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Research paper

Causes and effects of water pollution in the Soniwein Community, Central Monrovia, Liberia (March to May 2017)

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Abstract

Water pollution can be defined in many ways. Usually, it means one or more substances have built up in water to such an extent that they cause problems for animals or people. The objectives of this study were to determine the causes and effects of Water pollution in Soniwein Community and to determine whether the cases of water borne diseases can be attributed to unsafe and contaminated water in Soniwein Community as well as to come up with interventional strategies by which water pollution can be mitigated in the Soniwein Community. This research employed the cross sectional survey design. Field interviews were done by close-ended questionnaires, including health workers at Soniwein Community Clinic. Water samples were randomly collected and microbiological and chemical tests were conducted at the National Standards Lab to determined contamination by microbes and physical quality of the water respectively Samples were randomly collected from the Soniwein community and tested The microbiological test reveals a rejection in total viable count for Well 1, [2], [3] & [4], N/A in Yeasts & Mold, for Well 1, 2, 3, 4, detection of E. Coli in Well 1, 2, 3 & 4. The results of the chemical test reveals the iron content of Well [1-3] to be in acceptable range while that of well 4 was out of acceptable range; the chloride content of Well [1-4] were all in acceptable range; the pH values for Well 1, 2, 3 & 4 were all in normal rang; Well 1, 2, & 3 were all in acceptable turbidity range while that of well 4 showed a deviant. Water pollution in the Soniwein Community is caused by several factors such poor sanitation, improper disposal of domestic wastes and the effects lead to water- borne diseases such as Typhoid, Diarrhea and dysentery, and infants between the ages of 0-2 years are mostly affected.

Keywords: *Microbiological; Chemical; Pollution; Contamination; and Water-Borne*

1. Introduction

Water pollution can be defined in many ways. Usually, it means one or more substances have built up in water to such an extent that they cause problems for animals or people. Oceans, lakes, rivers, and other inland waters can naturally clean up a certain amount of pollution by dispersing it harmlessly. If you poured a cup of black ink into a river, the ink would quickly disappear into the river's much larger volume of clean water. The ink would still be there in the river, but in such a low concentration that you would not be able to see it. At such low levels, the chemicals in the ink probably would not present any real problem. However, if you poured gallons of ink into a river every few seconds through a pipe, the river would quickly turn black. The chemicals in the ink could very quickly have an effect on the quality of the water. This, in turn, could affect the health of all the plants, animals, and humans whose lives depend on the river [1].

Thus, water pollution is all about quantities: how much of a polluting substance is released and how big a volume of water it is released into. A small quantity of a toxic chemical may have little impact if it is spilled into the ocean from a ship. But the same amount of the same chemical can have a much bigger impact pumped into a lake or river, where there is less clean water to disperse it [1].

Water pollution can be caused by several factors, but not limited to fecal waste/ Sewage overflow/ Septic/Sewage system atmospheric contaminates/ particulate matters, and uncontrolled domestic waste [2].

The most serious effects of water pollution are infectious diseases, where there is a problem with sanitation. Waterborne diseases happen once a microorganism that carries diseases is spread through a body of water. These include typhoid, intestinal parasites, and most of the enteric and diarrheal diseases caused by bacteria, parasites, and viruses. Among the most serious parasitic diseases are amoebiasis, giardiasis ascariasis, and hookworm [3].

Water as a necessity for life, should be optimized in the Soniwein Community and the nation at large to maintain a healthy environment. The water used by dwellers in the Soniwein community must be safe for all of its vital uses (drinking, cooking, bathing, washing etc....) and the sanitary condition of the community should be good.

From the reviewed of records at Soniwein Health Center, of which there has been cases of water borne related diseases diagnosed from the dwellers of this community who seek medical care at the clinic, the researcher has decided to conduct this study. The objectives of this investigation were to determine the causes and effects of water pollution in the Soniwein Community by ascertain the sources of water supply, how the residents treat their water supply, analyzing the microbial load and chemical parameters of water samples collected randomly and determine the cases of water borne diseases at Soniwein Community clinic.

Findings gathered from this study serve as base -line information for future researchers who will want to conduct investigation on the causes and effects of water borne diseases.

2. Literature review

Driven by population growth and the need for increased agricultural production, water resources are coming under intense pressure across Asia. Annual water withdrawal and return flows are higher than in any other region. The volume of wastewater generated annually, excluding agricultural drainage, is some 142 km3 [4]. Inadequate provision of sanitation facilities, sewerage and wastewater treatment results in significant quantities of this wastewater reaching water bodies that may service human consumption [5].

Non-point source pollution, predominantly agricultural, is also of concern, especially given the rise in agrochemical consumption. Industrial waste plays its part too as Asia's economies grow and change. The impacts are being felt by nature and people: 42% of the deaths associated with unsafe or inadequate supply of water, sanitation, and hygiene occur in Asia [6]. Asian countries are making concerted efforts to address these problems but the pace and scale of this policy response must increase urgently [7]. In a recently published paper, we conducted an extensive survey of these issues [8]. Rivers in Asia Africa are highly polluted with domestic waste. Many of the region's rivers contain up to 3 times the world average of human waste derived bacteria measured in faecal coliforms [9]. Inadequate access to sanitation infrastructure (such as connections to public sewers and septic systems) is already a contributing factor today; yet, as urban centres grow so too will the need for more of this infrastructure. Based on current trends demand will continue to outstrip supply, worsening pollution. While there are strong efforts to equip exploding cities, a myriad of growing Asian towns remain completely un-served.

Most water pollution does not begin in the water itself. Take the oceans: around 80 percent of ocean pollution enters our seas from the land. Virtually any human activity can have an effect on the quality of our water environment. When farmers fertilize the fields, the chemicals they use are gradually washed by rain into the groundwater or surface waters nearby. Sometimes the causes of water pollution are quite surprising. Chemicals released by smokestacks (chimneys) can enter the atmosphere and then fall back to earth as rain, entering seas, rivers, and lakes and causing water pollution. That is called atmospheric deposition. Water pollution has many different causes and this is one of the reasons why it is such a difficult problem to solve.

Detergents are relatively mild substances. At the opposite end of the spectrum are highly toxic chemicals such as polychlorinated biphenyls (PCBs). They were once widely used to manufacture electronic circuit boards, but their harmful effects have now been recognized and their use is highly restricted in many countries. Nevertheless, an estimated half million tons of PCBs were discharged into the environment during the 20th century [10]. In a classic example of transboundary pollution, traces of PCBs have even been found in birds and fish in the Arctic. They were carried there through the oceans, thousands of miles from where they originally entered the environment. Although PCBs are widely banned, their effects will be felt for many decades because they last a long time in the environment without breaking down.

Another kind of toxic pollution comes from heavy metals, such as lead, cadmium, and mercury. Lead was once commonly used in gasoline (petrol), though its use is now restricted in some countries. Mercury and cadmium are still used in batteries (though some brands now use other metals instead). Until recently, a highly toxic chemical called tributyltin (TBT) was used in paints to protect boats from the ravaging effects of the oceans. Ironically, however, TBT was gradually recognized as a pollutant: boats painted with it were doing as much damage to the oceans as the oceans were doing to the boats.

The best-known example of heavy metal pollution in the oceans took place in 1938 when a Japanese factory discharged a significant amount of mercury metal into Minamata Bay, contaminating the fish stocks there. It took a decade for the problem to come to light. By that time, many local people had eaten the fish and around 2000 were poisoned. Hundreds of people were left dead or disabled [11].

These are the most common forms of pollution—but by no means the only ones. Heat or thermal pollution from factories and power plants also causes problems in rivers. By raising the temperature, it reduces the amount of oxygen dissolved in the water, thus also reducing the level of aquatic life that the river can support.

Another type of pollution involves the disruption of sediments (fine-grained powders) that flow from rivers into the sea. Dams built for hydroelectric power or water reservoirs can reduce the sediment flow. This reduces the formation of beaches, increases coastal erosion (the natural destruction of cliffs by the sea), and reduces the flow of nutrients from rivers into seas (potentially reducing coastal fish stocks). Increased sediments can also present a problem. During construction work, soil, rock, and other fine powders sometimes enter nearby rivers in large quantities, causing it to become turbid (muddy or silted). The extra sediment can block the gills of fish, effectively suffocating them. Construction firms often now take precautions to prevent this kind of pollution from happening.

Water quality differs markedly across the region, as does the collection and sharing of data. This complicates analysis of the picture and the ability of countries to implement remedial measures, especially across boundaries. India and China appear to have comprehensive monitoring systems, putting them in a strong position to address the problems. Other countries lack data sets with which to make informed decisions. In India, for example, 62 parameters are monitored at 1,700 locations and the results are published annually [12].Two key steps are needed across Asia: prevention and monitoring. Several countries are implementing ambitious programmes to build wastewater treatment plants and rehabilitate degraded water resources. Examples include China, India, Thailand, the Philippines, Bangladesh, and Indonesia. These and many more have passed water quality acts or laws to prevent pollution and protect receiving waters. Unfortunately, enforcement is challenging, especially in emerging economies where institutional capacities cannot keep pace with rapid industrialization, and economic instruments like taxation and removal of fertilizer subsidies clash with development goals. Monitoring is also costly and voluntary compliance unlikely. Given the transboundary nature of many river basins, and the need for their collaborative management, improved and effective water quality management strategies in Asia require the collection, analysis, and sharing of accurate data. Currently this task is, with some exceptions, generally poorly implemented. In most countries, sporadic or patchy data collection prevails, and it is often accompanied by inadequate analysis (Biswas, A. K. Seetharam, K. E. 2008)

3. Methodology

1) Study setting

This study was conducted in Soniwein Community, Monrovia, Liberia. It is located on the north by Crown Hill, south by Barclay Training Camp (BTC) Area, west by Randall and Lynch Streets, and east by Bernard Quarters. Dwellers in the Soniwein Community are engaged in businesses to include Partnership, Cooperation and Proprietorship. The sample size considered for the study was 150 persons to include dwellers, marketers, and petit traders. The qualitative and quantitative methods of data collection were employed in this study. Soniwein Community has the population of 6396, male 3293 and female 3103 [13].

2) Data collection

Data were collected using the simple random sampling technique. This procedure was vital, in that, all data collected were given equal chance and opportunity for consideration. Primary data was obtained from field observation using in depth interview (IDI) to gather information from dwellers relating to the causes and effects of water pollution in Soniwein Community.

3) Data analysis

Water sampling, however, was a cardinal method in data collection. Random sampling of water samples were collected from four wells out of 12 wells, two each from left & right blocks. They were collected in four bottles with cap and placed in a black plastic to avoid radiation from the sun. They were transported in 24 hours to the National Standard Lab (NSL) and placed in the storage room. Subsequently microbiological and chemical tests were conducted on the water samples. Information was also gathered from the Soniwein health center to validate the occurrence of water borne related sicknesses in Soniwein Community.

4. Results

76 out of 150 dwellers interviewed accessed water from dug well leading to 57%, the highest percentage obtained; indicated that dug well is a primary source of water supply by dwellers in Soniwein

Table 4.1: Source of Water Supply in Soniwein Community

Sources	Frequency	Percentage
Dug well	76	50.7
Sachet well	39	26
Liberia water & Sewer, LWSC	26	17.3
Hand pump	9	6
Total	150	100

68 out of 150 residents in the community are not informed about the treatment of water they accessed weekly, monthly, bi-monthly, or yearly. Therefore, resulting to 45.3%, the highest percentage obtained (Table 4.2).

Table 4.2: Frequency of Treatment of Water (H20) in Soniwein Community

Treatment of water supply	Frequency	Percentage
Unknown	68	45.3
Weekly	60	40
Monthly	12	8
Bi-monthly	6	4
Yearly	4	2.7
Total	150	100

82 out of 150 dwellers interviewed answered No to a confidential question in confirmation of being diagnosed with Water borne disease. Therefore resulting to 54.6%, the highest percentage obtained (Table 4.3).

Table 4.3: Confirmation by Respondents on Water Borne Diseases (WBD)

Confirmation by respondents on WBD	Frequency	Percentage
Yes	64	42.7
No	82	54.6
I don't know	4	2.7
Total	150	100

Septic/ sewer system, uncontrolled hazardous wastes, sewer overflow and air pollution are causes of water pollution in the study area (Table 4.4), and the effects of water pollution include typhoid, diarrhea and dysentery, with typhoid accounting for 64% (Table 4.5). Most of the wastes are disposed of at the central wastes disposal site in the community (Table 4.6).

Table 4.4: Causes of Water Pollution in Soniwein Community

Potential Sources of Groundwater contamination	Percentage
Septic/Sewage system	35
Uncontrolled hazardous waste	25
Sewage overflow	30
Atmospheric contaminants	10
Total	100

Table 4.5: Effects of Water Pollution in Soniwein Community

Water-borne diseases	Frequency	Percentage
Dysentery	16	10.7
Diarrhea	38	25.3
Typhoid	96	64
Total	150	100

Table 4.6: Methods of Waste Disposal in Soniwein

Disposal method	Frequency	Percentage
Central garbage disposal site	115	76.6
Disposing of waste to waste collectors	25	16.7%
By disposing waste in the surrounding	10	6.7%

Table 4.7: Microbiological Test

Sample Name:	Well water (Samples 1,2,3&4)				
Sample Type:	Liquid				
Sample Condition:	Ambient				
Test Condition:	Normal Room Temperature 25ºc and RH 55%				
Parameter	Unit	Average 1 2 3 4	Method	WHO & MOH Water Ref. Standard	Comment
Total Viable Count	cfu/ml	$1.9x10^2$ $1.6x10^2$ $2.0x10^2$ $3.3x10^2$	ISO 4833:2005	0cfu	Rejected
Yeast & Mold	cfu/ml	$1.5x10^2$ 1.1x102 $1.4x10^2$ $1.1x10^2$	ISO 4832:2008	N/A	N/A
Escherichia Coli	cfu/ml	Detected Detected Detected Detected	ISO 7251:2005	0cfu/ml	Rejected
AOAC = Association of Analytical Chemists					
cfu/ml = colony-forming units per milli-liter					
ISO = International Standards Organization					
mg/l = milligram per liter					

Table 4.8: Chemical Test

Sample Name:	Well Water (Samples 1,2,3&4)				
Sample Type:	Liquid				
Sample Condition:	Ambient				
Test Condition:	Normal Room Temperature 25ºc and RH 55%				
Parameter	Unit	Average Well 1 Well 2 Well 3	Method	WHO & MOH Water Ref. Standard	Comment
Iron	%	0.09 0.14 0.08 0.20	Spectroquant300	≤ 0.1	Out of range (#4)
Chloride	%	116 177 181 185	Spectroquant 300	≤ 250	Within range (All)
pH	-log	6.53 6.72 6.44 6.84	Janway 350 meter	6.5 – 8.0	Within range (All)
Turbidity	NTU	0.00 0.00 0.00 5.27	mrcTU-2016	0.0-5.0	Out of range (#4)
Physio-Chemical Check	• Visible particles were present in all samples • Settled particles present at the bottom of sample 2 & 4 only, after centrifuge • Color of sample is typical of sample 1, 2, & 3. Sample 4 appeared turbid				

- Odor of all samples is typical of the samples

AOAC = Association of Analytical Chemists
cfu/ml = colony-forming units per milli-liter
ISO = International Standards Organization
mg/l = milligram per liter

The results of the microbiological test reveals a rejection in total viable count for Well 1, 2, 3 & 4, N/A in Yeasts & Mold for Well 1, 2, 3, 4, Detection of E. Coli in Well 1, 2, 3 & 4 (Table 4.7). The chemical test reveals the iron content of Well [1], [2], [3] to be in normal range while well 4 out of range, the chloride content of Well 1, 2, 3&4 are all in normal range, the pH value for Well [1-4] were all in range, Wells [1, 3] were all in the turbidity range while well 4 was out of range. The physio-chemical check showed that, visible particles were present in all samples and particles were present at the bottom of sample 2 & 4 only (Table 4.8)

5. Discussion

From the inclusion of 150 persons as sample size, the result in this findings substantiate that 76 out of 150 dwellers, 57.0% in the Soniwein Community accessed water from dug wells. This underground water are contaminated by several causes: sewage overflow, septic waste, atmospheric contaminates, and uncontrolled hazardous waste according to Table 4.4. Similarly, research conducted on negative and harmful effects of water pollution and storm water runoff on the environment and the surrounding community proved that overflows of sewage intake can be caused by increased rainfall or poor sewage systems, but the most detrimental reason is the violation of sewage laws by humans. In the last three years, over 9,400 out of 25,000 sewage systems have reported traces of untreated human waste, chemicals, and other hazardous materials in our lakes, rivers, and other waterways which can cause serious damage to the environment and the heath of nearby communities [14], [18].

64 respondents, 42.7% confirmed diagnosed with Water borne disease in the Soniwein Community according to Table 4.3. A study done on Effect of Environmental Factors on the Relationship between Concentrations of Coprostanol and Fecal Indicator Bacteria in Tropical (Mekong Delta) and Temperate (Tokyo) Freshwaters proved that direct discharge of domestic waste, leaching from poorly maintained septic tanks, and improper management of farm waste are suspected as the major sources of water borne disease [15].

Findings from the Soniwein Community clinic authenticate diagnosis of WBD among dwellers from March to May, the beginning of rainy season in Liberia, 57.1% of 70 dwellers were diagnosed with water borne related diseases.. Acute Respiratory Infection (ARI) & Respiratory Tract Infection (RTI) were sicknesses mostly diagnosed at the clinic. Water borne diseases are the most common effects of water pollution in the Soniwein Community since there are no landfills or the widespread use of chemicals and road salts in the Soniwein Community.

The results of the microbiological test reveals a rejection in total viable count for Well 1, 2, 3 & 4, N/A in Yeasts & Mold for Well 1, 2, 3, 4, Detection of E. Coli in Well 1, 2, 3 & 4. The same results of the high number of total coliforms (E. coli) were observed by different authors in different water bodies in India during pre-monsoon and post monsoon seasons [16], [17]. The results of the chemical test reveals the iron content of Well 1, 2, & 3 to be in range while well 4 out of range, the chloride content of Well 1, 2, 3 & 4 are all in range, the ph. value for Well [1-4] were all in range, Well [1-3] were all in the turbidity range while well 4 was out of range. The physio-chemical check showed that (a) Visible particles were present in all samples (b) Settled particles present at the bottom of sample 2 & 4 only, after centrifuge (c) Color of sample is typical of sample 1, 2, & 3. Sample [4] appeared turbid. (d) Odor of all samples is typical of the samples.

6. Conclusion

From the findings of the study mentioned above, water pollution in the Soniwein Community is associated with several causes, uncontrolled hazardous waste, septic waste (poor sanitation) and atmospheric contaminants being major causes. Effects relating to water pollution in the Soniwein Community are mostly water borne diseases with Typhoid, Diarrhea, and Dysentery the most prominent. . Among those diagnosed at the community clinic in Soniwein, 0-2 years were mostly affected. Water supply is mostly from dug wells, they are not treated regularly.

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