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Domestic Sewage Disposal and Quality of Water from Hand Dug Wells in Ughelli, Nigeria

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Abstract

Rapid population growth due to urbanization which impinges the environment in most towns and cities in Nigeria, deteriorate the quality of water resources. Some of these activities include (daily discharge of liquid and solid waste as well as industrial effluent). The pollutants are discharged directly on the sources of water supply such as hand dug wells. The study showed that over 80% of household depends on hand dug (relatively shallow) wells for their source of potable water supply. About 84% of household use septic tanks, 8.9% use pit or pail latrine, 5.1% dispose of their sewage indiscriminately and 2% by dig and bury system. 20 well water samples were collected during the months of January, February, June, July and September, *2011 with the aid of sterilized buckets and sent to the laboratory for analysis. Results shows that wells located close to septic tanks and pit latrines were more polluted in terms of acidity, conductivity, $CaCO_3$, NO_3, ammonia, Pb and bacteriological quality. These results shows that unless there is proper education of the populace in this area, the continued use of water from these wells could lead to serious health hazards.*

Key Words: Wastes, Sewage, Wells, Pollution and Ughelli

Introduction

Waste if not properly disposed could affect the health and quality of environment of human settlement. As our environment gets urbanized, there is always the tendency for population increase and with the attendant increase in industrial development; wastes are frequently discharged into water courses and the land surfaces. The consequence is that, water quality is highly affected which becomes highly dangerous (Obasi and Balogun, 2001).

A number of literatures are now available on environmental pollution. However, most of them are focused on solid waste and the exploitation of resources like mineral and forest rather than on sewage pollution.

Domestic sewage is liquid waste. It is waste from kitchen, from the bathroom lavatory, laundry, toilet and the entire total run-off from residential areas (Oluwande, 1978).

In most tropical cities and in Nigeria in particular, large volumes of liquid wastes (sewage) deteriorates the quality of water in cities like Lagos, Port-Harcourt, Warri, Ibadan, Kaduna, Onitsha, Kano e.t.c. (Aina, 1991; Omuta, 1999; Obasi and Balogun, 2000). Leacheates from this wastes find its way into boreholes, lakes, wells and other water bodies.

In Ughelli, there has been a rapid Urbanization and population growth over the years from 13,000 in 1952 to 45,000 in 1963 and well over 166,020 estimated in 1991and 321,028 in 2006 (National Population Commission, 2006). This implies a rapid increase in domestic sewage generating capacity. Unfortunately, the rate of provision of infrastructural facilities in Ughelli town has not been growing pari-pasu with the rate of generating domestic sewage. Consequently, the few available facilities are over used and over stretched. The sewage is therefore haphazardly discharged into streets, open spaces and drainage channels.

Studies carried out by Ovrawah and Hymore (2001) and Efe (2005) both in Warri and Onitsha respectively were based on the effect of some environmental pollution on solid waste and other contaminants. This study has however deviated by seeking to establish the effect of liquid waste on hand dug wells in Ughelli and its environs.

Study area

Ughelli is located between latitudes $5^{O}28'$ and $5^{O}32'$N of the equator and also between longitudes $5^{O}58'$ and $6^{O}03'$E of the Greenwich Meridian.

It is bounded in the North West by Ethiope East local government area, in the West by Ughelli South Local Government Area, in the North-East by Ndokwa West and in the East by Isoko North and Isoko South, while in the South by Patani Local Government Area (See Figures 1 and 2).

On the other hand, Ughelli Urban is bounded by Eriemukhowaren to the North, Ovwor-Olomu in the West, Agbarha-Otor to the East and Oviri-Ogor in the South.

The area is characterized by tropical equatorial climate with mean daily maximum temperature of about 30^{O}C and a minimum of 28^{O}C (Efe, 2006). The relative humidity is high (about 98% during the wet season resulting in damp conditions and varies slightly to (about 96%) during the dry seasons. Rainfall distribution ranges between 3000mm to 3500mm. within the period water fall is usually very high in the valley region. The area lies within the lowland rainforest with swampy forest occurring in flat-floored valleys and adjourning low-lying areas that are seasonally or permanently waterlogged.

The soils are deeply weathered and nutrient deficient, being derived mainly from unconsolidated sediments of sandstone and are predominantly sandy.

The area has been experiencing steady growth in socio-economic activities such as the presence of the school of health and technology and there are a lot of industries; such as: oil and gas, Petrochemical, wood processing, rubber latex, metal and alloys and agro-allied. With these industries, there is influx of migrants into the town over the years thereby swelling the population.

The overall effects of these developments of rapid population increase are the high rate of domestic sewage generation and as well, increase in the attendant environmental sanitization problems.

Unfortunately, in spite of the awareness about the danger of un-kept environment, infrastructural facilities for domestic sewage disposal are not provided in Ughelli town to match the rate of sewage generation and the overall urban growth.

FIG. 1: MAP OF DELTA STATE SHOWING STUDY AREA
Source: Modified after **Ministry of Lands, Survey, and Urban Development, Asaba 2008**

Materials and method

A preliminary study was used to establish the methods of waste disposal and the importance of water from hand dug wells in the study area. Well water samples were the main experimental material which was subjected to laboratory analysis. The samples were drawn from twenty (20) hand dug wells in the area. During the onsite investigation, it was discovered that the depth of most of the wells ranged from 3m-6.5m, during the dry season and less than 1m at the peak of wet season (September). It was also discovered that wells No.1, 11, 14 and 17 were close to septic tanks, while the rest were close to pit latrine and along stream course. It was also found out in the course of the work that most of the inhabitants get most of their domestic water from the well and drink directly without purification.

The water samples used for the laboratory analysis were drawn with the aid of sterilized buckets, which had been thoroughly washed to avoid any physical, chemical and microbiological contamination of samples. Samples were aseptically transferred into 20 sterile plastic containers for five months period (January, February, June, July and September 2011). The mean of the five-month period were calculated and used for the study. Samples for microbial analysis were kept in capped bottles that have been sterilized in an auto case for 12 minutes at 12^{o}c. grains of boric acid were added into the samples to arrest any further bacteria growth prior to analysis. samples were then taken to the laboratory and kept in the refrigirator for microbial, physiochemical analysis. Ovramah and Hymore (2001) adopted similar method of data collection and achieved significant result.

For the study, Ughelli town was divided into twenty (20) sample sites and samples of water were collected from each of these sampling sites. (See Figure 2)

Analysis of well water samples

Sensitive parameters, such as temperature and pH were measures immediately at sites of collection. AMP230 pH meter and mercury thermometer was used for the pH and temperature. Conductivity and turbidity were determined with a MC226 conductivity meter and 214A turbidity meter. TDS, TSs, So_4^2, NO_3, HNO_3, NH_4CL and $CaCO_3$ in well water samples were determined using standard analytical methods. The Perkin Elemer 3110 Atomic Absorption Spectrophotometer (ASS) was used to determine the trace and heavy metals of well water with the approximate wavelength for each of the metals (Ca, Pb, Fe, Mg, Cl and Cr).

The most probable number technique was used to determine the presence of microbial in well water samples. The numbers of contained coliform per 100ml were estimated from MPM.

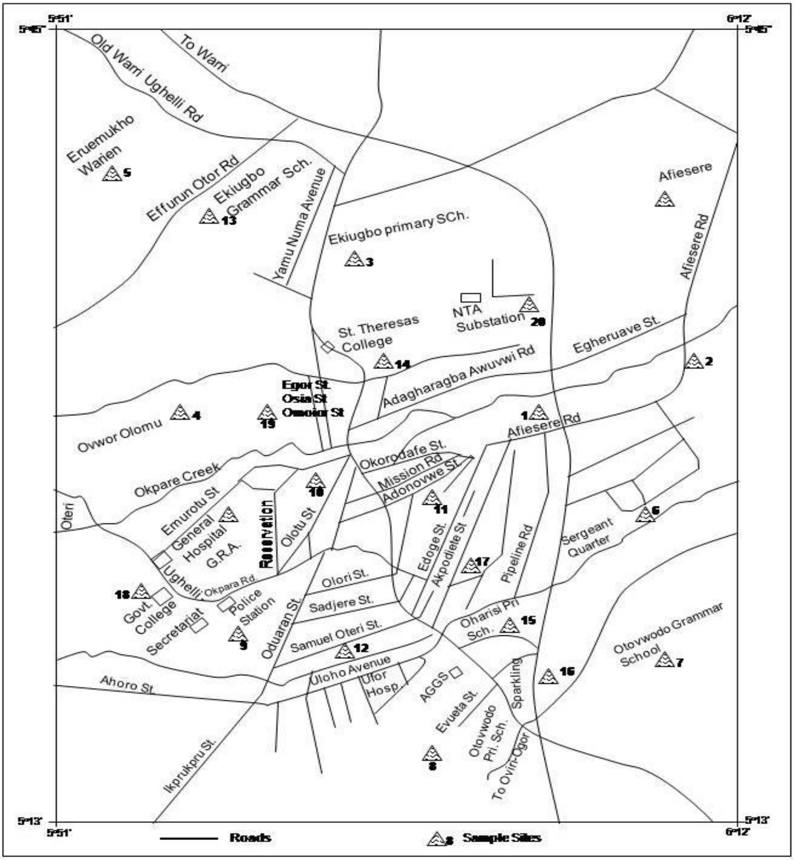

FIG. 2: MAP OF UGHELLI SHOWING SAMPLE COLLECTION SITES

Source: Fieldwork, (2011)

Method of domestic sewage disposal in ughelli town

In the developed world, domestic sewage is collected from all households and sent through underground sewage to carefully selected sites where the nuisance would be removed far always from settled area. But in the developing world, due to poor capital outlay, low technology and low education, the developed world, stand, cannot be transferred to developing countries out right.

The result of study carried out in Ughelli town shows that there are four different methods of domestic sewage disposal method mainly used. These are the soak away/septic tank system, pit or pail latrine system disposal into open stream/space system and the dig and bury system (See Table 1).

Table 1: Method of Domestic Sewage Disposal

S/N	Methods	No. of Respondents	Percentage
1	Soak away pit/septic tank	200	84.0
2	Pit or pail latrine system	20	8.9
3	Disposal into open stream/open space	15	5.1
4	Dig and bury system	8	2.0
	Total	**243**	**100.0**

Source: Field work, 2011

According to Oluwande, (1978), for the soak away pit to be danger free:

1. There is need for percolation test to know the absorption capacity of the soil before it is used.
2. The pit (bottom) should be covered with broken blocks if soak away is not lined.
3. Pits in areas where the water table is close to the surface should be equipped with drainpipes. The drains must be located 15cm below the inlet pipe.
4. Waste water from kitchen and bath rooms should be preferably through grease traps before entering the pit.

Unfortunately, in Ughelli town these prescriptions are not followed. The result is that the soak away pits are quite often too small and fragile, in the absence of concrete construction of the drain-pits, when they are filled up, the sewage over flows into streets to constitute threat to public health. For example, the soak away pits do not have protection against corrosion; they are not lined with water proof plastic materials while no percolation test is conducted before the pits are used. The result is that the sewage seep into the underground water to pollute it.

The pit system is widely used in Adonovwe/Mission area, Edoge/Akpodiete area, Egor/Omoior area, Ekuigbo area and Adagharagba/Awuvwi area. Many houses in these areas are yet to be modernized. The pit latrines system is not widely used nowadays because it smells a great deal. Pit latrine breeds a lot of flies. The building can collapse if the materials used for construction are not strong enough. Besides, there is the danger of contaminating the source of water supply if it is close to wells or springs particularly increase where the soil is porous and permeable.

There are those who discharge sewage right into the course of the river or nearby streams. In addition, others defecate in the open fields, undeveloped pots of land as well as uncompleted buildings.

Besides, the areas where faeces are discharged into open spaces are unsightly and emit pungent odour, which cause disaffection. The environment becomes polluted and makes it unhealthily for living. It is messy. The mess is only removed through the natural process of erosion, percolation, leaching or illuviation after rainfall.

SN	Parameters	Number of Wells																			
	Physical Parameters	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	Temperature ^oC	27.00	26.50	26.70	28.00	27.00	28.20	26.30	26.30	27.90	26.30	26.40	28.10	27.00	26.50	26.60	26.00	26.00	26.30	26.40	27.10
2	Turbidity (NTU)	6.20	5.00	6.30	6.40	5.70	6.80	6.40	6.70	7.20	6.20	6.00	7.30	6.50	5.50	5.80	6.00	6.20	6.40	6.90	6.30
3	TSS	25.00	27.00	26.00	26.20	23.00	28.00	20.00	15.00	27.00	25.00	15.00	12.00	23.00	14.50	10.50	16.40	23.50	16.80	25.0	24.00
4	Colour (PTCo U)	3.50	2.60	4.30	4.90	3.00	4.20	4.10	3.20	2.00	3.30	3.50	4.20	4.10	4.00	4.10	4.10	4.30	4.10	3.50	3.60
	Chemical Parameters																				
5	PH	5.10	5.60	5.60	5.30	6.40	5.20	7.00	5.80	4.90	5.60	8.60	4.30	6.40	5.40	7.30	6.30	4.50	5.50	6.90	7.30
6	Conductivity (us/cm)	640.0	420.0	560.0	690.0	580.0	790.0	520.0	520.0	860.0	510.0	450.0	770.0	553.0	630.0	639.0	580.0	520.0	635.0	550.0	490.0
7	Total hardness	120.0	135.0	110.0	226.0	220.0	240.0	120.0	135.0	230.0	221.0	140.0	335.0	156.0	195.0	200.0	165.0	149.0	152.0	210.0	220.0
8	TDS	250.0	220.0	260.0	420.0	325.0	580.0	265.0	260.0	345.0	230.0	275.0	620.0	332.0	390.0	242.0	265.0	255.0	242.0	230.0	220.0
9	Nitrate (NO_3)	11.00	10.0	9.5	9.5	12.4	8.6	4.60	6.50	12.50	10.2	12.6	13.7	10.5	9.6	8.6	7.8	11.2	11.5	10.3	9.6
10	Ammonia	10.2	28.5	11.3	30.5	6.2	7.1	6.30	6.20	5.50	10.5	15.3	20.2	9.2	6.2	8.4	12.4	9.2	8.1	7.3	6.1
11	Sulphate	6.7	15.9	22.0	27.0	9.4	10.5	22.30	20.0	27.0	26.20	27.4	36.6	15.5	18.4	9.4	11.2	9.7	17.4	22.0	15.0
12	Lead (Pb)	0.02	0.02	0.03	2.90	0.01	8.50	0.02	0.03	33.50	0.04	0.02	6.50	0.03	2.50	0.01	0.03	0.03	0.02	0.04	0.01
13	Cadmium (Cd)	0.015	0.042	0.055	0.135	0.328	0.029	0.42	0.120	0.080	0.193	0.010	0.020	0.095	0.136	0.198	0.175	0.020	0.112	0.136	0.176
14	Cromium (Cr)	0.10	0.20	0.10	0.20	0.11	0.02	0.32	0.02	0.30	0.20	0.32	0.33	0.33	0.42	0.20	0.20	0.10	0.40	0.40	0.30

15	Iron (Fe)	0.20	0.20	0.06	0.03	0.07	0.63	0.47	0.2	0.03	0.19	0.02	0.12	0.02	0.06	0.20	0.20	0.10	0.10	0.13	0.12
16	Magnesium (Mg)	0.11	0.25	0.35	0.35	0.36	0.32	0.12	0.11	0.24	0.22	0.43	0.52	0.55	0.51	0.25	0.24	0.26	0.12	0.11	0.12
	Biological Parameters																				
17	Total Coliform Count	20.0	11.0	14.0	16.0	23.0	45.0	10.0	36.0	15.0	15.0	16.0	55.0	19.0	10.0	25.0	64.0	25.0	30.0	37.0	20.0

Table 2: Mean values of physio-chemical and biological parameters of water quality from hand dug wells in the area of study for five months

Source: Field survey, 2011

Result and discussion

Physical parameters

Temperature, turbidity, total suspected solids and colour.

The temperature of samples ranged from 26.2^oC to 28.2^oC which is lower that atmospheric temperature. All well water samples had values above 5NTU recommended by world health organization (WHO) for portable drinking water. Values ranged from 6.0 to 7.3 NTU.

Total suspended solids for the well water samples were above the maximum acceptable limit of WHO 5mg/l. although values as high as 28mg/l were recorded for some wells but none was higher than the maximum allowable limit of WHO (30mg/l).

The colours of the well water samples in Ughelli town conform to the 5PT. Co. U of WHO. Colour values ranged from 2.0 to 4.9 units.

Chemical parameters

P^H, conductivity, total hardness and TDS

The pH of all samples were above the WHO limits at 6.6-8.5 except for wells 1,2,3,6,8,9,10,11,14,17, and 18 were been the WHO limit. The implication is all these wells listed are acidic (See Table 21)

Their acidity is due to their closeness to septic tanks pit latrines and their exposure to atmospheric influence.

Conductivity expresses the total ionic contents of liquids and soil extracts. The conductivity levels of well water generally high, higher that the 500 us/cm limits of WHO. Values of samples ranged from 420 to 860us/cm. however, wells 2,11 and 20 were below the WHO recommended value long values of 420, 450 and 490 respectively.

The total hardness ($CaCO_3$) levels in well water samples were generally high, higher than the 100gm/l maximum acceptable threshold of WHO. The values of samples spans from 110 to 355mg/l, the well water in Ughelli town are hard water.

Total dissolved solids samples were general low and below the acceptable limits of (500mg/l) as presented by WHO except for well water (No. 6, 12) with higher values of 580 and 620mg/l. the increase in the TDS in these two wells, are due to their closeness to septic tanks that leaks into the wells.

Nitrate, Ammonia and Sulphate

Nitrate values of well samples were generally above the WHO recommended acceptable limits of 10mg/l. values as high as 13.7 were recorded for well number 12, 12.6mg/l for well No. 11, well No.12.5mg/l and so far others. The only wells values whose value were below the WHO standard for nitrates are No. 's' 4 and 7.

Ammonia levels were generally high in all wells but particularly high in wells 4 and 2. Virtually all the values recorded within 5 months study period for these wells exceeded WHO are maximum allowable limits of 0.5mg/l for portable water. The reason for the generally high ammonia levels in the well water samples is not very clear. High ammonia value can be attributed to vegetable and animal decay, which have been leached in the well water, which has suffered de-oxygenation and de-nitrification underground and contamination from sewage are other possible causes of high ammonia found in these wells.

Sulphate levels were well within the WHO limits of 200mg/l. SO_4 ranged from 7 to 36.6mg/l.

Heavy Metals (Pb, Fe, Mg, Cd and Cr)

Some traces of lead were found in five well water samples numbers 4, 6, 9, 12 and 15, Pb levels ranged from 0.01 to 8.5mg/l, the reasons for the high level of lead found in the wells mentioned above could be their proximity to dumpsites and heavy septic tanks and all sorts of metals which was washed into the wells. The consistently high level of lead in such well could cause danger as the consumers of such well water are prone to Pb poisoning. The levels of other heavy metals such as Fe, Mg, Cd and Cr were very low for all the water samples <0.07mg/l for Fe, and 0.04 for Cd, Mg and Cr.

Total Coliform Count

The bacteriological quality was found to be above the threshold level required for portable water. Coliform count spans from 10-64mg/l representing over 1000 to 640% twice higher than the maximum acceptable limit of 0 (See Table 2).

Conclusion and recommendation

The inhabitants of the area of study rely heavily on well water as their source of portable drinking water for other domestic purposes. Others who cannot afford bore-hole water resort to well water when there is acute light failure from Power Holdings Company of Nigeria (PHCN) the corporation responsible for generating and supplying electricity for home consumption.

The method of sewage disposal in Ughelli town is very unsatisfactory especially as domestic water used for bathing and washing are allowed to flow free into any direction. These eventually are washed into some of the open wells during the rainy season. Most septic tanks and pit toilets are not constructed to required standard and therefore, liquid wastes are leached into adjourning wells. Moreover, the location of these shallow hand dug wells often leaves much to be descried, some being located rather too close to septic tanks, refuse dumps and other metallic wastes.

The result reveals that the nature of pollution of the well water samples was dependent on the proximity of such wells to the source of pollution.

Wells close to septic tanks, pit latrines contained especially high levels of ammonia, nitrate and all wells contained homeruns amount of coliform bacteria.

Other wells contained negligible to moderate levels of contaminants analyzed from the foregoing, there is need for proper education of the inhabitants who use water for drinking and other domestic purposes about the danger of using such wells without subjecting such to treatment. More especially, there is the need for awareness about the influence of environmental conditions of such septic tanks and pit latrines should be adhered to forestall proper disposal.

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