentrations like magnesium, copper, arsenic and lead. Cat ions too was found to have the highest concentration of manganese, sodium and dominant anions HCO_3, CO_2 and NO_3. The groundwater was generally found to be of good quality. In Ibadan Metropolis, Ayantobo et al. (2012) measured the quality of water from hand-dug wells and noted nitrate, faecal coliform and total coliform at objectionable levels and are pronounced in wells located close to domestic wastes, abattoir, pit latrine and stagnant water and drainage. Atarche and Egbuna (2013) assessed the quality of water from hand-dug well in Akure town noted groundwater to be acidic, with electrical conductivity exceeding WHO given limit for drinking water. Geology of the area is concluded to have influence the quality of groundwater of the area.

Furthermore, still on the acidity of groundwater, Nwankwoala and Udom (2011) carried out a study in the Niger Delta area of Nigeria, particularly in the eastern part and found groundwater to be acidic, with high chloride concentration which was linked to saltwater intrusion., All these studies have concentrated more on the constituents of groundwater rather than its impact on human health. The study therefore is designed to assess the geographical determinants of water quality in some selected urban residential states in Ibadan.

STUDY AREA

Ibadan-North Local Government is geographically located on latitude 70231N and 30331E and on longitude 70281N and 30531E. Ibadan-North is bounded in the North by Akinyele local government, in the East by Lagelu local government and Egbeda local government, in the West by Ibadan-Northwest local government and in the South by Ibadan-Northeast local government. It occupies a total landmass of 145.58 square kilometres (Federal Republic of Nigeria Official Gazette, 2007). The population of the local government according to 1991 population census was 300,939 out of which 151,838 are male and 49,101 are female. However, the projected population for 2015 is 414,508; this is because no official projection has been made since then. The static water level which is the stable depth from the surface where water will settle after a well is drilled and not pumped varies from 0.0 to over 35m. The chemical constituents as shown by the concentration of calcium, sodium, chloride and iron, reflect the general rock type of the environment, which contains mainly feldspars, amphibolites, pyroxenes and biotites. The study area is characterised by metamorphic Pre-Cambrian Basement Complex rocks with Gneisses as the predominant rock type.

There are six major land use types within the Ibadan-North local government area, which are residential land uses ($69.88km^2$) which is 49% of the local government, public and semi-public uses, which covers $53.87km^2$ with 38% of the local government, commercial land uses, which is 5% of the local government and coverage area of $7.82km^2$, recreation consists of 2% of the local government and coverage area of $2.91km^2$, government acquisitions is 3% with area coverage of $3.82km^2$ and industrial land uses with area coverage of $3.82km^2$ and 3% of the local government (Ministry of Lands, Housing and Urban Development, 2016). The residential allocation in the study area covers low density areas such as Agodi G.R.A., old and new Bodija Estate, Agala Estate, Ashi and Basorun, which are residence of elites and nobles in the society. The high density

Figure 1. Showing Oyo state within Nigeria

Source: Authors' Field work

residential areas include Agbowo, Mokola, Ijokodo, Oke-Itunu, Olopomewa and the core traditional areas of Oke-Are, Oke-Aremo, Ade-Oyo, Yemetu, Oniyanrin devvelopments with a considerable level of commercial activities as a result of distributor roads passing through the communities (See Figure 1 and 2).

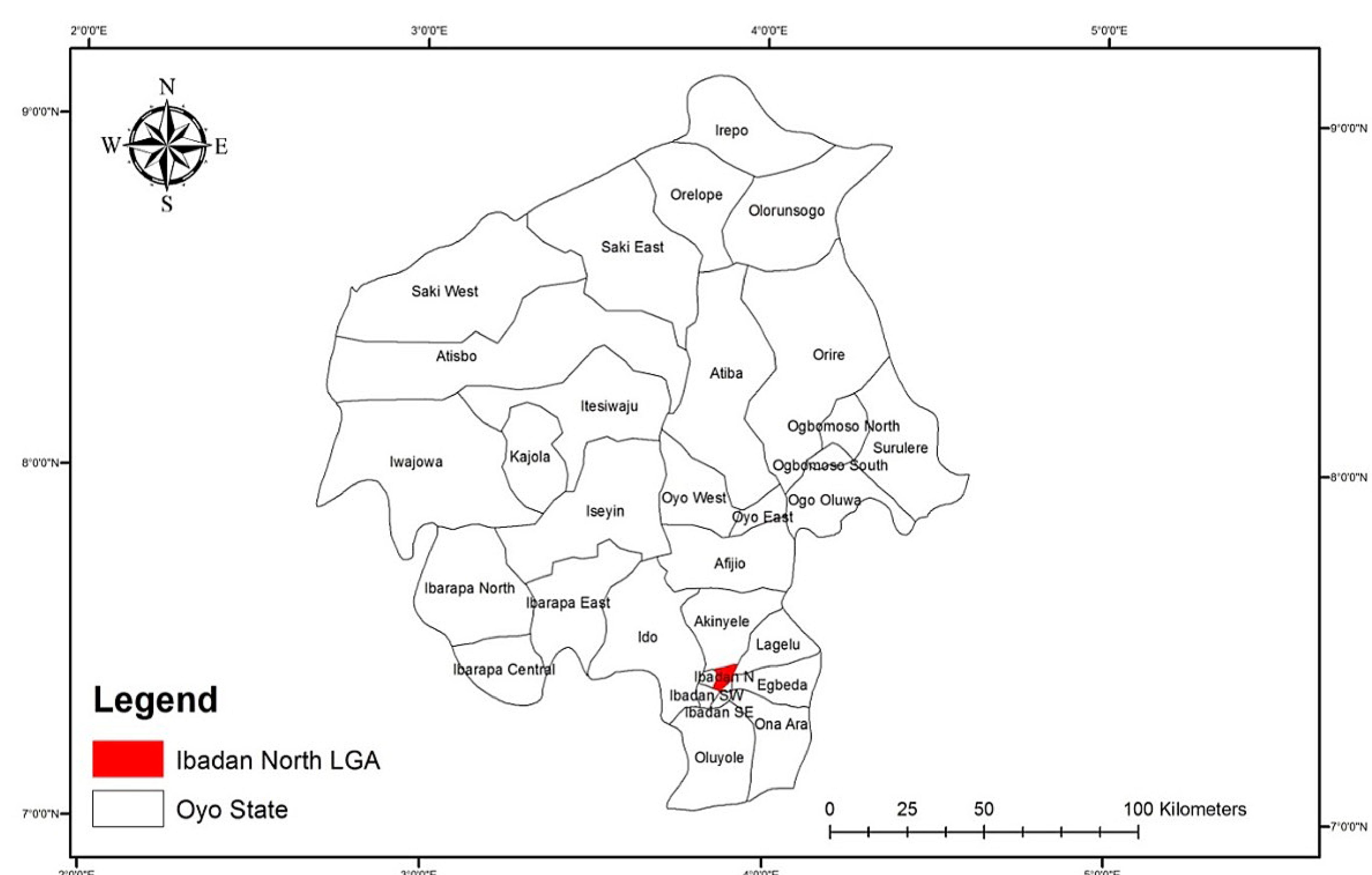

Figure 2. Showing Ibadan North Local Government within Ibadan

Source: Authors' Field work

METHODOLOGY

The cross-sectional survey research design was adopted for the study while both primary and secondary data were sourced. Using a multi stage sampling technique, the entire (11) local government area that makes up Ibadan metropolis was purposively picked, based on high concentration of of estates in the local government. Subsequently, Ibadan north LGA was randomly selected and the existing seven estates within the local government area were picked for the study. Through digitization of google imagery, all the houses within each estate were counted to determine the sample frame. Thereafter, ten (10%) percent of the total number of the houses within each estate was used to determine the sample size of 326 questionnaires which was eventually administered to the respondents. This was done in order to obtain relevant information on water quality and its perceived effects on the residents. (see Table 1) Later, identification of boreholes locations was done in which one water sample was taken from each estate. A standard laboratory method was employed for the analysis for the information on the state of water quality. Physiochemical properties, standard analytical technique and instrument such as thermometer to measure the temperature, pH meter to measure p H were employed. Both descriptive and inferential statistics (Analysis of Variance (ANOVA) and qualitative (in-depth interview) statistics were used to analyse the data at p=0.05% confidence level.

Table 1. Estates, sampling frame, sampling unit, sampling size

S/N	Estates within the study area	Sample frame	Sampling unit (10%)	Sampling size
1	Aerodrome	253	10%	26
2	Ikolaba	1103	10%	110
3	Oluwokekere	90	10%	9
4	Oluwonla	165	10%	17
5	Ashi	384	10%	38
6	Bashorun	1050	10%	105
7	Bodija (Aare)	206	10%	21
Total	7	3260		326

Source: Authors' Field work.

RESULTS AND DISCUSSION

Socio-economic Characteristics of the respondents

Investigation was carried out on the socio-economic characteristics of the respondents in the study area. Variables that were considered include; gender, educational distribution, employment status of the respondents. The results are captured in table 2. On gender distribution of respondents, the result indicated a female domination. This may arise from the fact that while the men would have gone for daily work, women remain at home for domestic activities. Their contribution to the outcome of the study is very germane, since there domestic activities revolve round the use of water.

The study revealed that more than half of respondent have formal education which implies that majority of the residents interviewed have quality education suggesting a quality and objective response regarding the study. Furthermore, investigation revealed that majority (85.5%) of the respondent were gainfully employed.

Table 2. Socio-economic Characteristics of the respondents

A. Gender				
Location	Male		Female	
	Frequency	Percentage	Frequency	Percentage
Ikolaba	27	8.2%	83	25.4%
Aerodrome	8	2.4%	18	5.5%
Oluwokekere	7	2.1%	10	3.1%
Oluwonla	2	0.6%	7	2.1%
Ashi	11	3.4%	27	8.2%
Bodija (aare)	10	3.1%	11	3.4%
Bashorun	39	11.9%	66	20.2%
B. Educational Qualification				
Location	Formal education		Informal education	
	Respondents	Percentage	Respondents	Percentage
Ikolaba	97	29.8%	13	3.9%
Aerodrome	24	7.4%	2	0.6%
Oluwokekere	15	4.6%	2	0.6%
Oluwonla	7	2.1%	2	0.6%
Ashi	30	9.2%	8	2.5%
Bodija (aare)	15	4.6%	6	1.8%
Bashorun	88	27.0%	17	5.2%
C. Employment Status				
Location	Employed		Unemployed	
	Respondents	Percentage	Respondents	Percentage
Ikolaba	103	31.6%	14	4.3%
Aerodrome	14	4.2%	12	3.7%
Oluwokekere	13	4.0%	4	1.3%
Oluwonla	9	2.8%	0	0
Ashi	37	11.3%	1	0.3%
Bodija (aare)	19	5.8%	2	0.6%
Bashorun	85	26.1%	20	6.1%

N = 326; Source: Authors' Field work

Dominant Sources of Water in the Study Area

Study was done on the sources of water in the study area. Findings on the sources of water revealed that 12.3% of the houses had tap water. Those respondents whose sources of water was well accounted for 21.5%, while the proportion of houses whose sources of water was boreholes accounted for majority (65.3%), (See Table 3).

Table 3. Dominant Sources of Water In the Study Area

Location	Tap water		Well water		Borehole water		Others	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Ikolaba	12	3.7%	19	5.8%	79	24.2%	0	0
Aerodrome	3	0.9%	7	2.1%	15	4.6%	1	0.3%
Oluwokekere	3	0.9%	4	1.2%	17	5.2%	1	0
Oluwonla	0	0	2	0.6%	7	2.1%	1	0
Ashi	5	1.5%	7	2.1%	26	7.9%	1	0
Bodija	5	1.5%	4	1.2%	11	3.4%	1	0
Bashorun	12	3.7%	24	7.4%	68	20.9%	2	0.6%

N = 326; Source: Authors' Field work

Laboratory Analysis of Water Quality in the Study Area

Moreover, assessment was carried in order to determine the quality of water in the study area, in order to achieve this, a laboratory analysis was carried out and variables that were tested for the water quality includes the following, pH (level of acidity or alkalinity) of the water, water temperature, total dissolved solids, total suspended solids, dissolved oxygen and three heavy metals which are iron (fe), lead (pb), zinc (zn). The result of laboratory test is revealed as follows:

The result of pH test revealed that Aerodrome, Ikolaba, Basorun, Oluwonla, Oluwokekere, Bodija and Ashi had 4.0, 4.8, 4.4, 4.5, 4.7, 5.5 and 5.4 respectively. Normally, pH ranges from 0 to 14. In general, water with a pH value of 7 is considered neutral, lower than it, is referred to being acidic while greater than 7 is known as basic. According to WHO standards, pH values of water should be between 6.5 to 8.5 in which any value below 6.0 is said to be acidic. It can be deduced that water samples for the study area is acidic and corrosive, portending danger for human consumption. This confirms a study carried out by Adedeji et al. (2017) on physiochemical and microbiological examination of hand-dug wells, boreholes and public water sources in selected areas of Ibadan, Nigeria. The pH ranges between 8.06 in water from a hand-dug well at Kobomoje to 9.03 in water from a borehole in Agbongbon. Water pH recorded for the borehole in Agbongbon was slightly higher than the range of 6.0 – 9.0 standard limit of World Health Organisation (WHO, 2011a).

Regarding water temperature in the study area, the result ranged from 26.0°C to 29.5°C with an average of 27.6°C. This result suggest that groundwater temperature is generally ambient and good for residents and for specific reason of water quality; since, high temperature negatively impact water quality by enhancing the growth of micro-organisms which may increase taste, odour, colour and corrosion problems (UNICEF, 2008). The result negates the study of physical and chemical assessment of boreholes in Gwagwalada, Abuja, where it was revealed that the water sample temperatures ranged between 31.2°C – 32.0°C, with borehole B1 having the highest temperature while boreholes B2 and B3 have the lowest.

Environmental waters may contain a variety of solid or dissolved impurities. In quantifying levels of these impurities, suspended solids are the term used to describe particles in the water column. Smaller particles, along with iconic species, are referred to as dissolved solids. In considering waters for human consumption or other uses, it is important to know the concentrations of both suspended and dissolved solids. The value of the suspended solids for Aerodrome, Ashi, Bodija, Ikolaba, Oluwonla and Oluwokekere include the following mg/L: 0.0136, 0.0139, 0.0130, 0.0130, 0.0129, 0.0137 and 0.0128 respectively. This result shows that all the values are below the WHO limit. The most common pollutant in the world is 'dirt' in the form of total suspended solids (TSS), this finding confirms the study carried out on physiochemical properties and heavy metal content of water sources in Ife North Local Government Area of Osun State, Nigeria.

The total dissolved solids (TDS) of water samples in the area is 34.50 mg/L to 90.00 mg/L which is below 500 mg/L limits. TDS comprise inorganic salts (principally calcium, magnesium, potassium, sodium, bicarbonates, chlorides and sulphates) and some small amounts of inorganic matter that are dissolved in water. Water containing more than 500 mg/L of TDS is not considered desirable for drinking water supplies, though more highly mineralised water may be used where better quality water is not available (Jain, 2002). The total dissolved solids for Aerodrome, Ashi, Bodija, Ikolaba, Oluwonla, Oluwokekere and Basorun are 0.001, 0.001, 0.007, 0.0004, .0.0003, 0.0002 and 0.0005 mg/L respectively. All the values are lesser than 1.000 mg/L, it can be deduced that the particles and dirt in the water are low which makes the water suitable for drinking.

Dissolved oxygen is the amount of gaseous oxygen (O_2) dissolved in the water. Oxygen enters the water by direct absorption from the atmosphere, by rapid movement, or as a waste product of plant photosynthesis. The criteria values range from 5 to 9.5 mg/L oxygen depending on water temperature. A minimum dissolved oxygen concentration of 5 to 6 mg/L and cold water ranges from 6.5 to 9.5 for cold water biota. The dissolved oxygen values for Aerodrome, Ashi, Bodija, Ikolaba, Oluwokekere, Oluwonla and Basorun respectively include the following: 1.9 mg/L, 2.6 mg/L, 3.1 mg/L, 1.5 mg/L, 1.4 mg/L, 2.0 mg/L and 1.7 mg/L, which are lesser than the range given by World Health Organisation which made the water not permissible for human consumption.

Furthermore, iron is an essential element in human nutrition. Its daily minimum estimate requirement for iron depend on age, sex, physiological status and iron bioavailability and range from about 10 to 50 mg/day (WHO, 1996). The recorded value for iron (fe) in Aerodrome, Ashi, Bodija, Ikolaba, Oluwonla, Oluwokekere and Basorun were 1.813 mg/L, 0.500 mg/L, 0.758 mg/L, 0.438 mg/L, 1.475 mg/L, 0.525 mg/L and 0.634 mg/L respectively. From the result, while the permissible value for iron in drinking water per litre is 1.0 mg/L, the result revealed Aerodrome and Oluwonla to be higher than the permissible limit per litre for water intake.

Regarding lead, it is the commonest of the heavy elements, accounting for 13 mg/kg of Earth's crust. Lead is present in tap water to some extent as result of its dissolution from natural sources, but primarily from household plumbing systems in which the pipes solder, fittings or service connections to homes contain lead. The values of lead in Aerodrome, Ashi, Bodija, Ikolaba, Oluwonla, Oluwokekere and Basorun are 0.053 mg/L, 0.154 mg/L, 0.124 mg/L, 0.063 mg/L, 0.024 mg/L, 0.134 mg/L and 0.058 mg/L respectively. It can be deduced from the values that apart from Oluwonla, all the other areas are above the WHO standard of 0.058 mg/L having implication for health. Concentration of lead in all the collected water samples ranged between 0.167 to 0.723 mg/L.

Zinc occurs in small amounts in almost all igneous rocks. The principal zinc ores are sulphides, such as sphalerite and wurzite. The natural zinc content of soils is estimated to be 1 – 300 mg/kg. Zinc imparts an undesirable astringent taste to water. Tests indicate that 5% of a population could distinguish between zinc-free water and water containing zinc at a level of 4 mg/litre (as zinc sulphate). The values of zinc in water include the following mg/L: 0.088 for Aerodrome, 0.058 for Ashi, 0.070 for Bodija, 0.124 for Ikolaba, 0.080 for Oluwonla, 0.091 for Oluwokekere and 0.073 for Basorun. All these values are lesser than the WHO limit of 5.0 mg/L having a serious implication for health (See Table 4).

On general note, lead is a cumulative general poison, with infants, children up to 6 years of age, the foetus and pregnant women being the most prone to adverse health effects. Its effects on the central nervous system can be particularly serious (WHO, 2011). Obvious signs of acute intoxication, restlessness, including dullness, irritability, poor attention span, headaches, abdominal cramps, muscle tremor, kidney damage, hallucinations, loss of memory and encephalopathy, occur at blood lead levels of 100 – 120 µg/dl in adults and 80 – 100 µg/dl in children. Signs of chronic lead toxicity, sleeplessness, including tiredness, irritability, headaches, joint pain and gastrointestinal symptoms, may appear in adults at blood lead levels of 50 – 80 µg/dl. After 1 – 2 years of exposure, gastrointestinal symptoms, muscle weakness, lower scores of psychometric tests, disturbances in mood and symptoms of peripheral neuropathy were observed in occupationally exposed populations at blood lead levels of 40 – 60 µg/dl (US EPA, 1986).

Table 4. Result of Water Analysis

Parameter and unit of measurement	Aerodrome	Ashi	Bodija	Ikolaba	Oluwonla	Oluwokekere	Bashorun
Ph (kg/l)	4.0	5.4	5.5	4.8	4.5	4.7	4.4
Temperature (°C)	26.2	29.5	26.0	28.3	29.0	27.5	27.0
TDS(mg/l)	0.001	0.001	0.007	0.0004	0.0003	0.0002	0.0005
TSS(mg/l)	0.0136	0.0139	0.0130	0.0130	0.0129	0.0137	0.0128
DO (colorimetary)	1.9	2.6	3.1	1.5	1.4	2.0	1.7
Iron (Fe)	1.813	0.500	0.758	0.438	1.475	0.525	0.634
Zinc (Zn)	0.088	0.058	0.070	0.124	0.080	0.091	0.073
Lead (Pb)	0.053	0.154	0.124	0.063	0.0244	0.134	0.058

Source: Authors' Field work

Moreover, acute toxicity arises from the consumption of excessive amounts of zinc salts, either unintentionally or intentionally as an emetic or dietary supplement. Vomiting usually occurs after the consumption of more than 500 mg of zinc sulphate. Mass poisoning has been reported following the drinking of acidic beverages kept in galvanised containers; fever, vomiting, nausea, stomach cramps and diarrhoea occurred 3 – 12 hours after consumption. Estimates of the minimum daily requirement for iron depend on age, sex, physiological status and iron bioavailability, and range from about 10 to 50 mg/day. The average lethal dose of iron is

200 – 250 mg/kg of body weight, but death has occurred following the ingestion of doses as low as 40 mg/kg of body weight. Autopsies have shown haemorrhagic necrosis and sloughing of areas of mucosa by the stomach with extension into the sub-mucosa (WHO, 1996).

Respondents' perception on taste of water, smell of water and treatment of water

The study further investigated on respondents' perception on taste of water, smell of water and treatment of water in the study area. This is contained in Table 6. On the taste of water, less than half of the respondents' seldom have taste in their water. Majority of the respondents did not have taste in their water. From the result gotten from the laboratory it can be deduced that most of the water samples contain zinc and this gives astringent taste in water (See Table 5). Findings also revealed that the proportion of respondents that seldom have smell in their water accounted for less than quarter of the respondents. Furthermore, 74.5% revealed that they do not have smell in their water.

With respect to respondents' perception on water treatment, the findings revealed that less than half (42.3%) treated their water as against the majority who do not treat their water. It can be deduced from the study that majority of the respondent do not see any reason in treating their water for a singular believe that groundwater from borehole sources are the purest (See Table 5).

Table 5. Respondents Perception on Water Smell, Taste and Treatment

A. Perception on the Taste of Water						
Location	Yes		No		Total	
	Freq	%	Freq	%	Freq	%
Ikolaba	23	7.1%	87	26.7%	110	100%
Aerodrome	2	0.6%	24	7.3%	26	100%
Oluwokekere	8	2.5%	9	2.8%	16	100%
Oluwonla	3	0.9%	6	1.8%	9	100%
Ashi	18	5.5%	20	6.1%	38	100%
Bodija(aare)	9	2.8%	12	3.7%	21	100%
Bashorun	20	6.1%	85	26.1%	105	100%
B. Presence Of Smell in The Water						
Location	Yes		No		Total	
	Freq	%	Freq	%	Freq	%
Ikolaba	9	2.8%	101	30.9%	110	100%
Aerodome,	0	0%	26	7.9%	26	100%
Oluwokekere	4	1.2%	13	3.9%	17	100%
Oluwonla	2	0.6%	7	2.1%	09	100%
Ashi	5	1.5%	33	10.1%	38	100%
Bodija	3	0.9%	18	5.5%	21	100%
Bashorun	26	7.8%	79	24.2%	105	100%
C. Perception on Water Treatment						
Location	Yes		No		Total	
	Freq	%	Freq	%	Freq	%
Ikolaba	54	16.6%	56	17.2%	110	100%
Aerodome,	5	1.5%	21	6.4%	26	100%
Oluwokekere	7	2.1%	10	3.1%	16	100%
Oluwonla	6	1.8%	3	0.9%	9	100%
Ashi	15	4.6%	23	7.0%	38	100%
Bodija	7	2.1%	14	4.3%	21	100%
Bashorun	44	13.5%	61	18.7%	105	100%

N = 326; Source: Authors' Field work.

Perceived Impact of Water Consumption on Health of Respondents in the Study Area

Since most groundwater is colourless, odourless and without definite taste, we are typically most concerned with its biological and chemical qualities. Numerous cases of infections due to consumption of contaminated water by pathogenic bacteria have been reported in many parts of the world, sometimes causing epidemics followed by loss of life (Angulo et al., 1997; Ishaya and Abaje, 2009; Idris-Nda et al., 2011; Ayantobo et al., 2012; Danmo et al., 2013; Awodumi and Akeasa, 2017). In the 19th century, in Britain, it was a common practice to obtain groundwater and to dispose of sewage through earth closets; this lead into contamination of groundwater and outbreak of cholera. Yorkshire was affected by gastroenteritis in 1980 as a result of the Braham borehole becoming contaminated by leaking sewer and a polluted surface stream which passed within 8m of the well (Angulo et al., 1997). In Ibadan Metropolis, Ayantobo et al (2012) assessed the quality of water from hand-dug wells and noted nitrate, faecal coliform and total coliform at objectionable levels and are pronounced in wells located close to domestic wastes, abattoir, pit latrine and stagnant water and drainage. Atarche and Egbuna (2013) assessed the quality of water from hand-dug well in Akure town noted groundwater to be acidic, with electrical conductivity to exceed WHO prescribed limit for drinking water. Geology of the area is concluded to influence the quality of groundwater of the area. The increase in industrial activities has strengthened environmental pollution problems and the deterioration of several aquatic ecosystems with the build-up of metals in fauna and flora. These traced metals are harmful because they tend to bio-accumulate, leading to heavy metal poisoning (Abolude et al., 2009).

Iterating water quality and safety, lead, is a cumulative general poison, with infants, children up to 6 years of age, the foetus and pregnant women being the most prone to adverse health effects. Its effects on the central nervous system can be particularly serious (WHO, 2011). Obvious signs of acute intoxication, restlessness, including dullness, irritability, poor attention span, headaches, abdominal cramps, muscle tremor, kidney damage, hallucinations, loss of memory and encephalopathy, occur at blood lead levels of 100 – 120 µg/dl in adults and 80 – 100 µg/dl in children. Signs of chronic lead toxicity, sleeplessness, including tiredness, irritability, headaches, joint pain and gastrointestinal symptoms, may appear in adults at blood lead levels of 50 – 80 µg/dl. After 1 – 2 years of exposure, gastrointestinal symptoms, muscle weakness, lower scores of psychometric tests, disturbances in mood and symptoms of peripheral neuropathy were observed in occupationally exposed populations at blood lead levels of 40 – 60 µg/dl (US EPA, 1986).

Acute toxicity arises from the consumption of excessive amounts of zinc salts, either unintentionally or intentionally as an emetic or dietary supplement. Vomiting usually occurs after the consumption of more than 500 mg of zinc sulphate. Mass poisoning has been reported following the drinking of acidic beverages kept in galvanised containers; fever, vomiting, nausea, stomach cramps and diarrhoea occurred 3 – 12 hours after consumption. Estimates of the minimum daily requirement for iron depend on age, sex, physiological status, and iron bioavailability and range from about 10 to 50 mg/day. The average lethal dose of iron is 200 – 250 mg/kg of body weight, but death has occurred following the ingestion of doses as low as 40 mg/kg of body weight. Autopsies have shown haemorrhagic necrosis and sloughing of areas of mucosa in the stomach with extension into the sub-mucosa (WHO, 1996).

Following literature evidence, the impact of the consumptions of elements in water on human health as the effect over time could lead to the following, stomach cramp, nausea, loss of appetite and joint pain. The studies also revealed that 1.2% of the respondents often have stomach cramp. Those who experienced stomach cramp very often accounted for 0.8%. About 23.6% occasionally have stomach cramp. Investigation further revealed that respondent that never had stomach cramp accounted for the majority (74.55) (See Table 6).

On nausea, no respondents from the selected estates often have it, except 10.1% who experienced it very often. Findings equally revealed that only 24.8% occasionally have it, also, the proportion of the respondents that never had it accounted for the majority (65.0%). On the loss of appetite, finding revealed that none of the respondents often experienced loss of appetite in all the estates. Those that loss it very often accounted for 4.6%. About 22.3% experienced it occasionally. Investigation also revealed that respondents that never had loss of appetite accounted for the majority (73.0%). Based on these findings, it could be said that respondent with loss of appetite are not many within the study area.

Finally, investigation was made on those respondents that have joint pain in the study area. It was revealed that very few (2.1%) often have it. Those who experienced it very often accounted for 4.0%. Respondents who occasionally experienced it accounted for over half (57.1%) of the respondents, whereas those that never had joint pain accounted for 36.8% (See Table 6).

Table 6. Perceived Impacts of Water Consumption on Health of the Respondents.

A. Stomach Cramp										
Location	Often		Very often		Occasionally		Never		Total	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
Ikolaba	0	0%	0	0%	22	6.7%	88	26.9%	110	100%
Aerodrome	2	0.6%	1	0.4%	4	1.2%	19	5.8%	26	100%
Oluwokekere	0	0%	0	0%	6	1.8%	11	3.4%	16	100%
Oluwonla	0	0%	0	0%	3	0.9%	6	1.8%	9	100%
Ashi	0	0%	0	0%	10	3.1%	28	8.6%	38	100%
Bodija(Aare)	0	0%	0	0%	7	2.1%		4.3%	21	100%
Bashorun	2	0.6%	1	0.4%	25	7.7%	77	23.6%	105	100%
B. Nausea										
Ikolaba	0	0%	8	2.5%	26	7.9%	76	23.3%	110	100%
Aerodrome	0	0%	2	0.6%	3	0.9%	21	6.4%	26	100%
Oluwokekere	0	0%	3	0.9%	5	1.5%	9	2.8%	16	100%
Oluwonla	0	0%	0	0%	4	1.2%	5	1.5%	9	100%
Ashi	0	0%	6	1.6%	14	4.3%	18	5.5%	38	100%
Bodija (aare)	0	0%	4	1.2%	5	1.5%	12	3.7%	21	100%
Bashorun	0	0%	10	3.0%	21	7.4%	71	21.8%	105	100%
C. Loss of Appetite										
Ikolaba	0	0%	6	1.8%	15	4.6%	89	27.3%	110	100%
Aerodrome	0	0%	1	0.4%	4	1.2%	21	6.4%	26	100%
Oluwokekere	0	0%	1	0.4%	5	1.5%	11	3.4%	16	100%
Oluwonla	0	0%	0	0%	3	0.9%	6	1.8%	9	100%
Ashi	0	0%	1	0.4%	12	3.7%	25	7.7%	38	100%
Bodija (aare)	0	0%	2	0.6%	5	1.5%	14	4.3%	21	100%
Bashorun	0	0%	4	1.2%	29	8.9%	72	22.1%	105	100%
D. Joint Pain										
Ikolaba	3	0.9%	0.6%	17.8%	48	14.7%			110	100%
Aerodrome	0	0%	0%	2.8%	17	5.2%			26	100%
Oluwokekere	0	0%	0.6%	3.4%	4	1.2%			16	100%
Oluwonla	0	0%	0%	2.8%	0	0%			9	100%
Ashi	1	0.3%	0.9%	7.7%	9	2.8%			38	100%
Bodija(Aare)	1	0.3%	0.6%	3.4%	7	2.1%			21	100%
Bashorun	2	0.6%	1.2%	19.6%	35	10.7%			105	100%

N = 326; Source: Authors' Field work.

Respondents on Reasons for Hospital Visitation

Furthermore, investigation was conducted on the reason for hospital visitation by the respondents; this was done so as to establish the linkage between the sickness and water consumption in the study area. It was discovered from the study area that sickness which made respondent visit the hospital includes the following: malaria, typhoid, joint pain, while others visited just for medical checkup. The proportion of respondents that treated malaria is 63.8% while those that treated typhoid were 7.4%. Those that went for medical check-up accounted for 26.0%. The number of respondents that treated joint pain accounted for 2.4%. The variation across the study area is presented in table 7. Focus group discussion was carried out on people that did medical checkup; more than 90% of respondent that went for medical checkup have been diagnosed with diabetes which can be as a result of presence of lead in the water as stated in literature review, too much exposure to lead over time leads to renal disease. This confirms a recent study on assessment of drinking water quality and its impact on resident's health in Bahawalpur City Pakistan, where it was estimated that, about 230,000 infants (less than five-year-old) were dying each year due to waterborne diseases (DigiTex, 2013).

Table 7. Reasons for Hospital Visitation

Location	Malaria		Medical checkup		Typhoid		Joint pain		Total	
	F	%	F	%	F	%	F	%	F	%
Ikolaba	73	22.4	30	9.2	5	1.5	2	0.6	110	33.7
Aerodrome	15	4.6	5	1.5	4	1.2	2	0.6	26	7.9
Oluwokekere	8	2.5	6	1.8	3	0.9	0	0	17	5.2
Oluwonla	6	1.8	2	0.6	1	0.4	0	0	9	2.8
Ashi	25	7.7	11	3.4	2	0.6	0	0	38	11.7
Bodija (Aare)	15	4.6	3	0.9	1	0.4	2	0.6	21	6.4
Bashorun	66	20.2	29	8.9	8	2.5	2	0.6	105	32.2
Total	208	63.8	85	26.0	24	7.4	8	2.5	326	100

Source: Authors' Field work

CONCLUSION AND RECOMMENDATIONS

Conclusively, the quality of water in the area fell below the acceptable standard. This can cause health effects such as dehydration, gastrointestinal illness, nervous system or reproductive effects and chronic disease such as cancer. Groundwater is the most important source of freshwater for domestic use in Ibadan north local government Area as well as in most cities in Nigeria. The study showed that most borehole owners and users are not aware of contamination problems, particularly those of geo-genic origin. The health implications of continued exposure to excessive levels of heavy metals in drinking water make the presence of geo-genic contaminants and the lack of awareness of their presence a matter of grave concern.

It is therefore recommended that Government should request test of private boreholes which tap into both deep and shallow aquifers and remedial measures for the treatment of contaminated boreholes be effected within the study area. Also, planning regulations, standards and enforcement should be exercised when picking a borehole location. All land use activities capable of polluting water sources both surface and underground should be properly regulated to safe guide their quality. Finally, groundwater exploitation systems such as boreholes and hand dug wells should only be sited after proper sanitary inspection and approved recommendation by the appropriate unit.

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CONFLICTS OF INTEREST

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