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Full Length Research Paper

Open wells, sanitary features, pollutions and water qualities: case study of Ibadan slums, Nigeria

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The study was carried out to assess the well waters, their sanitary features, prevailing pollutions and water qualities in some communities in the South- east Local Government Area of Ibadan metropolis, Nigeria. A random selection of houses in the area with forty shallow hand dug wells grouped into eight zones was considered. Structured questionnaires and oral interviews were used to gather information and data apart from physical inspection. Sanitary features of the well considered were lining, apron, cover and water drawing buckets. Well water sampling and quality tests were done during the dry season and parameters such as total solids, suspended solids, total hardness and coli form count were determined, using various laboratory methods. Findings showed that most of the wells are grossly polluted by unsanitary practices such as unsanitary maintenance of wells and their features, proximity to potential pollution sources such as pit latrines, indiscriminate dumping of refuse and poor sanitation. These communities are therefore prone to health risks, because of their dependence on these sources, thus there is need for improvement and in some cases reconstruction of the wells and well waters treatment.

Key words: Well waters, features, pollution, Ibadan slum.

INTRODUCTION

Groundwater is a valued fresh water resource and constitutes about two-third of the fresh water reserves of the world (Chilton, 1992). It is used for agricultural, industrial and domestic purposes. It accounts for about 50% of livestock and irrigation usage and just under 40% of water supplies, whilst in rural areas, 98% of domestic water used is from groundwater (Todd, 1980).

Utilization of groundwater as a source for domestic, municipal, agricultural and industrial activities continue to increase principally because of the heavy capital outlay and maintenance of surface water development through dams. This is particularly true of developing countries (Sangodoyin et al., 1988).

Quality of drinking water is of highest importance and this depends on source and level of contamination or pollution. About 80% of diseases in the tropics e.g. cholera, typhoid, diarrhea and dysentery are as a result of water source contamination.

Buchanan (1983) puts the groundwater reservoir of the world at about 5.0 x 10^{24} litres. This volume is more than 2,000 times the volume of waters in all the world's rivers and more than 30 times the volume contained in all the world's fresh water lakes. Groundwater is abstracted through hand-dug wells; hand-pump operated shallow-wells and submersible pump operated deep well or boreholes (Ojo, 2002). Oluwande (1983) identified water hole as the oldest means of obtaining sub-surface water. Wells are holes in the ground that intersect the water table as water bearing rocks flowing as aquifers.

Shallow wells are generally less than 15 m deep while deep wells are greater than 50 m in depth (Hofkes, 1981). They both exhibit differences in bacteriological

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quality and yield, with the water becoming purer and more constant with increase in depth. Deep wells are usually boreholes with depth above 100 m and 150 m diameter especially in the sedimentary formations; they serve large communities due to their high yield, but with high cost of construction and maintenance (Ojo, 2002).

Hand dug wells as the name implies are constructed manually and are little more than irregular hole in the ground, intersecting the water table (Todd, 1980). They are prone to pollution from air borne materials, run-off from the surface, though their sanitary status may be improved by including certain features such as lining with cement ring or metal ring (Drum), cover (wooden or metal), apron and drain. Todd (1980) gave an approximate yield of a properly constructed well to be between 2,500 to 7,500m^3 per day, but most domestic hand dug wells yield less than 500m^3/day.

Sources of pollution

Sangodoyin (1993) observed that the unsanitary mode of disposal of wastes, such as defecation in streams and the dumping of refuse in pits, rivers and drainage channels as seen in most Nigerian urban settlements could be expected to affect surface and groundwater quality.

Sangodoyin et al. (1990) observed that well liming eliminates contamination and hence improves water quality. Industrial waste disposal method of discharging effluents unto land, stream and sanitation sewers also have the potential of polluting ground water. Other sources of groundwater pollution include tank and pipeline leakage and mining activities. Sangodoyin (1987) gave the following considerations as a way of reducing groundwater contamination or pollution:

i. A well should be sited uphill of a polluting source. This is with a view to diverting to drain from the well into a polluting source rather than converse.
ii. The distance between a well and a polluting source should not less be than 30 m (100 feet).
iii. Well construction should start towards the end of the dry season.

Groundwater quality

The chemical, physical and bacterial characteristics of groundwater determine its usefulness for municipal, commercial, industrial, agricultural and domestic water supplies. Chemical analysis of groundwater includes the determination of the concentrations of inorganic constituent. The analyses also need to include measurement of pH and specific electrical conductance. Temperature, colour, turbidity, odour and taste are evaluated in a physical analysis. Bacteria analysis generally consists of tests to detect the presence of coli form organisms.

Lloyd and Helmer (1991) observed that the water quality problem may be associated with and traceable to, any or all of the following:

i. Poor quality source of water,
ii. Poor site selection or protection such as apron and lining
iii. Construction difficulties and
iv. Structural deterioration with age

Physicochemical quality

The term physicochemical quality is used in reference to the characteristics of water which may affect its acceptability due to aesthetic considerations such as colour and taste; produce toxicity reactions, unexpected physiological responses of laxative effect, and objectionable effects during normal use such as curdy precipitates (WHO, 1995) (Tables 1 and 2).

Problem statement

High density areas in Ibadan South east Local Government Areas such as Beere, Bode, Molete, and Kudeti lack pipe-borne water and have to rely on polluted shallow – hand dug wells and streams. The objective of this study is to obtain baseline information on type of water facility/ source, sanitary features of the source, health related risks perceived, and also assessing the quality of well waters used by the people with a view to recommending a protocol sustainable livelihood.

RESEARCH METHODOLOGY

Description of study area

The city of Ibadan under study is located on the longitude 3° 58' E and latitude 7° 22' N. The altitude general ranges from 15 to 21 m above mean sea level (Alawode, 2000). The four Ibadan inland LGAs have a population of about 966,631 and South East LGA of the study location is the third largest with a population of 272,865 (112,144 males, 115.721 females). This is about 29% of the total population (Table 3 and Figure 1). Molete, Kudeti, Idi-arere and Oja-oba, Labo, Kobomoje, Oke-odo and Bode are all located within the study area and their water – wells were surveyed.

Data collection

The data were collected using:

I. Interviewer administered questionnaire to obtain baseline information and data on water source points, well type, well pollution distance and type,

Table 1. Taste threshold for major cations.

Element	Taste threshold (mg/l)
Calcium	100
Magnesium	30
Sodium	100
Potassium	300
Iron II	0.4 in distilled water
Iron III	0.12 in distilled water
Zinc	4.3 in distilled water
Zinc	6.8 in mineralized water

Source: WHO, 1995.

Table 2. TDS level of drinking water for consumer ratings.

Rating	TDS levels (mg/l)
Excellent	<300
Good	300-600
Poor	600-900
Unacceptable	>1700

Source: WHO, 1995.

Table 3. Population of Ibadan City.

	Male	Female	Total
Ibadan N/ West	72,849	75,270	146,759
Ibadan N/ East	133,609	139,390	272,979
*Ibadan S/ East	112,144	115,721	272,865
Ibadan S/ West	137,084	136,944	274,028
Total	455,686	466,325	966,631

*Local Government Area under consideration.
Source: 1991 Census (National Population Commission).

II. sanitary features of wells, water treatment techniques and water related health risks,
III. Analysis of sampled well waters for the physiochemical and bacteriological qualities.

Materials

Well water samples

A total of 40 shallow well water samples were collected in the South East Local Government Area of Ibadan City. The samples were collected in 1 litre plastic bottles in the morning and taken to the laboratory for analysis.

Laboratory analysis

The collected samples were taken for physiochemical laboratory analysis. Some chemicals used in the analysis include: kaolin for suspended solids and distilled water used in all reagent preparations. The chemicals were of analytical grade.

Methods

Questionnaire administration

The questionnaire used consisted of varying questions such as type of water source, well age, sanitary features, pollution type, source and distance to the well water point.

Physiochemical analysis

The physiochemical qualities were determined in the laboratory using various laboratory methods.

RESULTS, ANALYSIS AND DISCUSSION

Demographic characteristics

Result of the questionnaire survey indicated that 123 households around the water well points were interviewed and 118 respondents were women between the ages of 16 and 65 years that is 98.3%, while the remaining were boys of ages 10 to 16 years. About the occupation of the respondents, 84 (70%) had low-income unskilled jobs such as petty trading, tailoring etc, while others were unemployed or had medium to high-medium income job (Tables 4 and 5).

Water source and usage

Table 9 indicates that 85% of the respondents were dependent on wells for drinking, while the remaining 15% depends on other drinking water sources such as public tap, pond and water from commercial vendors. The same water sources were also used for cooking, washing, toileting and other household works (Table 6).

Depth of water

Table 9 gave a picture of water depth column in the wells, a majority of 78 (65%) were below 2 m, 24 (20%) were > 2 m and less than 6 m, 13 (10.8%) were greater than 6 m and less than 8 m and the remaining (54.2%) were less than 8 m (and above).

Water consumption pattern the household

Each household has occupants ranges between five (5) to twenty (20). The water used in each household for drinking purposes was found to be less than 18 litres per

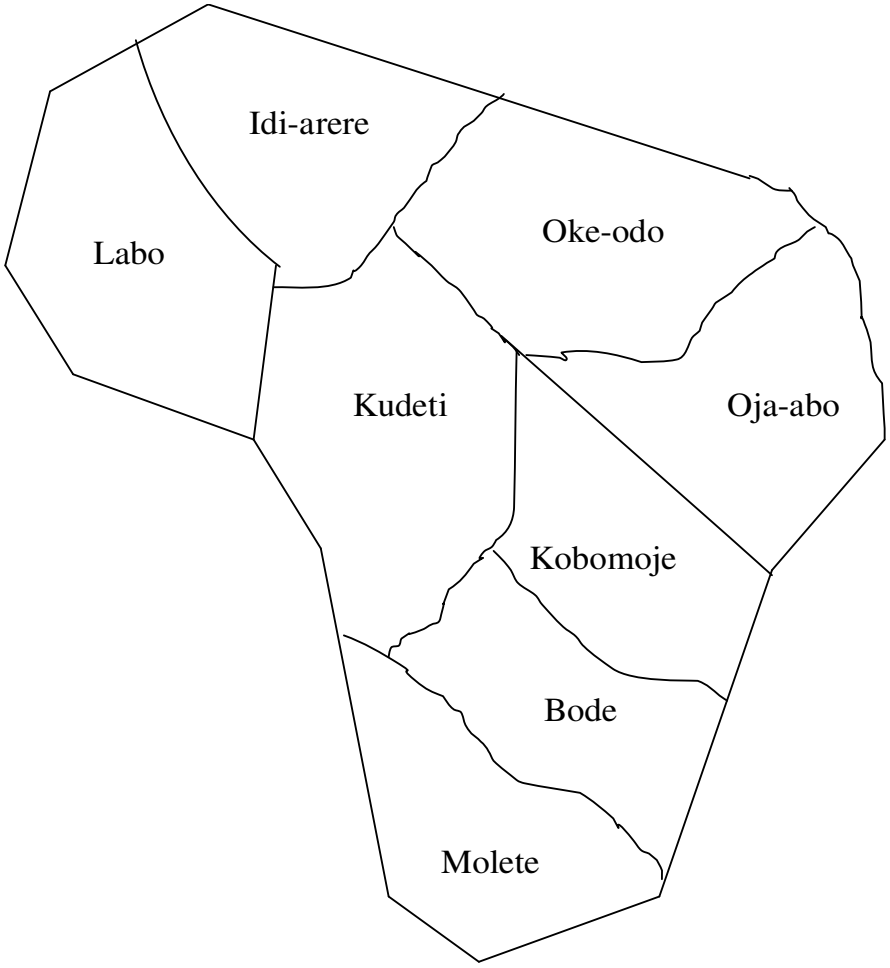


Figure 1. Sketch of the study area (Ibadan South East LGA) showing the zones.

Table 4. Age distribution of the respondents.

Age distribution	Frequency	%
< 20 years	43	35.8
20 – 40 years	60	50.0
40 – 50 years	9	7.5
50 – 56 years	6	5.0
> 65 years	2	1.7

Table 5. Occupation of the respondents.

Age distribution	Frequency	%
Low-income unskilled	84	70
Low-income skilled	18	15
Unemployed	5	4.17
High medium income	12	10
No response	1	0.83
Total	120	100

day amongst 120 respondents.

Wells location and years of construction

On well location, 78 (65%) respondents had the wells inside their house compounds and 38 (31%) had the wells outside their compounds that is, the well is shared. The remaining 4 (4%) respondents did not respond. Regarding the well age, 51 (42.5%) respondents dug them in the last 5 years, 49 (40.8%) in the last 6 – 10 years, 11 (9.17%) in the last 11 – 15 years and the remaining constructed their wells with ages greater than 16 years (Table 7).

Sanitary features of the wells

The sanitary features of each well such as well lining, apron, cove/broken cover, pail for drawing water and

Table 6. Sources of water and usage.

Source/Usage	Drinking (%)	Cooking (%)	Washing (%)	Toileting (%)	Bathing (%)
Shallow well	102 (85)	102 (85)	92 (76.7)	72 (60)	81 (67.5)
Rain	5 (4.2)	5 (4.2)	19 (15.5)	21 (17.5)	25 (20.8)
Public tap	8 (6.7)	8 (6.7)	2 (1.6)	7 (5.8)	7 (5.8)
Pond	2 (1.6)	2 (1.6)	6 (5)	19 (15.8)	4 (3.3)
Commercial vendor	3 (2.5)	3 (2.5)	1 (0.8)	1 (0.8)	3 (2.5)
Total	120 (100)	120 (100)	120 (100)	120 (100)	120 (100)

X (Y%), X = no of respondents; Y = % of total respondents.

Table 7. Age of water wells in use.

Age distribution	Frequency	%
Less than 5	51	42.5
6 – 10	49	40.8
11 – 15	11	9.17
> 16	9	7.5
	Nil	Nil
Total	120	100

Table 8. Sanitary features of the wells used by respondents.

Sanitary features	Present		Absent	
	Number	%	Number	%
Well lining	76	63.3	44	36.7
Apron	68	56.7	52	43.3
Cover	103	89.2	6	5
Broken cover	9	7.5	2	1.7
Pail for drawing water (fixed)	66	55	54	45
Waste material around well	62	51.7	53	44.2
Animals around well	49	40.8	70	58.3

waste material/animal pen around the well were observed. Table 8 and 11 showed the general sanitary features of the wells used by the respondents. An average number of respondents had wells with a permissible level of sanitary features. However, one or more sanitary features were absent from many of the wells.

Depths of wells

The depths of the wells used by the respondents were measured during the dry season (early December). It was found that 42 (35%) were below 5 m depth, 53 (44.2%) between 5 and 10 m depth and the remaining9 (7.5%) were of between 15 and 40 m (Table 9 and Figure 2).

Potential pollution sources of wells

The potential pollution sources of the wells were found to be mainly domestic refuse and animal and human excreta. On this, some information were collected as follows.

Domestic refuse dumps

The presence of indiscriminate disposal of refuse or presence of refuse heaps within a distance less than recommended 30m from the water source were recorded.

Table 9. Depth of the wells in the study area.

Depth of well (m)	Number	Percentage
<5	42	35
>5 – 10	53	44.2
10 – 15	16	13.3
> 15 – 40	9	7.5
> 40	Nil	Nil
Total	120	100

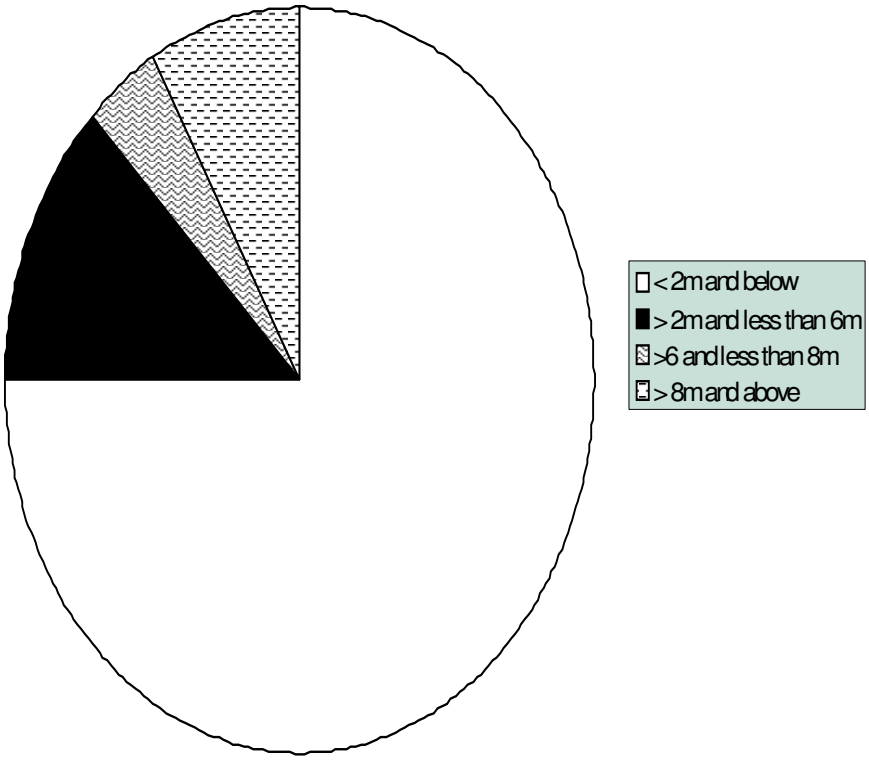


Figure 2. Pie chart describing the depth of water column in wells.

It was observed that about 63% of the respondents had such refuse within their premises. The domestic refuse observed mainly consisted of leaves, left-over and kitchen garbage and animal wastes (Table 10).

Excreta disposal facilities

About 103 (85%) of the respondents indicated that they have some type of excreta disposal facility within their houses/compounds; the remaining 15% go outside their house to dispose them. Among the facilities the respondents possessed, 76 (74.5%) had pit latrines, 18 (17.7%) had septic tank with soak away, 5 (4.9%) had flush latrines; the remaining 2.9% used other alternative, such as ventilated improved pit latrine, open public sewer and bush (Table 10).

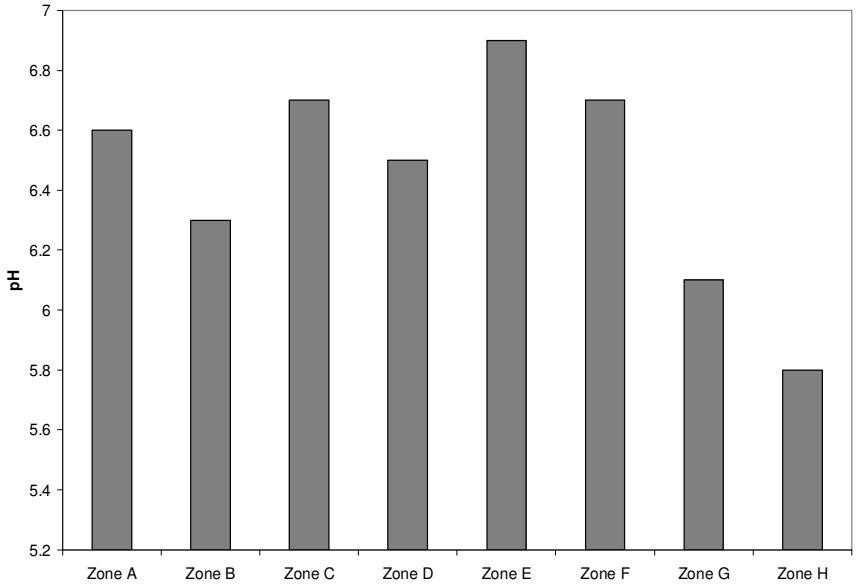
Well water quality in the study area

A total number of 40 wells (5 well each in 8 zones (Figures 3a, 3b, 4a, 4b, 5a, 5b and 6)) were sampled in the study area during the dry season (December). The results indicate that the quality of most of the water samples were within WHO standard except for the bacteriological quality as indicated by the coli form number (Table 11).

Table 10. Types of excreta disposal facilities used by households in the study area.

Excreta	Number of users	Percentage
Pit latrine	76	74.5
Septic Tank	18	17.7
Flush Latrines	5	4.9
Ventilated improved pit latrine	1	2.9
Open public sewer	1	2.9
Bush	1	2.9
Total	102	100

A



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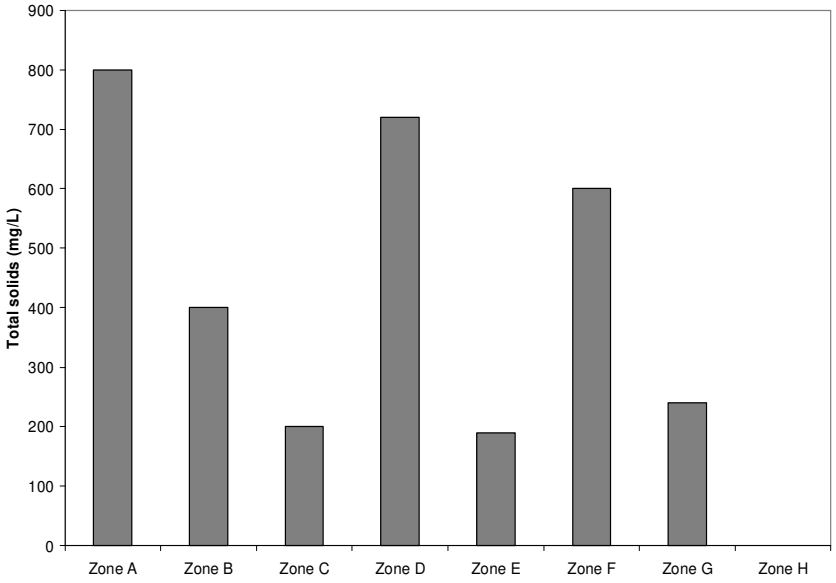

Figure 3 (a and b). Well water quality in the study area.

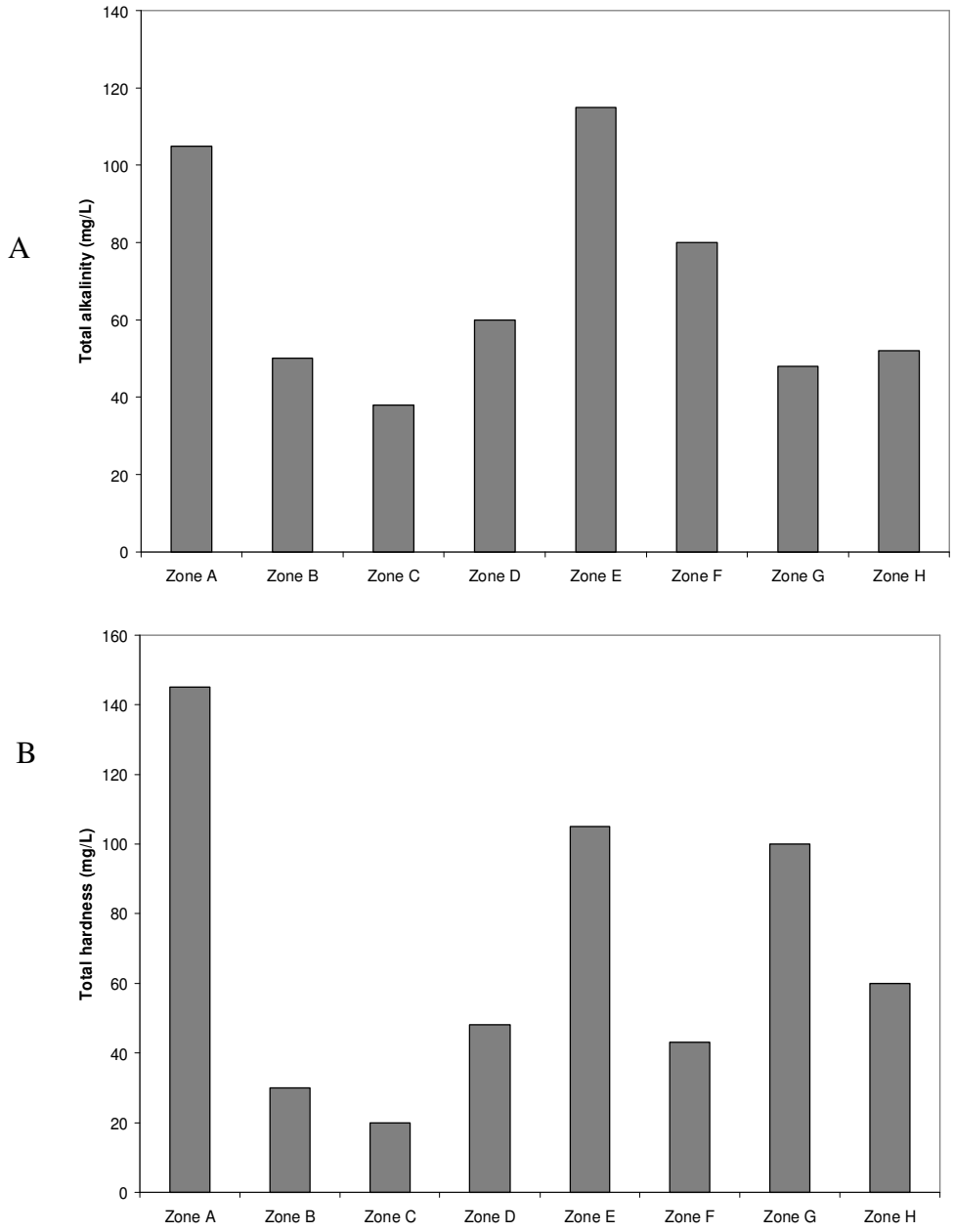

Figure 4(a and b). Well water quality in the study area.

CONCLUSIONS AND RECOMMENDATION

Conclusions

The South-east Local Government Area of Ibadan slums studied is an high-density area to rely on groundwater in the form of wells, which are grossly polluted by unsanitary practices such a unsanitary maintenance of wells and their features, proximity to potential pollution sources such as pit latrines, indiscriminate dumping of refuse and poor sanitation. Of 123 households around the water well points interviewed there are 118 respondents being women between the ages of 16 and 65 years that is 98.3% and also, on the occupation of the respondents having 84 people (70%) as low-income. This is clearly evident in the water well usage lifestyle and maintenance attitude resulting in heavy pollution observed.

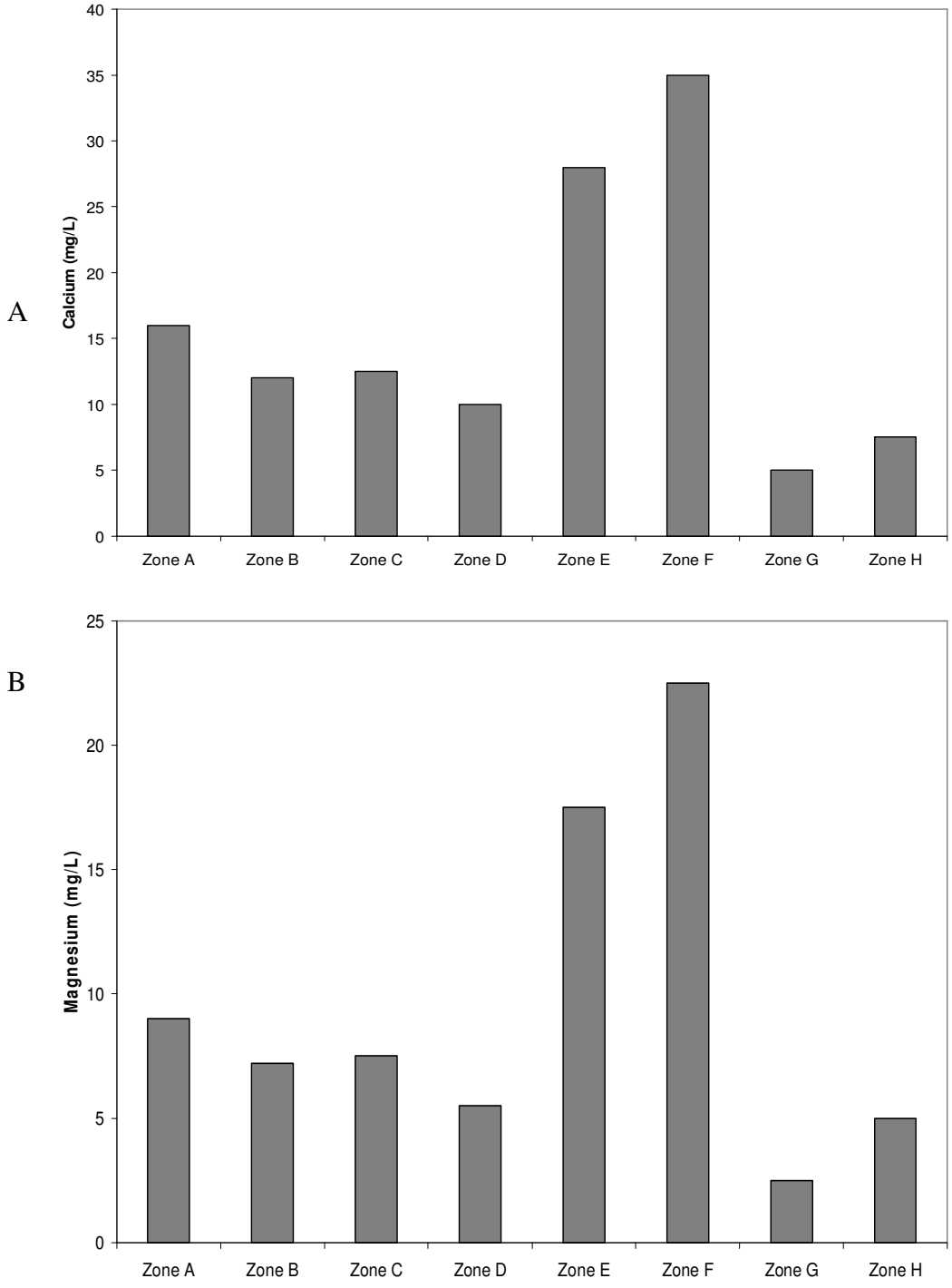

Figure 5 (a and b). Well water quality in the study area.

These communities are therefore prone to health risks, because of their dependence on these sources; thus there is need for improvement and in some cases reconstruction of the wells and well waters treatment. The treatment method should be appropriate which implies it is being economical and efficient.

There is the need to further asses the wells during the wet season also, as the research work was only carried

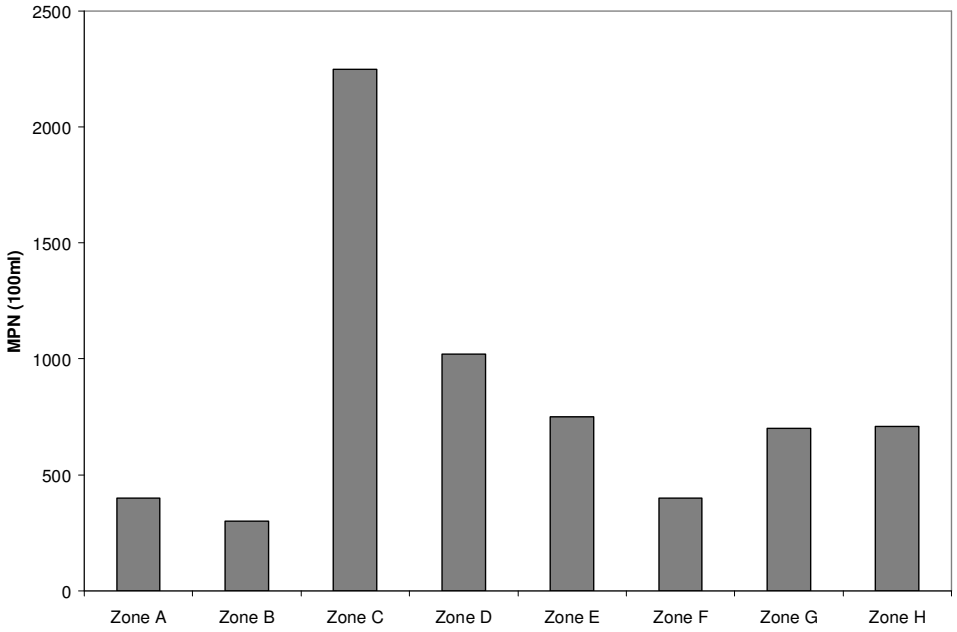

Figure 6. Well water quality in the study area.

Table 11. Characteristics of well water.

Parameters	Sample No. 1	Sample No. 2	Sample No. 3	Sample No. 4	Sample No. 5	Sample No. Min	Ranges Max.	Mean	S.D
pH value	6.30	6.50	6.60	5.80	5.90	5.80	6.60	6.20	±0.3563
Total solid (mg/l)	180.50	186.50	180.00	159.00	164.5	159.00	186.50	174.10	±11.7228
Suspended solids (mg/l)	26.67	33.34	13.34	40.01	53.34	13.34	40.01	33.34	±14.9078
Alkalinity (mg/l)	37.00	54.00	36.00	57.00	57.00	36.00	57.00	48.20	±10.2563
Hardness (mg/l)	33.00	28.20	34.00	65.00	49.00	28.2	65.00	41.84	±15.1105
Calcium (mg/l)	11.60	12.40	12.00	18.80	16.00	11.60	18.80	14.16	±3.13.177
Chloride	1.10	3.00	2.00	10.00	9.00	1.10	10.00	5.02	± 4.15956
MPN Per 100 ml	9,200	2,300	3,300	5,400	5,400	2,300	9,200	5,120	±2648.96

out during the dry season.

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APPENDIX: Questionnaire

Surveillance/questionnaire on wells in Ibadan slums (South East L.G.A), Nigeria

Section I:
Type of facility: Dug well or other specify

General information

1. Location
2. Date of visit
3. Name, designation and address of the person being interviewed
4. Is water sample taken? Sample no:

Section II: Specific diagnostic information for assessment

1. What is the estimated depth and diameter of the well?
   Depth? Diameter SWL?
2. Is the well covered? (a) Yes (b) No
3. If yes specify type of cover (please tick one) (a) Iron (b) Wood (c) Others
4. Is the well lined? (a) Yes (b) No
   If yes what type (please tick one)
   (a) Cement block (b) Concrete (c) Super concrete (d) Drum
5. What is the well wall thickness? (m)
6. How many people is the well serving?
   Give an approximate figure
7. Is there any purification of the well water before use? Pls tick one;
   (a) No purification (b) Slow sand filtration (c) Filter cloth (d) Boiling
8. What type of purification (pls tick one)
   (a) Use of Chlorine (b) Slow sand filtration (c) Filter Cloth (d) Boiling
9. Any change in the physical parameter after rainfall?
   (i) Suspend solid (a) Yes (b) No
   (ii) Colour (a) Yes
   (b) No
   (iii) Odour (a) Yes (b) No
10. What is the nature and distance of the nearest source from the well?
    (a) Nature (b) Distance
11. Are the rope and bucket left in such position that they may contaminate the water?
12. Is there any association of diseases with the use of the well?
    (a) Yes (b) No
13. If yes, please list (i) (ii) (iii)

Section III others

1. What are your household's major sources of water during dry and rainy season?
2. What are your household uses for the various sources?
3. How long does it take you to get to the various sources?
   Please use table below:
4. Where is the well located? In your Compound 1 Outside compound 2
5. If outside well, please specify distance ……
6. How long have your been drinking the well water (years)……..
7. What is the main excreta disposal facility used in your household?

(i) Household connection to sewer
(ii) Septic tank
(iii) Open public sewer
(iv) VIP
(v) Pail
(vi) Pour/flush latrine
(vii) Simple pit latrine
(viii) Bush
(ix) Aqua privy
(x) Any other specify _____

Is the stool disposal facility on these premises/compounds Yes/no?