Standard Journal of Education and Essay Vol 1(6) pp. 81– 90, July 2013
Available online http://standresjournals.org/journals/SJERE/index.html

Accepted 21 July, 2013

Research Article

Effect of Underground On-Site Sewage Disposal System on the Quality of Water from Hand Dug Wells in the Urban Centre of Ughelli, Delta State, Nigeria

[*1]Ushurhe Ochuko and [2]Origho Thaddeus

[1]Delta State Institute of Continuing Education, Ughelli, Delta State.
[2]Department of Geography, College of Education, Warri, Delta State

*Corresponding Author Email: ochuksbeloved201@yahoo.com

Abstract

This study examines the effect of underground onsite sewage disposal system on the quality of water from hand dug wells in Ughelli, Delta State with a view to assessing its impact on human health. It is an experimental research survey of 20 hand dug wells sited alongside septic tanks on the same plot of land 100ft by 50ft. Laboratory analysis of water samples collected at varying distances of 5m, 15m, 25m and 30m of hand dug wells to septic tanks, to ascertain the quality of water in line with WHO (2010) drinking water standard, including a security of the health records of patients who suffered from water borne diseases from the only government owned hospital in the area was carried out. From the analysis, it was discovered that there is variation in water quality obtained from the hand dug wells in the area as a result of the proximity of onsite sanitary facilities to sources of drinking water. The variation is believed to be responsible for most of the water borne diseases in the area. The paper recommends that hand dug wells be located at least 25m from any polluting source, decongestion of onsite facilities in Urban centers and construction of offsite network facilities in order to safeguard human health.

Keywords: on site, sewage, system, water quality, hand dug wells, urban.

INTRODUCTION

A septic tank is a settling tank which collects and stores sewage solids and liquid. Raw sewage flows into the tank from the house sewer (Machmeier, 2000). It is the essential first part of an onsite sewage treatment system. It represents a major household wastewater treatment option (Brassard, 1996). A septic tank is made up of concrete, blocks and should last for about fifty years. The tank itself is water tight and divided into two semi-compartments. When waste flows into the tank, the heavy solids especially feaces sink to the bottom to form a layer of “sludge” while the lighter materials such as grease, fats, small food particles float on the surface forming a layer of “scum”. Between these two layers in a soup of suspended materials and water soluble chemicals such as urea from urine and many household chemicals (Davis, 2000).

A septic tank is designed to break down human excrement and is one of the best for waste disposal in many parts of the country. However, one of the problems of septic tank is underground water contamination as a result of poor design, use and or maintenance. Microbes may travel with the plume of percolating water from the septic tank and contaminate drinking water sources; either borehole or hand dug wells.

In the urban areas of Nigeria, more than 87 percent of the populations live in single rooms or combination of rooms and only 5 percent occupy flats, which are all usually shared or used as family units (Ademoroti, 1988). Access to drinking water and sanitation facilities may be a problem especially where there are proliferation of squatter settlements at city outskirts or within the urban area. In many parts Of Nigeria, urban dwellers have very poor access to safe water and sanitation services; pit and cesspool latrines predominates, of which about seventy-five percent of the urban household make use of either pit or privy latrines (Oluwande, 1985). Water pollution especially underground water pollution is the most evident form of pollution in the area. The predominant use of pit latrines, privies, cesspool water closet toilet leading to the construction of underground septic tanks lead to microbial contamination of drinking water wells through underground water flow.

In Nigeria, pipe-borne water is available to only 11 percent of urban household and this supply is erratic, while 40 percent of urban household obtain their water from hand dug wells (Ayeni, 1994). The altitude of urban residents to drinking water especially water from hand dug wells taking into consideration the construction and nearness of the septic tank to the hand dug well has posed more problems than could be solved (Oluwande, 1985). Sometimes, underground water is polluted and contains substances which are harmful to plants and animals in the environment. In such cases, according to Ademoroti (1988), water which should be a blessing to life becomes a carrier of poisons, toxicants and pathogens leading to dreadful diseases that cause death ultimately.

Polluted underground water may be characterized by the presence of odour; taste and cloudy colour. Thus, chemicals from water buried in septic tanks in the ground contaminate soil water which eventually mixes with underground water. The pollutants move into hand dug wells thereby contaminating water supply. Dissolved chemicals arising from the use of detergents, solid human waste and toxins in the polluted underground water pose a threat to the environment and humans. Some of these substances such as salts, phenols, cyanides, lead, mercury etc. have been associated with cancer, birth defects in children and alteration of genetic make-up of plants and animals (Ademoroti, 1988).

In Nigeria, the awareness of waste pollution is quite low, thus tapping underground water through hand dug wells, sometimes very close to an excreta dump is not uncommon. Incidences of water-borne diseases in Nigeria urban areas leading to millions of death have been reported. Some of these deaths have been traced to the use of waters grossly polluted by untreated waste (UNEP, 2005). Thus, the effect of uncontrolled disposal system renders underground water system unsafe for human, recreational use; poses a threat to human life and is therefore against the principle of sustainable development. Moreso, water-borne diseases and water related health problems are mostly due to inadequate and incompetent management of water resources. Safe water for all can only be assured when access, sustainability and equality can be guaranteed. There has to be an effort to sustain it and there has to be a fair and equal distribution of water to all segments of the society.

Environmental Health and Domestic Sewage

Sewage carries bacteria that transmit organisms that cause gastro-intestinal diseases such as typhoid, dysentery and cholera which affect the health of man. These organisms may be transferred directly into the mouth through the consumption or drinking of water obtained directly without further purification from hand dug wells. This becomes a major environmental health problem in urban centers due to overcrowding of persons in residential areas, squatter settlement, slums development and lack of adequate toilet facilities including improper disposal of sewage. In Nigeria, it has been estimated that the average per daily flow of sewage from house hold is 180 litres (Fantola, 1998). Therefore, certain public health measures such as the use of septic tanks without due consideration on its impact on underground water have been adopted in most urban centres of Nigeria to alleviate environmental health problems resulting from improper sewage disposal.

Development of Sanitary Facilities: A Historical Perspective

The disposal of excreta existed in its crudest form as open-air defection right from the time of man's existence on earth. The pit latrine was man's earliest attempt at proper disposal of sewage. It was created for convenience, privacy and to safeguard human health. But, due to industrialization, rapid development and technological growth, the use of the bucket system and flush toilets came into existence. However, improvement in technology and the development of municipal water schemes led to the improvement of sanitary standards and facilities. This culminated in the introduction of the underground septic tank system to improve healthy living, aesthetic, convenience and environmental sustainability. This gave birth to the water system disposal methods and the flush toilets incorporating the septic tanks as underground storage system.

Flush toilets and sewage facilities in most cases are connected to old pit latrines and or septic tanks or linked directly to open drains and surface water courses. The debate on the suitability of on-site sanitary facilities such as the underground septic tank sewage facility for developing urban settlement ranges on. The solution to this problem lies in field assessment and the consideration of the impinging factors and situation in the urban centres concerned.

On-site Sanitary Facilities

The disposal of excreta and wastewater depends on the types, variation and operational parameters of the sewage system. Thus, each system may either be an off-site disposal system which may be water dependent or an independent system. The on-site sanitary facilities are associated with the management of sewage and wastewater at the point of production. The on-site sanitary facilities are non-network system and tend to serve individual households. They are cheaper and easier to construct, either single or combined systems. The on-site sanitary facilities provide primary settlement alongside sludge stabilization by digestion within the same chamber, thus reducing the sludge volume (Grey, 1989). The septic tank has been identified as one of such settlement tanks for the break-down of sewage. This study therefore is centred on the septic tank as a system dependent on water for operation and as an on-site sewage disposal system.

The Septic Tank

The modern septic tank is made of block, concrete or fiber glass and buried underground. It consists of a single chambered tank unit, plastered and made waterproof on the inside or in more sophisticated versions, it may be multi-chambered and also plastered on the outside, if they are to be situated in water-logged environments. The block types are predominantly in use in Nigeria. On the other hand, the concrete ones are used for the collection of large sewage. Both the concrete and the fiberglass types are well suited for sites with high water tables.

The septic tank provides only partial treatment as the effluent produced requires further treatment before final disposal. This is achieved by combining the tank system with a soil adsorption system. Here, the percolation area provides the required secondary treatment for the primary treated effluent released from the septic tank. Generally, the waste content in the septic tank consists of three separate zones; a scum layer on top; a clarified liquid zone in the middle and a sludge layer at the bottom. Generally, for the operation of the tank, the scum layer prevents oxygen transfer through the water interface thus maintaining anaerobic conditions. It also insulates the anaerobic chamber preventing heat loss, hence increasing micro-organic activities. As sludge builds up, the volume of the liquid zone is reduced and settlement efficiency and retention time is reduced. In all, the supernatant product of the primary treatment process flows through the effluent pipe and filters into the ground to the zone of saturation where it meets the groundwater table.

Groundwater and Groundwater Monitoring

Groundwater supplies drinking water to man when it is tapped through the construction of boreholes or shallow wells. Groundwater feeds most of our lakes, rivers and streams. It accounts for about ninety-five percent of all freshwater found on the earth surface (Krantz and Kifferstein, 2005). In the rural and urban centres of Nigeria, the people rely on groundwater as a source of drinking water. Also, groundwater located beneath the soil surface is a vital resource for the success and survival of the entire ecosystem.

Ground water has been tapped for thousands of years but only recently have we started to understand its importance and how to manage this precious resource. Much remains to be discovered about groundwater and wider public awareness of its nature and properties is an important first step. The groundwater reserve is particularly at greatest health related risk especially because its largely unmonitored and visual perception of its quality on extraction is usually deceptive. Measuring the physical and or chemical properties of ground water to determine its contaminants concentrations is frequently monitored to ascertain if they are increasing, decreasing or remaining in the same range. Monitoring is also performed at and in the vicinity of water supply sources to determine the quality of the water and trends of indicator of water quality. Thus, groundwater flow modeling is generally used to define the quality of ground water available or direction of dissolved contaminant migration (Agbede, Akpokodje and Kupolati, 2003).

Hand Dug Wells

From time immemorial and even to the present day, holes or pits were dug by hand or machines into the ground to tap the water table. Hand dug wells are usually 3 – 10 feet in diameter, 10 – 40 feet deep and lined with blocks, brick, stone, tile, wood cribbing or steel rings to prevent the walls from caving in. Dug wells depend entirely on the natural seepage from the penetrated portions of water table aquifers.

Hand dug wells are disadvantageous in the sense that they are more difficult to protect from contamination and their yield are very low because they do not penetrate into the reliable, productive water table aquifer. However, most of the shallow wells in Ughelli urban are of the dug type, usually by hand rather than by machines and sited within the vicinity of underground septic tanks. This work is centred on hand-dug wells and the impact of septic tanks effluent on them.

Statement of the Problem

Several researches on water point to the fact that there have been increased studies on the quality of water from the surface (Streams, lakes, ponds and rivers) and rainwater quality to the neglect of well water resources (Egborge, 1991: Akporido, 2000 and Efe, 2003). The reason for this neglect is that most of the inhabitants in the study area consider the water as potable and depend on it for domestic uses. Some consume the water without further purification as it is their only source of water supply.

In Ughelli, the patronage on hand dug wells is more when compared to other sources of water supply. The quality of this water for domestic consumption is still questionable. Also, cases of water borne diseases have been reported in the area. The need to assess the water quality of the hand dug wells in order to scale to its barest minimum incidences of water borne diseases in the urban centre of Ughelli forms the main thrust of this research.

Aim, Objectives and Hypothesis

This study is aimed at assessing the effects of underground onsite sewage disposal system on the quality of water from hand dug wells in the urban centre of Ughelli, Delta State. The specific objectives are:

1. Assess the quality of water from hand dug wells at varying distances of septic tanks to hand dug wells in the area.
2. Ascertain the level of variation in the quality of water.
3. Ascertain if the variation is responsible for water borne diseases in the area.
4. Ascertain if there is any relationship between water borne diseases and the zonal trend of groundwater quality in the area.
5. Suggest ways of improving the water quality vis-à-vis minimizing the incidence of water borne diseases.

Ho: The prevalence of water borne diseases (Diarrhea, dysentery and typhoid) is not significantly dependent on the quality of water in the area.

Study Area

Ughelli is located between latitudes 5^0 28'N and 5^0 32'N of the equator and also between longitude 5^0 58'E and 6^0 03'E of the Greenwich Meridian. Ughelli is the headquarters of Ughelli North Local Government Area of Delta State. Ughelli is one of the largest urban towns in Delta State, in terms of physical size and total population of people. By virtue of this fact, it exhibits most of the developmental attributes of most Nigerian urban centres which include the use of the underground septic tanks as on-site sewage disposal system. Also, Ughelli is a rapidly growing urban centre as a result of rural-urban drift. As such, it serves as an ideal choice for a representative reassessment of urban sanitary facilities in Nigeria.

Generally in Ughelli, the problem of sewage and wastewater disposal can be described as endemic. To a large extent, disposal takes place in the same site where domestic water is generated. As such, the health of the people and the environment is at risk. Also, the indiscriminate proliferation of inadequate underground septic tank facilities often due to poor construction, poor maintenance and poor aesthetic quality in the area are detrimental factors of concern. Furthermore, the area of study in sub-divided into component units based on house clusters and their general dwelling characteristics as:

1. **Uloho Avenue and environs:** This is a modern post colonial area situated in the southern part of the town. The area is moderately populated and well planned with good quality houses. The area is predominantly residential. It represents quite fairly the middle income group area of Ughelli. The area is well served by underground septic tanks and

water supply from hand dug wells and boreholes.

2. **Overbridge and environs:** This area lies to the north of the town. It covers the main market and has a high population density. Based on visual assessment, most of the area is relatively unplanned with some areas tending to slum location, especially around the streets surrounding the main market. This trend stems from an inadequate controlled scramble for space and a bid to maximize land use.

3. **Upper Afiesere and environs:** This area is situated in the east of the study area. The area is densely populated. Some of the area is largely unplanned and devoid of modern basic facilities because of its pre-colonial timing. There is also very little spacing between building (Okorodafe axis). This area can best be described as a slum. There is the predominance of pit latrines and flush toilets including unkept and unmaintained underground septic tanks. In the other parts of the area – Iwhrekpokpor axis, the area is fairly well planned. It is a newly developed residential layout with good quality houses. It represents a fairly middle income group area. It is well serve with relatively sanitary facilities, but water supply is irregular. The people still depend more on supplies from hand dug wells in the area.

4. **Sergeant Quarters and environs:** This are lies to the south-east are. The area is well planned with sanitary facilities. Poor and erratic water supply from state government owned water services led to the development and construction of individual hand dug wells and boreholes in the area.

5. **Government Reservation Area (GRA) and environs***:* This area covers the traditional core of the town and houses most state government owned establishments. The traditional core areas can be considered as areas of high population density except for GRA, Hospital and Police Station areas. They are colonial and characterized by narrow roads with inadequate facilities, consisting mainly of refuse choked makeshift gutters. The building here are of older generation and densely packed. The same applied to the limited available sanitary facilities. Indigenous people predominantly occupy this are. The occupants are mainly traders and workmen.

In the greater GRA area consisting of government institution and government houses, the area is considered a modern low-density area. The roads are poorly developed and the area covered with low shrubs and scattered trees. Houses are situated in spaced compounds with individual sanitary facilities and enough space.

METHODOLOGY

This study is an empirical research. It involves field measurement of distances of underground septic tanks to hand dug wells and laboratory analysis of well water collected. Also, archival records of persons who suffered from water borne diseases (such as typhoid, diarrhea, dysentery and cholera) at the Central Hospital Ughelli were collected as secondary sources of data for analysis.

Method of Data Collection

The data for this study were derived from water samples collected from hand dug wells from five different zones (Uloho Avenue, Upper Afiesere, Overbridge, GRA and Sergeant Quarters) in the area. The water samples were collected at varying distance of 5m, 15m, 25m, 30m. The 30m distance was used as the control in line with WHO standard. The water samples were collected from twenty (20) different hand dug wells (four from each zone) once in the month of March, April, May, and June, 2006 from each sampled well as varied depth in the area. The collection was done using sterilized bucket for the withdrawal of water. From this container, 100ml of water from each sample was collected using autoclaved sterilized glassware fitted with information tag for identification. Glassware were securely corked and stored in icepacked container before being transported to the laboratory. This was done within 6 hours of such collection. All samples were allowed to settle down for about 4 hours before any form of laboratory analysis. This was done to eliminate any form of turbidity influence on tests.

In addition, epidemiological records of people treated for water borne disease (such as typhoid, dysentery, cholera and diarrhea) for the period of study (January – December, 2006) were collected from the archives of the Central Hospital, Ughelli for the study. The case files of the patients were scrutinized to ascertain the zones/areas they came from in Ughelli.

Moreso, the materials and equipment used for the analyses and assessments of the water samples were based on the analytical equipment recommended and validated by the World Health Organization (WHO), United States Public Health Services (USPHS), American Society for Testing and Materials and the Federal Ministry of Environment for testing of water quality.

DISCUSSIONS AND FINDINGS

Spatial Distribution of hand dug wells

A total of five hundred and fifty seven (557) hand dug wells are located in the area. Overbridge and environs has 92 wells, Uloho Avenue and environs has 137 wells, GRA and environs, 84 wells; Sergeant Quarters and environs, 122 wells and Upper Afisere and environs 132 wells. Of the total number of hand dug wells in the area, forty (40) wells are located within 5 metres distance to septic tanks, 42 wells are 10 metres apart to septic tanks, 70 wells are 15 metres apart to septic tanks while 74 wells are 20 metres apart to septic tank. Also, 80 wells are of a distance of 25 metres to septic tanks. 101 wells are 30 metres distance to septic tanks and 150 hand dug wells are more than 30 metres apart to septic tanks.

The depth of the wells vary from 6 metres at the valley to 9 metres at the upper and middle slope soils; while the depth of the septic tanks is between 3.2 metres and 4.5 metres depending on the location.

Zonal Trend of the Groundwater Quality

Average concentration values for the zones are shown in table 1

Table 1. Physico-Chemical Water Quality Average – Zonal Trend

Zone	^{O}C	Odour	Taste	NTU	pH	No3	NH_{+4}	CL^{-}	PO^{3}_{4}	SD_4^{2}	Zn^{2+}	Fe^{3+}	Pb^{2+}	Mg^{2+}	BQD	TDS	TSS	COD	Coli form	DO
A	26.8	UN	UN	0.99	6.77	0.75	0.06	1.37	0.42	3.65	0.20	0.03	ND	0.13	2.02	23.35	0.53	5.32	10.5	2.98
B	26.6	UN	UN	9.73	7.79	0.24	ND	1.24	0.40	3.20	0.28	0.03	0.03	0.20	1.03	20.13	0.26	3.10	ND	3.63
C	27	UN	UN	1.01	6.66	1.02	0.12	1.47	0.28	3.51	0.53	0.04	0.04	0.12	2.00	24.00	0.78	5.43	2.5	2.85
D	26.9	UN	UN	1.39	6.64	1.00	ND	1.54	0.27	3.81	0.50	0.03	0.03	0.14	2.03	23.5	0.64	5.38	9.5	2.34
E	26.8	UN	UN	0.98	6.67	0,51	0.06	1.38	0.43	3.72	0.21	0.03	0.03	0.14	1.97	23.4	0.55	5.37	7.5	2.73
C	26.8	UN	UN	0.26	6.93	0.38	ND	1.76	0.53	4.41	0.27	0.04	0.01	0.06	0.94	23.6	0.14	2.12	ND	3.64

A = Overbridge and environs
B = Uloho Avenue and environs
C = GRA and environs
D = Sergeant Quarters
E = Upper Afiesere and environs
UN = Unobjectionable
* = All values are in mg/l
ND = Not Defined

Source*:* Field work, 2006.

Generally, there were increases in turbidity values in all the zones ranging from 0.99 NTU at overbridge and environs to 0.73 NTU at Uloho Avenue and environs to 1.10 NTU at GRA and environs; 1.39 NTU and 0.98 NTU at Sergeant Quarters and environs and Upper Afiesere and environs respectively when compare to the control value of the area. Nitrate values at overbridge, GRA, Sergeant Quarters and Upper Afiesere zone were on the high side with values ranging from 0.75mg/l, 1.02mg/l, 1.00mg/l and 0.51 mg/l respectively. Ammonia values of 0.06 mg/l at overbridge, 0.12mg/l at GRA and 0.06mg/l at Upper Afiesere were equally recorded. Zinc values at Uloho Avenue was 0.28mg/l; GRA, 0.53mg/l and 0.50mg/l at Sergeant Quarters were also above the control values of the area.

At GRA and Sergeant Quarters, iron value of 0.28mg/l and 0.07mg/l were recorded above the control values. Lead values in all the zones except Overbridge also increase. Thus, at Uloho Avenue, it was 0.03mg/l; GRA, 0.04mg/l; Sergeant Quarters; 0.03mg/l and Upper Afiesere, 0.03mg/l. Magnesium in all the zones were higher than the control values with 0.13mg/l, 0.020mg/l, 0.12mg/l, 0.14mg/l at Overbridge, Uloho Avenue, GRA, Sergeant Quarters and Upper Afiesere respectively. Also Bod values in all zones were equally high with 2.02mg/l at overbridge, 1.03mg/l at Uloho Avenue, 2.00mg/l at GRA, 2.03mg/l at Sergeant quarters and 1.97mg/l at Upper Afiesere. Total dissolved solids at GRA with a value of 24.0mg/l was higher than the background values of the area. Total suspended solids in all the zones increased above the control values with 0.53mg/l at Overbridge; 0.26mg/l at Uloho Avenue; 0.78mg/l at GRA; 0.64mg/l at Sergeant Quarters and 0.55mg/l at Upper Afiesere. Chemical oxygen demand was high in all the zones with overbridge having a value of 5.32mg/1; Uloho Avenue, 3.10mg/1; GRA, 5.43mg/1; Sergeant quarters, 5.38mg/l and Upper Afiesere, 5.37mg/l above the control value of 2.12mg/l in the area. Coliform count per 100ml was high in all the zones except at Uloho Avenue. At Overbridge, 10.5/100ml; Sergeant Quarters recorded 9.5/100ml and Upper Afiesere 7.5/100ml. All these values indicate negative influence on the physic-chemical concentrations actually reaching the groundwater.

Low average pH values of 6.77 at Overbridge; Uloho Avenue, 6.79; GRA, 6.66; Sergeant Quarters, 6.64 and Upper

Afiesere, 6.77 compared to the background values imply a predominance of acid production in the existing on-site sanitary facilities in the area. Low DO in all the zones with value of 2.95mg/l, 3.63mg/l, 2.85mg/l, 2.34mg/l and 2.72mg/l at Overbridge, Uloho Avenue, GRA, Sergeant Quarters and Upper Afiesere respectively when compared to the background values. It can be attributed to high deoxygenetion of the groundwater due to the excessive presence of soluble organics and inorganics which reach the groundwater. This can be attributed to the proximity of a co-existing sanitary facilities in the area. Also, phosphate in the area was low with values of 0.42mg/l at Overbridge, 0.40mg/l at Uloho Avenue, 0.28mg/l at GRA, 0.27mg/l at Sergeant Quarters and 0.43mg/l at Upper Afiesere. Sulphate concentration in the area was also low with 3.65mg/l at Overbridge, 3.20mg/l at Uloho Avenue, 3.51/l at GRA, 3.81mg/l at Sergeant Quarters at 3.72mg/l at Upper Afiesere. These low concentrations indicate low amount of phoisphate and sulphate in the wastewater generated by households in the area (see table 1)

Epidemiological Records: Zonal Trend

On zonal basis, 115 cases of water borne diseases (diarrhea, dysentery and typhoid) representing 20.24 percent of all cases were reported at Overbridge, 92 cases representing 16.05 percent of all reported cases at Uloho Avenue, 138 cases representing 24.08 percent at GRA and 116 case representing 20.24 percent of all reported cases at Sergeant Quarters. Also, 111 case representing 19.34 percent of all reported cases of water borne diseases at Upper Afiesere (see table 2)

Table 2. Spatial Distribution of Reported Cases of Water Borne Diseases

Diseases	Overbridge	Uloho Avenue	GRA	Sergeant Qtr.	Upper Afiesere
Diarhea	22	19	33	23	14
Dysentery	64	44	54	55	54
Typhoid	30	29	51	38	43
Total	116	92	138	116	111
Percentage	20.24%	16.05%	24.8%	20.24%	19.35%
Mean Values of Water Quality above WHO Stand	20.30	5.63	37.62	20.08	17.11

Source: Field work 2006.

However, reported cases of water borne diseases are almost uniform in the area but the highest at GRA followed by Sergeant Quarters, Upper Afiesere and low at Uloho Avenue. This is in line with the mean values of water quality above WHO standard recorded in the area. Thus at GRA, a mean value of 37.62 was recorded with 138 cases of water borne diseases. Overbridge, 166 cases of water borne diseases was recorded with a mean value of 20.30 water quality above WHO standard. Uloho Avenue with 92 cases of water borne diseases has the lowest mean value of waster quality of 5.63 above WHO standard. In Sergeant Quarter and Upper Afiesere, 166 and 11 cases of water borne disease were reported with 20.68 and 17.11 mean values of water quality above the WHO water quality standard. The implication of this is that zones with more pollutants in their samples recorded more cases of water borne diseases (see table 2)

Test of Hypothesis

The multiple regression analysis was used to test the hypothesis, "that the prevalence of water borne diseases (diarrhea, dysentery and typhoid) is not significantly dependent on the quality of water in the area" (see table 2)

H_0: That the prevalence of water borne diseases (diarrhea, dysentery and typhoid) is not significantly dependent on the quality of water if the correlation is zero.

H_1: That the prevalence of water borne diseases (diarrhea, dysentery and typhoid) is significantly dependent on the quality of water if correlation is one or close to one.

From the model summary in table 3, the correlation between Y and the predictors (X_1, X_2, X_3) is 0.999, which shows that there is a high relationship between water quality and water borne diseases.

Table3. Results of multiple regression Analysis of water quality standard above WHO standard and cases of Water borne Diseases

	Mean	Std. Deviation	N
Y	20,2680	11,4620	5
X_1	22,2000	6,9785	5
X_2	54,2000	7,0852	5
X_3	38,2000	9,2033	5

Where:
X_1 = Diarrhea
X_2 = Dysentery
X_3 = Typhoid

Regression Descriptive Statistics

Correlation

		Y	X_1	X_2	X_3
Person Correlation	Y	1,000	.814	.453	.809
	X_1	.814	1,000	.156	.505
	X_2	.453	.156	1,000	.038
	X_3	.809	.505	.038	1,000
Sig(I – tailed)	Y		.047	.222	.049
	X_1	.047		.401	.193
	X_2	.222	.401		.476
	X_3	.049	.193	.478	
N	Y	5	5	5	5
	X_1	5	5	5	5
	X_2	5	5	5	5
	X_3	5	5	5	5

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the estimate
1	1.000[a]	.999	.997	.6087

ANOVA[b]

Model	Sum of Squares	df	Mean Square	F	Sig
1 Regression	525.136	3	175.045	472.397	0.34[a]
Residual	.371	1	.371		
Total	525.507	4			

a. Predictors (constant), X_3, X_2, X_1
b. Dependent Variable Y

Coefficients[a]

Model	Unstandardized Coefficients		Standardized Coefficient	t	Sig
	B	Std Error	Beta		
I (Constant) X_1	-54.863	2.623		-20.918	.30
X_2	.786	.051	.479	15.362	.041
X_3	.578	.044	.358	13.284	.048
	.689	.038	.553	17.966	.035

Coefficient[a]

Model	Correlation		
	Zero-order	Partial	Part
I (Constant)			
X_1	.814	.988	.408
X_2	.453	.997	.353
X_3	.809	.998	.477

Also the coefficient of determination
R = $(0.999)^2$ x 100
R = .9980 x100
R = 99.8%

Also, from the correlation (coefficient[a]), shows that typhoid (0.477) has the highest impact on the people, followed by diarrhea, with 0.408 and dysentery with 0.353. Therefore, H_1 is accepted that the prevalence of water borne diseases (diarrhea, dysentery and typhoid) is significantly dependent on the quality of water, since R^2 = 0.999.

FINDINGS

Based on the aim and objectives of the study and the hypothesis posited, the following observations have been made:

1. There is variation in water quality obtained from hand dug wells in the area as a result of the proximity of on-site sanitary facilities to sources of drinking water. There were physic-chemical pollutions in well water located at 5 metres distance of septic tanks to hand dug wells than at 15 metres, 25 metres and 30 metres distances. Although the level of pollutants by physic-chemical elements is low in the area with respect to WHO drinking water standard, more pollutants are however found in shallow wells closest to septic tanks.
2. Epidemiological records obtained from the Central Hospital, Ughelli and analyzed showed the effects of polluted water on human; this being responsible for cases of typhoid, diarrhea and dysentery in the area. Although the recorded cases are small when compared to the entire population.
3. The zonal distribution and effects of epidemiological diseases showed that GRA and environs is most affected. It had total of 138 cases of water borne diseases recorded for the period January, 2006 to December, 2006 representing 24.08 percent with a mean value of 37.62 of water quality above the WHO water quality standard. This confirms the fact that the zone with low water quality equally recorded the highest of number of persons affected by water borne diseases.
4. The study also revealed that the spatial distribution of hand dug wells located at 5 metres distance of underground septic tanks to hand dug wells are fewer than those located at 15 metres, 25 metres and 30 metres distances.

RECOMMENDATIONS

In line with the laboratory results of the water samples analyzed and the hypothesis tested, the researchers recommend:

1. Hand dug wells should be located at least 25 metres from any polluting source especially underground sewage disposal system. In the study, all the parameters examined fell within the WHO permissible water quality standard at 30 metres of underground septic tanks to hand dug wells in the area. Also, this minimum distance is convenient and ensures that as much as provided no bacteriological and chemical contamination occurs.
2. The location of neighbouring percolation facilities in adjoining compounds should always be taken into consideration when siting hand dug wells.
3. Domestic groundwater sources such as hand dug wells should be protected from surface discharge of sewage especially from open drains. Surface drains which carry such discharges must be adequately constructed, covered and disinfected regularly, if they must carry any form of sewage.

To achieve the above recommendations, the town planning unit must engage in the monitoring and siting of hand dug wells and underground septic tanks in each compound to ascertain their compliance with the minimum standard recommended for their location. Efforts should be made by the government to decongest the urban centres of on-site sanitary facilities such as underground septic tanks and encourage the construction of off-site network facilities (sewer system) and re-cycle such waste for agricultural purposes in the country.

CONCLUSION

The study revealed that the rate of pollution of hand dug wells in the area decreases with increasing distance of underground septic tanks to hand dug wells. Invariably, the groundwater in Ughelli urban in the vicinity of households is definitely polluted by the presence of on-site sanitary facilities, but not to an extent that it adversely affects the public health or contaminates the groundwater beyond levels acceptable by WHO drinking water standard. However, the use of the underground septic tank as an on-site sewage disposal system may be considered as most suitable for developing countries. But with time, they will become incompatible with co-existing domestic groundwater supply facilities in their vicinities.

References

Ademoroti CMA (1988). "Environmental Management: Case studies of Industrial Wastewater Treatment", in P.O Sada and F.O. Odemerho (eds) Environmental Issues and Management in Nigeria Development, Ibadan, Evans. Pp. 105-109
Agbede OA, Akpokodje OI, Kupolati WE(2003). "Failure of on-site sanitary facilities in Nigeria Urban Centres, Ibadan as case study", Paper Presented at the 18th International conference on Solid Waste Technology and Management, Philadelphia, USA, March 23 – 26.
Akporido CE(2000). "A study of the Characteristics of Surface and Underground Water in Sapele and Ogharefe Oil Producing Areas of Delta State", The Nigeria J. Sci. Environ., 5(7):65 –75
Ayeni B(1994). "The Metropolitan Area of Ibadan, its growth and structure", Ibadan Region department of Geography, University of Ibadan, Nigeria, Pp.72 – 84
Davies UC (2000). "Septic Tanks: The Real Poop", Florida, Water Resources J., April, Pp.45 – 51
Efe SI (2003). Water Quality and its Utilization in the Nigeria Rural Setting of Abraka, Delta State, Nigeria, "The environmentalist. 26:175 – 181
Egborge AB (1991). "Industralization and Heavy Metals Pollution in Warri", 3rd Inaugural (Lecture, University of Benin, Benin City).
Fantola A (1998). Introduction to Public Health Engineering, Ibadan, University Press.
Grey NF (1989). Biology of Waste Water Treatment, New York, Oxford University Press.
Krantz D, Kifferstein B(2005). "Water Pollution and Society", Environ Law Pract., 4(1): 1 – 12
Machemier RC (2000). "Get to know your septic tanks". Environ Plann. Manage, 39(1):113 – 115
Oluwande PA (1985). Environmental Health for Rural Areas: Principles and Practice of Community Health in Africa, Ibadan, University Press. Pp. 65-72
UNEP(2005). "Freshwater Pollution", UNEP/GEMS Environmental Library. 5(6): 5 - 10