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Impact of Poor Sanitation Infrastructure (Pit Latrine and Septic Tank) on Hand-Dug Well and Borehole in Voinjama, Liberia

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Abstract - In many rural areas of Liberia safe drinking water does not occur and wherever it does it is infrequently unreliable, therefore, in these areas, residents mainly rely on groundwater for living, and as such, it is common to find individual wells in each cell of such a country house. In addition, in most cases, these houses do not have the town`s drainage system, forcing residents to build latrines or septic tanks near their wells. This study aimed to determine the level of contamination in the samples and to estimate the effect instigated by the building of septic tanks and latrines near groundwater in Voinjama, Liberia. Water samples were taken in triplicate from seven sampling points and transported to the Liberia Water Supply and Sewerage Cooperation Quality Laboratory (LWSC) in Voinjama for analysis. The pH, nitrate, and nitrite intensities were examined in the samples by spectrophotometry using a colorimeter DR890 (Hach). Lead stages were analyzed by the use of a DR 5000 spectrophotometer (Hach). Bacterial analysis (E. coli and coliforms in stool) become completed by the use of the Palintest kit (Hach) at the same time as turbidity stages had been calculated by the use of a T100 turbidimeter (Oakton). Furthermore, microbiological isolates had been recognized for the use of API 20E assay. Results were compared with World Health Organization (WHO) and Water Sanitation and Hygiene (WASH Liberia) standards. Coliforms Faecal and E.coli were found in all, however very excessive in wells closest to septic tanks or pit latrines. The physicochemical factors (pH, turbidity, nitrite, nitrate, lead) were all beneath the acceptable standard in all analyzed samples. The study, therefore, concludes that the location of the septic tanks negatively affects the water value in the study area with more noticeable magnitudes at hand-dug wells constructed very close to the septic tank or pit latrine system.

***Key Words*: (Pit Latrines; Septic Tanks; Boreholes and hand-dug well; Pollution, Measurement; contamination)**

1. INTRODUCTION

In many rural areas of Liberia, safe drinking water does not occur and where it does it is hardly unreliable, therefore, in these zones, inhabitants mainly depend on groundwater for living, and as such, it is mutual to find specific wells in each cell of such a country house. In addition, in most cases, these houses do not have the town`s drainage system, forcing residents to build latrines or septic tanks near their wells. Voinjama is the capital metropolis of Lofa County is confronted with extreme demanding situations of securing water for its people; which can be attributed to the terrible sanitation infrastructures and shortage of technical tips when constructing pit latrines, septic tanks, and hand-dug wells. This rural metropolis additionally lacks sewer and drainage structures making its population depend upon personal connection through the development of pit latrines and septic tanks to deliver the sewage that's poorly built and controlled thereby contaminating the groundwater sources. This study aimed to determine the level of contamination in the samples and to estimate the impact caused by the construction of septic tanks and latrines near groundwater in Voinjama, Liberia. The study area is positioned along the hills of the northernmost tip of the country, close to the Guinean border. According to the 2008 census, it has a population of approximately 26,594. The residents in this area rely on agriculture for their livelihood, particularly growing rice. In this rural metropolis, there's no sewage system to serve the populace, and as such, all residential, industrial and public homes rely upon pit latrines and septic tanks for wastewater deposition.

Figure 1-Map of Study area (Voinjama)

2. Methodology

A set of seven (7) water samples was taken from separate sites in the rural town of Voinjama, Lofa County, Liberia. At each specimen point, the size (distance) between the manually dug well and the nearest septic tank or latrine, including depth, was measured with a 50 m tape measure and recorded. Seven rapid resamplings exceed the 30m distance requirement recommended by the Liberian Water and Sanitation Authority/MPW (WASH/MPW, 2010). Samples were collected in easy 1.5 L flexible flasks, clearly marked for clear identification, and stored in an insulated container with an ice ratio before being shipped to our laboratory substation in Liberia for analysis; samples were examined within 24hrs of collection. The factors measured during the study were pH, turbidity, nitrate, nitrite, lead, general microbial count (TBC), and E.coli. The investigative method used for every factor is indexed in Table 1.0. Additionally, the microbiological isolates have been identified by the use of the Analytical Profile Index (API 20E) assay created in the Seventies through Pierre Janin (Holmes et al 1978).

Table 1.0 Investigative procedures and factors

Investigative procedure/ Equipment	Parameter Unit
Multi parameter (in-situ)-pH Meter	PH
Absorptometric method (USEPA 8237)- Turbidity Meter (T100 Oakton)	Turbidity (NTU
Diazotization method (USEPA 8507)-DR 890 (Hach)	Nitrite (ppm)
Cadmium reduction (USEPA 8192)-DR 890 (Hach)	Nitrate(ppm)
Flame Spectrophotometry – DR 5000 (Hach)	Lead (ppm)
Microbiological Assay – Palintest Kit	TBC (ufc/100ml)
Microbiological Assay – Palintest Kit	E.coli (ufc/100ml)

3.0 Results and Discussion

The study evaluated an effect of a septic tank or pit latrine placement near groundwater infrastructures (Hand-dug wells). Samples were taken from seven (7) hand-dug wells in the rural metropolis of Voinjama, Lofa County, Liberia. To verify the effect, physicochemical parameters (pH, turbidity, nitrate, nitrite, lead) and microbiological (TBC, E.coli) were examined from the samples collected, and the distance from the hand-dug wells to the pit latrines or septic tank. Table (2) shows the measured distances from the septic tanks or pit latrine system to hand-dug wells. Table (3) indicates the outcomes of physicochemical parameters from the analyzed water samples. The pH concentrations from the samples collected ranged from 6.03 to 6.60 with all samples dropping in WHO allowable limits of 6. 0 to 9.0 and of the Quality Consistent Type I limits. Liberia (LWQS) is 6.5 to 8.5.

Turbidity samples ranged from 0.8 to 6.5 NTU from analysis recorded in Well (5) which became the sampling factor (18.29m) far from a pit latrine. The maximum turbidity analysis was recorded in well (1), a well-positioned 9.04m from a pit latrine to the wetland that was used as a dumpsite of stable waste. Altogether, but one (Well 5) of the samples went above the WHO acceptable limit of one NTU and the Liberian Water Quality Standard (LWQS) Class I of five NTU (UNDP, 1978). The nitrate and nitrite concentrations in all samples were decreasing as per d WHO and LWQS standards. Well (2), 15.19m from a pit latrine system, documented the best nitrate and nitrite values. The lead stayed unobserved in all samples examined (WHO, 2011). The outcomes of bacteriological analysis (Table 4) discovered the presence of microorganisms (TBC and E-Coli) in all of the samples wells. The existence of microorganisms became even extra obtrusive in Well (2). This fashion looks to be regular with the findings of Fubara Manuel and Jumbo, 2014, who mentioned that water infrastructures that have been situated near pit latrines or septic tanks are extra liable to be contaminated through microorganisms. Bacteria have been detected from the use of the API 20E assay. Outcomes confirmed the existence of each Escherichia coli and Salmonella type in all of the seven (7) samples tested. Escherichia adecarboxylata and Klebsiella pneumonia have been detected in all examined samples. Therefore, the revealing of fecal infection is a sign of health threat to humans consuming water from those hand-dug wells. These findings show that septic tank place unpleasantly influences the microbial excellence of water and devours a far-attaining effect on human well-being.

Table 2: Results of measured seven (7) samples wells depth, type, water level, distance from a point source, and WASH standards of Liberia for a septic tank or pit latrine from wells)

Well#	T.W	DWP	W.L(m)	D.P.S (m)	WASH (m)	PC	RM
Well# 1	Hand-dug well	5.18	3.80	9.14	30	NO	NTS
Well# 2	Hand-dug well	6.09	4.09	15.19	30	NO	NTS
Well# 3	Hand-dug well	6.09	4.71	14.04	30	NO	NTS
Well# 4	Hand-dug well	5.18	3.28	13.11	30	NO	NTS
Well# 5	Hand-dug well	6.40	4.39	18.29	30	NO	NTS

Well#6	Hand-dug well	5.94	4.04	13.72	30	NO	NTS
Well#7	Hand-dug well	5.92	4.03	13.44	30	YES	NTS
AVG		5.83	4.05	13.49			

WHO-World Health Organization; WASH- Water, Sanitation, And Hygiene; **TW**-Types of Well; **DWP**-Depth of Well; **WL**-Water Level; **DPS**-Distance from Point Source (pit latrine/septic tank); **PC**-Pipe Culvert; **RM**-Remark; **AVG. DW**-Average Depth of Well; AVG. WT-Average Water Table; ST-Septic Tank; **NTS**- Not to Standard.

Table 3: The physio-chemical quality results of water samples from the seven hand-dug wells

Sample #	Type of well	D.P.S (m)	PH	Turbidity (NTU	Nitrite (ppm)	Nitrate(ppm	Lead (ppm)
Well#1	H.DW	9.14	6.40	6.5	2.12	0.12	BDL
Well#2	HDW	15.19	6.05	6.3	6.27	0.20	BDL
Well#3	HDW	14.04	6.20	3.1	4.47	0.14	BDL
Well#4	HDW	13.11	6.30	2.3	2.41	0.11	BDL
Well#5	HDW	18.29	6.72	0.8	0.10	0.05	BDL
Well#6	HDW	13.72	6.35	2.6	2.23	0.30	BDL
Well#7	HDW	13.44	6.60	2.2	0.12	0.13	BDL
WHO Standards	6.0 - 9.0	≤ 7	≤ 30	≤ 3	ND		
LWQS Standar#1	6.5 - 8.5	≤ 7	≤ 30	≤ 3	≤ 0.001		

BDL=Below Detection Limit; LWQS= Liberia Water Quality Standard; Standard#1=Drinking; ND= Not Detected; HDW=Hand-dug well

Table 4 Bacteriological quality of sample wells water

Well#	Total bacteria count (CFU/100ml)	E-coli (CFU/100ml)
Well#1	TNTC	TNTC
Well#2	TNTC	TNTC
Well#3	TNTC	TNTC
Well#4	TNTC	TNTC
Well#5	TNTC	TNTC
Well#6	TNTC	TNCT
Well#7	TNTC	TNTC
WHO Standard Value	ND/100ml	ND/100ml
LWQS (Standard#1)	ND/100ml	ND/100ml

TNTC= Too numerous to count; ND= No detectable; WHO= World Health Organization; LWQS= Liberia Water Quality Standard

Table 5: Identity of micro-organism isolates using API20E assay (Smith et al, 1970)

Microbes isolated	Well #1	Well #3	Well #4	Well #5	Well #6	Well #7
Escherichia coli	Positive (+)	Positive (+)	Positive (+)	Positive (+)	Positive (+)	Positive (+)
Escherichia decarboxylate	Negative (-)	Negative (-)	Negative (-)	Negative (-)	Negative (-)	Negative (-)
Samonella Chloleraesuis	Positive (+)	Positive (+)	Positive (+)	Positive (+)	Positive (+)	Positive (+)
Salmonella pullorum	Positive (+)	Positive (+)	Positive (+)	Positive (+)	Positive (+)	Positive (+)
Salmonella typhi	Positive(+)	Positive(+)	Positive(+)	Positive(+)	Positive(+)	Positive(+)
Samonella parathyphi	Positive (+)	Positive (+)	Positive (+)	Negative (-)	Positive (+)	Negative (-)
Kelebsie Pneumoiae	Negative (-)	Negative (-)	Negative (-)	Negative (-)	(Negative -)	Negative (-)

4.0 Conclusion

This study evaluated the impact of the location of septic tanks and latrines on groundwater quality in a total of seven (7) groundwater sources (all dug wells in rural areas) in the rural city of Voinjama, Lofa County, Liberia. To fully evaluate

the effect, designated Physio-chemical and microbiological factors were examined in the samples and a relationship was established between the distance of the septic system or latrine at the source and the measured water quality. Outcomes were matched with World Health Organization (WHO) and Liberian Water Quality (LWQ) standards. Fecal coliforms and E.coli were existing in all seven (7) wells sampled from well No. 1 of well No. 7. The physicochemical factors (pH, turbidity, nitrite, nitrate, lead) were all below the allowable limit in the sample. All samples were analyzed. Nevertheless, the recognition of Escherichia coli and Salmonella species in all of the seven (7) samples examined submits that water from these hand-dug wells may pose a health risk to consumers and is therefore not suitable for direct human ingestion without onsite handling. In addition, a resilient relationship was detected among water quality and the immediacy of the source to septic facilities; with contamination levels higher than observed at bases near septic tanks. The study, therefore, concludes that the location of the septic tanks negatively affects the water value in the study area with more noticeable moments at hand-dug wells constructed very close to the septic tank or pit latrine system Finally, maintaining a safe minimum distance of 30m away from potential sources of pollution such as a pit latrine, septic tanks, and grave can reduce the contamination of the hand-dug wells and borehole which are major sources of drinking water of the resident of Voinjama.

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