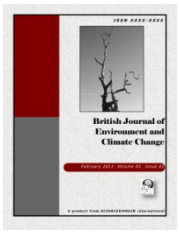

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Effect of Depth on Microbial Pollution of Shallow Wells in Makurdi Metropoilis, Benue State, Nigeria

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Research Article

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ABSTRACT

This study looked at the effect of depth on the microbial pollution of shallow wells in the three floodplains of Makurdi metropolis of Benue State, Nigeria. Water samples from the wells were collected and analyzed monthly for seven months from February to August (covering both wet and dry seasons) using the pour plate technique. The assessment was for the presence coliform bacteria. The species isolated were *Salmonella typhilis*, *Escherichia coli, Streptococcus faecalis, Proteus spp*. and total coliform. The pollution of wells was found to increase with decrease in depth and decrease with increase in depth. The water table varied from 4.3m (in wet season) to 6.4m (in dry season). Generally pollution level in the floodplains was between 17cfu/ml and 297cfu/ml of bacterial population. No well studied met the limit by World Health organization (WHO) for drinking water which is 0cfu/ml and 10cfu/ml by the National Agency Food and Drugs Administration and Control, Nigeria (NAFDAC). This shows that wells must be up to 15m deep so as to be free from pollution. Screening the wells to the depth of 15m and treatment by disinfection before drinking were the recommendations made.

Keywords: Floodplains; disinfection; septic effluent; pollution; coliform; wells; Nigeria;

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1. INTRODUCTION

Water pollution is mainly a function of human activity which results in the deterioration of physical, chemical and biological properties of water. Animal faeces and vegetable materials decompose during the hydrologic cycle and are brought into the water sources, thus polluting them. As water percolates through the soil, natural filtration takes place therefore making it less harmful. Studies by Onoja and Adelakun (2009) showed that there is prevalence of water borne diseases arising from ingestion of water contaminated with pathogens. This has manifestated in diseases like typhoid fever, amoebic dysentary and cholera etc which has resulted in deterioration of health and in some cases death. This is so because of dependent on shallow wells for drinking and domestic water within the floodplains. From records available at the Federal Medical Center Makurdi, over 50% of ailments treated at the hospital are of water related causes: typhoid fever, amoebic dysentery, and cholera. The outbreak of these diseases is at the peak around the months of July-August over the years.

Efe (2008) stated that the longer the polluted water travels through the soil formation the better (cleaner) it becomes. Iserman (1977) and Essien (1996) stated that shallow wells close to sites that are contaminated will inveriably be contaminated with the contaminating substances if they are less than 15m deep. Studies by Bolaji and Martins (2008) in Abeokuta western Nigeria, showed that the microbial quality of water from 24 wells varied with depth and nearly all of the wells were faecally contaminated.

In Makurdi the early wells were sand point and without cover. Water could be fetched by getting into the well. These wells were cased with bricks with wellhead built with metal cover. Onwuka et al (2004) evaluated eighty samples in Enugu Southeastern Nigeria, for bacteriological quality. The results showed evidence of sewage contamination. The work recommended improved ways of managing domestic wastes like the use of central sewer system.

Agbede and Akpen (2008) in their study on the bacteriological and physico-chemical qualities of ground water in Makurdi metropolis floodplains (depth between 1.82 and 7.43m) found that all the ten wells studied were polluted with faecal bacteria; while the wells outside the floodplain were polluted with non-faecal bacteria.

The objective of study is to determine the microbial water quality of hand-dug wells with respect to depth variation in the floodplains of Makurdi metropolis of Benue State.

2. MATERIALS AND METHODS

2.1 Study Area

The study area is the three floodplains (Wurukum, Wadata and Idye) in Makurdi, Benue State. Makurdi lies between latitude 7˚ 45’ and 7˚ 52’ N and longitude 8˚ 4 35’ and 8˚ 41’ E. River Benue (second largest river in Nigeria) traversed the town. The South Bank has three flood plains namely, Wurukum, Wadata, and Idye. These areas are flooded in the rainy season and are highly populated. The study area has two seasons, wet season (May - October) and dry season (November - April). Nwajide (1982) showed that the Makurdi formation in which these floodplains are situated comprises of the lower Makurdi sandstone, the upper Makurdi sandstone and the Wadata limestone. Most part of the town rely on hand-

dug wells to meet their domestic and daily water needs; and some others take water directly from River Benue for drinking. All these wells are sand-point wells (wells that are without casing). A survey carried out in the Wurukum floodplain shows that nine out of ten households in the area depend entirely on these hand-dug wells for drinking water.

2.2 Sample Collection

The well water samples were collected in 500ml screw-capped bottles that were sterilized to avoid contamination by any physical, chemical or microbial means. Weights were attached to the bottles so that they will vertically sink into the well (this is to avoid collecting water samples at the surface only). The samples which were collected in three replications were aseptically transferred into sterile 500ml containers. These samples from fifteen wells (five from each of the three flood plains) were taken to the laboratory within one hour of collection for analyses. Sampling covered both dry and wet seasons. A total of three hundred and fifteen samples were collected and analyzed. The study was limited to the flood plains because they are the lowest and most easily flooded, thus presumed to be most susceptible to pollution in the metropolis.

2.3 Bacteriological Analysis

The analysis of water sample was carried out within twenty four hours of collection using the Pour Plate technique as described by Fankhauser (2003). Cystine Lactose Electrolyte Deficient –CLED (agar) Medium was used to obtain plate count of living bacteria (viable cell count). The procedure involves innoculating 10ml of liquefied agar at 37 ºC with 1 ml of water sample in Petridishes that have been sterilized in the autoclave at 110 ˚C for 15 minutes. The agar sets to a jelly, thus fixing the bacteria cell in position and preventing swarming of colonies. The plates were inverted and incubated for 24 hours at 37 ºC for bacteria organism from animal or man. At the end of the incubation, the individual bacteria produced colonies visible to the naked eyes and the number of colonies was determined by using Stuart Scientific Colony Counter. The colonies were identified by their different colors and sizes. A magnifying glass was used in counting the colonies. After the colonies had been counted they were calculated using the equation below:

Cfu/ml= cfu/plate x dilution factor x 1/aliquot (1)

3. RESULTS AND DISCUSSION

Table 1 shows detailed information on Wells studied with depth varying between 0.87m to 8.2m. Four sources of contamination were identified as; pit latrines, soak away pits, septic tanks and refuse dumps. The potability of wells studied was defined in terms of their bacteriological quality which was compared with the WHO (2004) and NAFDAC (2004) standards.

Figures 1, 2, and 3 show coliform contamination of wells in the three flood plains respectively. Generally it was noticed that pollution decreases with depth within the floodplains. This confirms the fact that pollution was affected by the depth of the wells as earlier pointed out by Bolaji and Martins (2008) and Abimbola and Sangodoyin (1994). This shows that the soil profile acted as a natural filter which purifies the contaminated water.

Figure 4 is the depth-coliform variation. The deepest well was 8.2m and was least polluted by total coliform bacteria. The main coliform bacteria contaminants isolated were escherichia coli, salmonella typhilis, streptococcus faecalis and proteus spp. This is in agreement with the findings of Agbede and Akpen (2008) and Iorver (2011) that the main coliform bacterial contaminant of the wells within the Makurdi floodplains is of feacal origin. The shallowest well was 0.87m deep and has an average pollution level of 128cfu/ml which has exceeded WHO's (2004) limit of 0cfu/ml and NAFDAC's (2004) limit of 10cfu/ml for potable water.

Table 1. Detailed Information on Wells Studied

Well No.	Proximity to Effluent Source(m)	Well depth (m)	Waste disposal type	Use of Well/ Remarks
W/01	18.8	8.2	Septic tank	Used for drinking, washing, cooking lined with bricks.
W/02	11	7	Refuse dump	Used for brewing local drink (burukutu) washing, and drinking, lined with bricks.
W/03	13	1.78	Pit latrine	Used for cooking, drinking lined with bricks.
W/04	8	1.65	Soak away pit	Used for cooking and drinking.
W/05	15	2	Soak away pit	Used for cooking, washing and drinking.
W/06	5	6	Soak away pit	Used for cooking, washing and lined with bricks.
W/07	2	4	Soak away pit	Used for cooking, drinking and washing.
W/08	10.7	0.87	Pit Latrine	Used for cooking, washing, lined with bricks.
W/09	3.7	1.8	Refuse dump	Used for cooking, washing and drinking.
W/10	3	2.1	Septic tank	Used for cooking, and washing.
W/11	10	3	Septic tank	Used for drinking, and cooking.
W/12	4.6	6	Soak away pit	Used for drinking, and cooking.
W/13	7	5	Soak away pit	Used for drinking.
W/14	13.04	7.4	Septic tank	Used for drinking.
W/15	16.9	3.6	Refuse dump	Used for drinking, lined with bricks.

The study has also shown that the quality of wells studied was dependent on the season of the year. All the wells studied in the three floodplains were least polluted in dry season and most polluted in wet season irespective of the depth (Table 2). This is because during the wet season most pit latrines and septic tanks are over flooded and some collapse.

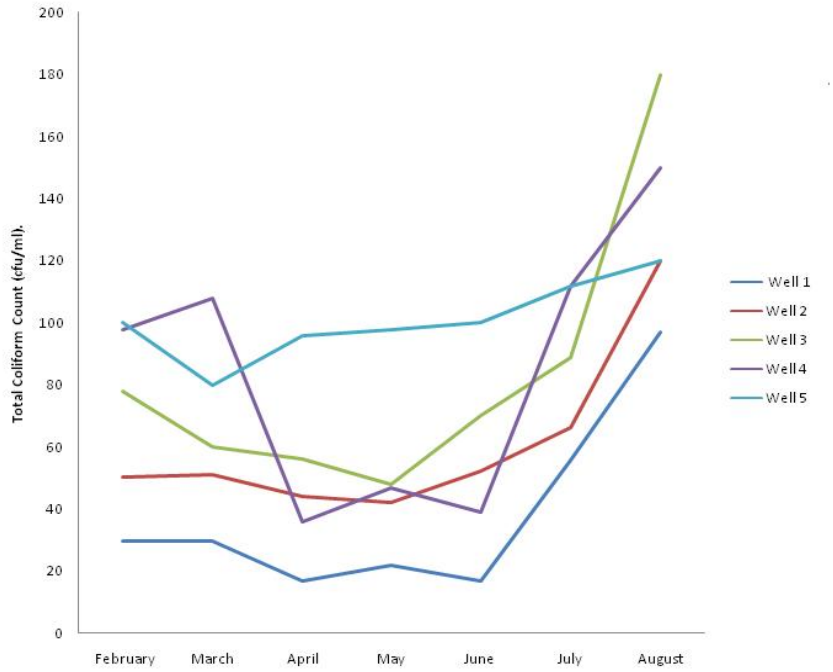

Fig. 1. Contamination of Wells in Wurukum Floodplains

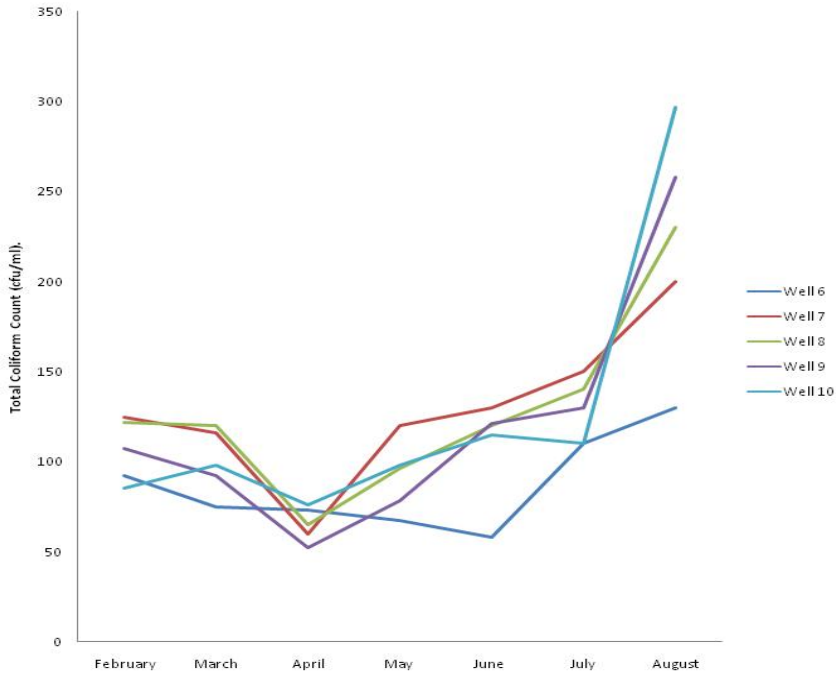

Fig. 2. Contamination of Wells in Wadata Floodplains

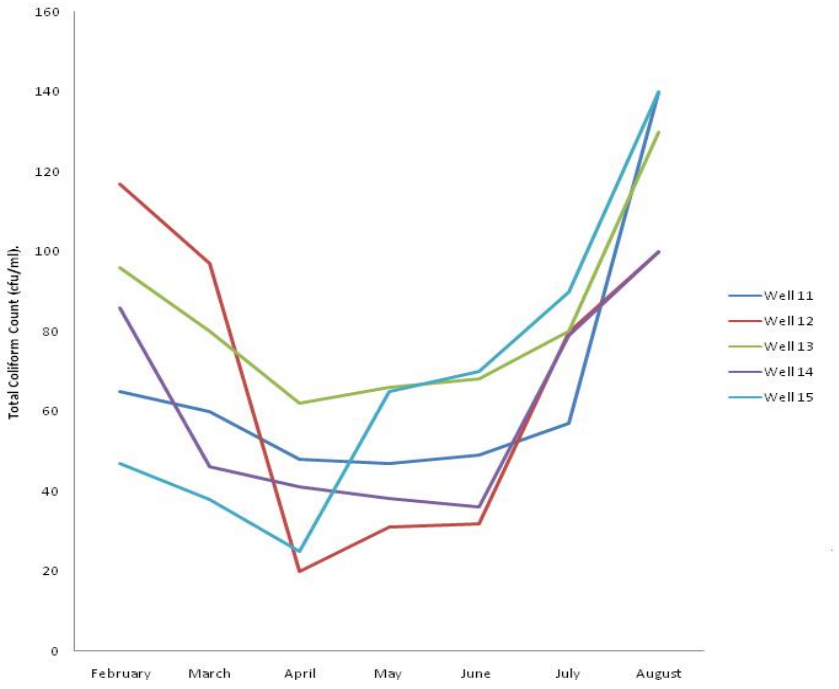

Fig. 3. Contamination of Wells in Idye Floodplains

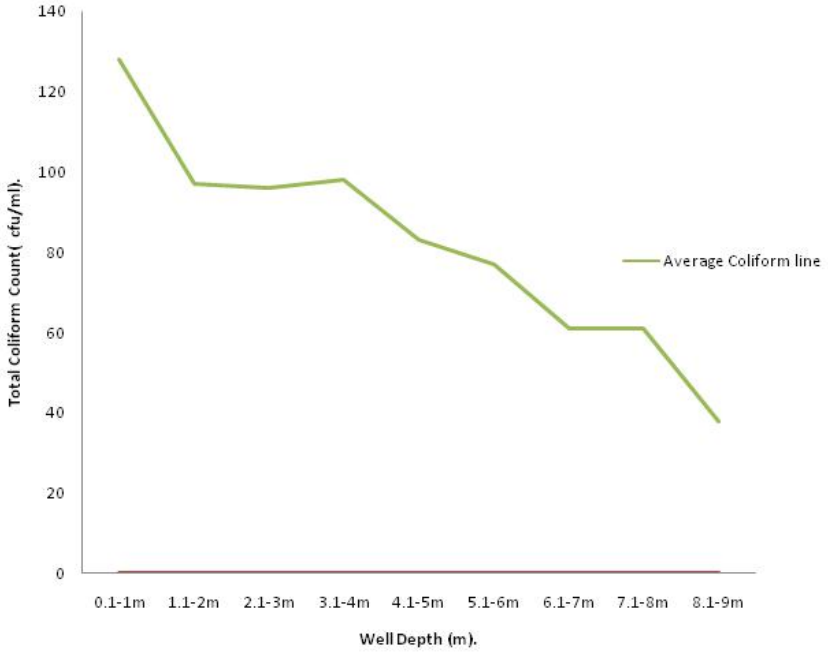

Fig. 4. Variation of Bacterial Pollution of Wells with Depth

Table 2. Seasonal variation in bacteria contamination of the wells

Well No.	Dry Season (cfu/ml)	Wet Season (cfu/ml)
w/01	26	48
w/02	48	70
w/03	65	97
w/04	81	87
w/05	92	108
w/06	80	91
w/07	100	150
w/08	102	147
w/09	84	147
w/10	86	155
w/11	58	73
w/12	78	80
w/13	79	86
w/14	58	63
w/15	37	91

Wells were found to be most polluted in wet season, when water table was highest. Wells in wadata were most polluted. This is generally due to lack of adequate drainage facilities and high population density. The wells in idye were least polluted because it is the inlet of the floodplains which distributes water to wurukum floodplain. It also has improved drainage network and low population density.

4. CONCLUSION

From this study, it is concluded that:

1. Quality of water of shallow wells in the three floodplains of Makurdi is dependent on depth and season of the year.
2. Pollution levels of 17cfu/ml - 297cfu/ml are unsuitable for drinking because they are above 0cfu/ml limit of WHO and 10cfu/ml limit of NAFDAC.
3. The wells are contaminated by coliform bacteria. This means that the water has to be treated (chlorinated) before drinking.
4. The continued use of these wells has given rise to increased cases of waterborne related diseases like tularemia, leptospirosis, typhoid fever, cholera, aseptic meningitis, amebiasis, hepatitis etc in the Makurdi metropolis. This incidence of these diseases is found to be peak in July/August over the years as confirmed from hospital records at the Federal Medical Centre Makurdi.
5. All the corresponding results were higher in the wet season and were increasing with rise in water table.
6. The casing of these shallow wells from 15m depth is recommended to reduce surface contamination.

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