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(RESEARCH ARTICLE)

Effect of solid waste landfill leachates on groundwater quality

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Abstract

Water is a universal solvent which is of inevitable use in our daily activities both domestic and industrial. It sources: ground and surface are indispensable to inhabitants of any community. Population increase over the years is directly proportional to the demand of water. And this has affected the composition and quality of waste generated. The need to dispose wastes result in the use of the simplest method, land filling, without due consideration to its effects on the environment. Land filling method is the breeding ground of leachate which contributes negatively to the quality of groundwater sources. This study aimed at assessing the effect of solid waste landfill leachate on ground water quality in the area. Water samples were collected from five different locations around the study dumpsite in Ajakanga, Ibadan. The samples were transported to the laboratory where the water tests on the physical, chemical, biological and bacteriological characteristics were carried out. The physicochemical parameters analyzed included colour, turbidity, pH, conductivity, TS, TDS, and total hardness while the bacteriological and biological parameters included biological oxygen demand (BOD), total viable count, total coliform count and total fungal count. The results observed varied from samples tested. The colour, turbidity, total hardness and total dissolved oxygen of the samples were within the WHO guideline. The pH samples of the two wells did not conform to WHO specification from 6.5 to 8.5. Both pH were acidic. Conductivity is temperature dependent. Higher conductivities recorded in samples 1, 2, 4 and 5 signified presences of contaminations. Total solids gave an idea of both suspended solids and total dissolved solids. Samples with more than 500mg/l TDS usually have disagreeably strong taste. In the bacteriological loading, only sample 2 showed the presence of Escherichia coli (E. *coli*). The presence of E. coli in the stream sample indicates feacal coliform contamination which is a potential health risk for individuals exposed to this water.

In conclusion, the proximity of wells and the exposure of surface steam to the dumpsite promote groundwater pollution due to leachate migration. This study recommended that wells should be cited at distance recharge area rather than the closed discharge side of the dumpsite. Sinking of borehole was recommended in the area rather than shallow well. The risks of leachate generation can be mitigated by properly designed and engineered landfill sites, such as sites that are constructed on geologically impermeable materials or sites that use impermeable liners made of geo membranes or engineered clay. This will prevent by gravity infiltration and percolation of leachate to the underground water thereby causing contamination. Periodic physicochemical and microbiological treatment of water is of essence.

Keywords: Solid waste; Landfill; Leachates; Groundwater

1. Introduction

Man, water and waste are hardly separable. Waste is defined as any substance or object discarded for any reason, whether part or all and such substance may be recycled e.g. rubbish, trash, scraps, tiles, bottles, cans, papers, chemicals, slugs, machine parts, scrap metals etc. Once waste is deposited at the landfill (dumpsite), pollution can arise from the migration of both gas and leachate. Leachate is any liquid that, in passing through matter, extracts solutes, suspended

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solids or any other component of the material through which it has passed. Urbanization and population increase have tremendously affected the composition and quantity of waste generated. The need to dispose such wastes results in the use of the simplest method, land filling without due consideration to its effects on the environment. Solid wastes like metals, plastics and artificial fibres, which pollute water bodies in and around the urban centres, with the efforts of the different arms of government engaged in solid waste disposal, a lot still has to be done as waste are still dumped indiscriminately in available open spaces, on streets, gutters, streams and rivers. **It** is observed that ground and surface sources of water are indispensable to inhabitants of any community. Due to increase in population and corresponding increase in water demands, provision of potable water through the treatment of polluted water sources is exorbitant. Groundwater, which in most cases may not require treatment, is preferred by residents. Groundwater sources are tapped to satisfy the increased demands. Groundwater resources include shallow and deep rechargeable aquifers that are connected to rivers, streams or seas while non-renewable aquifers or fossil water are those that may have been created by age.

Leachate is generated by the percolation of water through the waste. Because paper probably absorbs both original and metabolically generated water, leachate production above the water table requires infiltration of surface water. Solids, gases, and liquids from the waste are incorporated as dissolved, suspended, or sorbed, and miscible or immiscible components. Metabolic carbon dioxide, produced by bacterial action, dissolves easily, decreasing pH. The resulting dissolution of calcium carbonate increases hardness and dissolved solids. The solvent capability of the leachate is increased also by the bacterially generated organic acids, allowing some metals in the landfill to be dissolved, notably iron and manganese. During degradation of the solid waste, leachate produced from the waste finds its way back into our streams. The non biodegradable ones constitute physical pollution, commonly clogging up water bodies converting them into unsightly junk yard, and promoting destructive flooding as was the case of Ogunpa river in Ibadan some years back (Agbede 1991).

A number of incidences have been reported in the past, where leachate had contaminated the surrounding soil and polluted the underlying ground water aquifer or nearby surface water (Chain and DeWalle, 1976; Kelley, 1976; Lo, 1996; Mor *et al.*, 2006). Even if there are no hazardous wastes placed in municipal landfills, the leachate is still reported as a significant threat to the groundwater (Lee, 2002). Contamination of groundwater resources due to improper solid waste disposal have been reported in many cities in India like Kanpur, Delhi and Chennai (Gopal *et al.*, 1991; Olaniya *et al.*, 1998; Kumaraswamy *et al.*, 2000; Mor *et al.*, 2006; Vasanthi *et al.*, 2008).

1.1. Study area

There are four major dumpsites in Ibadan. The four dumpsites are Afofura (Aba Eku), Awotan, Lapite, and Ajakanga. Table 1 showed the dumpsites, locations, years of establishment and the sizes in hectares.

The study area is the dumpsite in Ajakanga, Oluyole LGA, Ibadan, Oyo State Nigeria. Its geographical coordinates are 7°18′41.32″ North (latitude) and 3°50′29.34″ East (Longitude). Due to rapid urbanization, the dumpsite is gradually being surrounded by built up areas. An overview of the dumpsite is shown in Plates 1 and 2. The Ajakanga area is drained by River Ona and its tributaries. Ibadan is now the largest indigenous city in tropical Africa. It is approximately 128km northeast of Lagos and generates about 1,618,293kg of solid wastes daily with the average waste generation per capita per day to be around 0.3kg.

Table 1 Major Dumpsites Location In Ibadan

No	Dumpsite	Location	Year established	Size (hectares.)
1	Ajakanga	Old Ijebu Road, Oluyole LGA.	1997	10.7
2	Lapite	Moniya, Oyo Road, Akinyele LGA.	1998	9.3
3	Awotan	Apete, Akufo Road, Ido LGA.	1998	20.3
4	Aba-Eku	Olunloyo, Akanran Road, Ona-Ara LGA.	1994	10.7

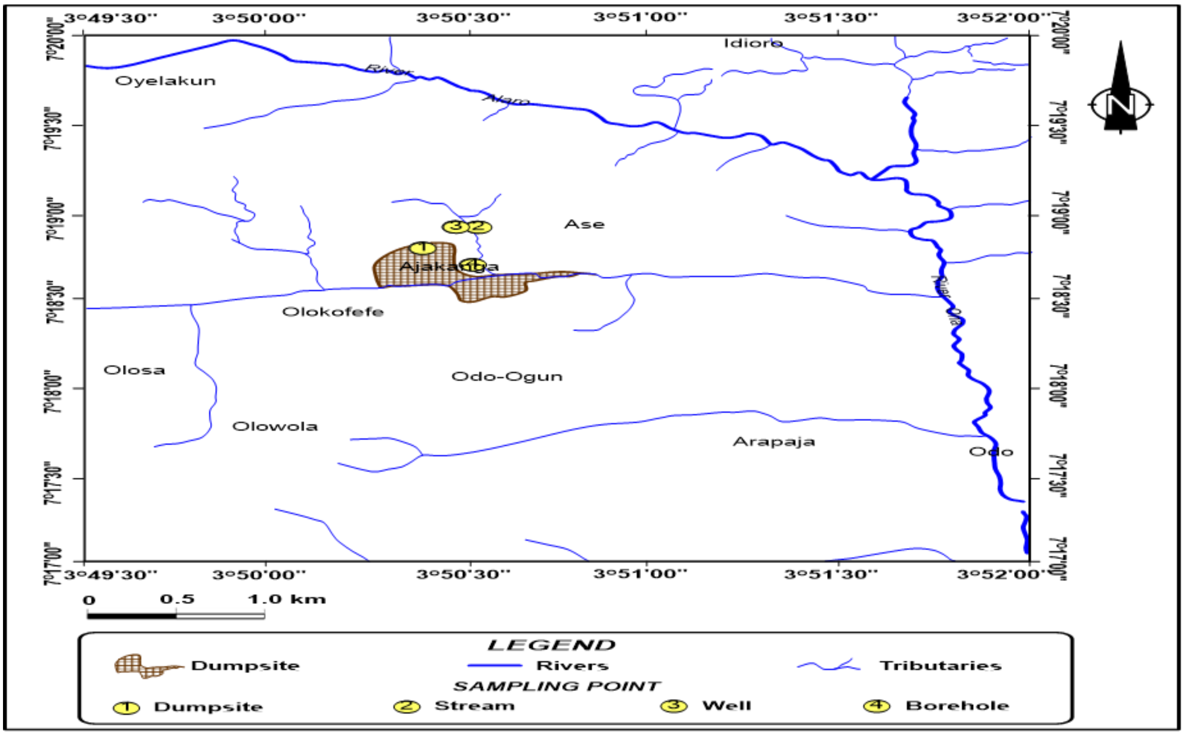

Figure 1 Drainage Map showing the sample numbers and their location

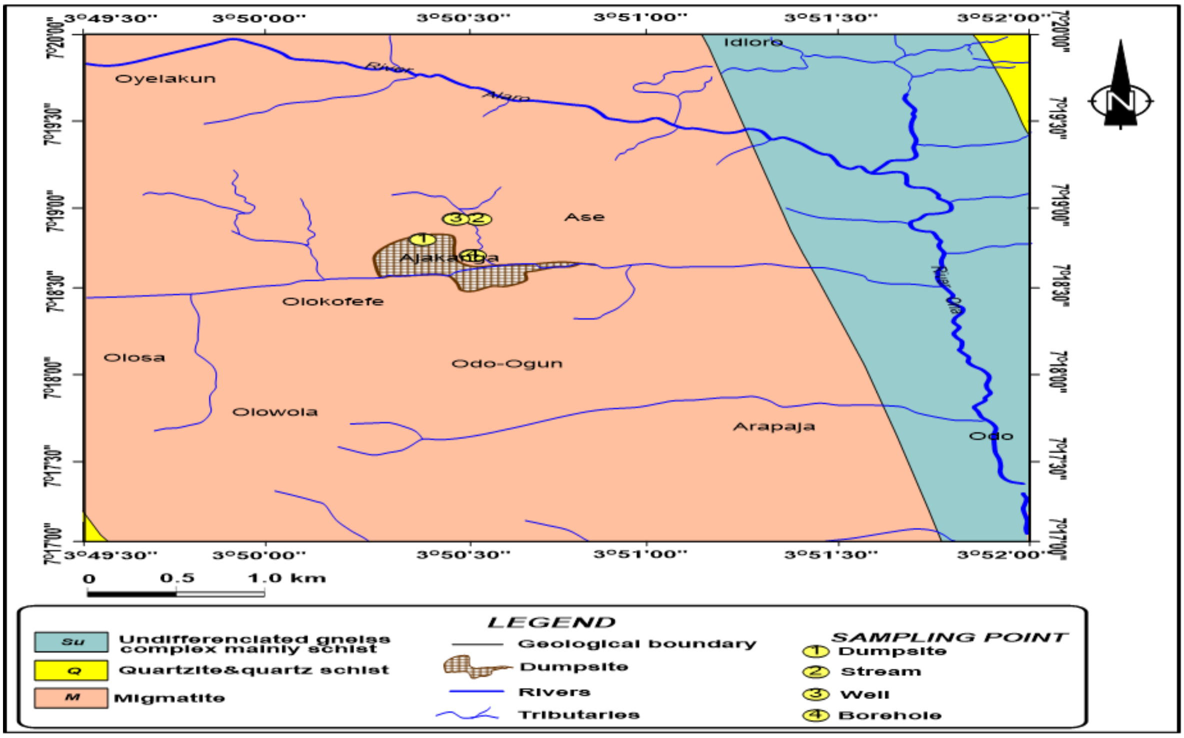

Figure 2 Geological Map of the area

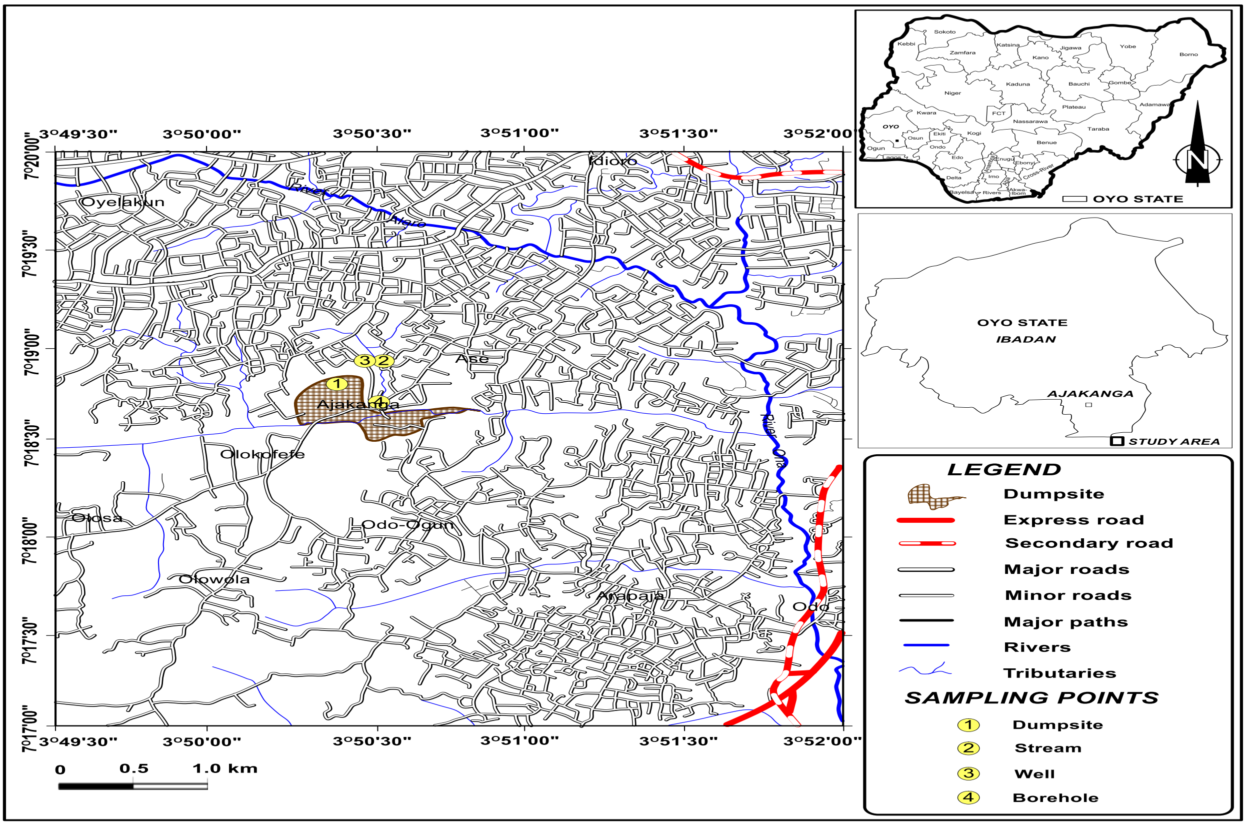

Figure 3 Location Map Showing the sampling points and locations

1.2. Literature review

Ground-water supplies are obtained from aquifers, which are subsurface units of rock and unconsolidated sediments capable of yielding water in usable quantities to wells and springs. The hydrologic characteristics of aquifers and natural chemistry of ground water determine the availability and suitability of ground-water resources for specific uses. Ground water is the part of precipitation that enters the ground and percolates downward through unconsolidated materials and openings in bedrock until it reaches the water table (Figure 2.). The water table is the surface below which all openings in the rock or unconsolidated materials are filled with water. Water entering this zone of saturation is called recharge.

The geochemistry of ground water may influence the utility of aquifer systems as sources of water. The types and concentrations of dissolved constituents in the water of an aquifer system determine whether the resource, without prior treatment, is suitable for drinking-water supplies, industrial purposes, irrigation, livestock watering, or other uses. Changes in the concentrations of certain constituents in the water of an aquifer system, either because of natural or anthropogenic causes, may alter the suitability of the aquifer system as a source of water. Groundwater quality can affect not only health, but also our societal and economic values. Groundwater contamination can adversely affect property values, the image of the community, economic development and the overall quality of life. Once contaminated, it is usually very difficult to clean..

For many years, groundwater was thought to be protected from contamination by layers of rock and soil that has filters but contaminants do make their way into the groundwater and affect its quality. Since groundwater moves through rocks and sub surfaces, it has a lot of opportunities to dissolve substances as it moves. For that reason, groundwater will often have more dissolved substances than surface water will. This fact is candidly supported by **Adegbola and Adewoye (2012)** which states that the chemistry of groundwater is a reflection of the composition of both man made materials and country rocks through it has come in contact with.. The common water quality problems associated with most rural and suburban water supplies are bacterial contaminations from septic tanks leakage and leachate contaminations from dumpsites. These are due to improper sewage treatment systems and waste disposal systems.

Leachate is any liquid that, in passing through matter, extracts solutes, suspended solids or any other component of the material through which it has passed. Leachate is a widely used term in the environmental sciences where it has the specific meaning of a liquid that has dissolved or entrained environmentally harmful substances which may then enter the environment. It is most commonly used in the context of land-filling of putrescible or industrial waste.

In the narrow environmental context leachate is therefore any liquid material that drains from land or stockpiled material and contains significantly elevated concentrations of undesirable material derived from the material that it has passed through.

Leachate from a landfill varies widely in composition depending on the age of the landfill and the type of waste that it contains. It can usually contain both dissolved and suspended material. The generation of leachate is caused principally by precipitation percolating through waste deposited in a landfill. Once in contact with decomposing solid waste, the percolating water becomes contaminated and if it then flows out of the waste material, it is termed leachate. Additional leachate volume is produced during this decomposition of carbonaceous material producing a wide range of other materials including methane, carbon dioxide and a complex mixture of organic acids, aldehydes, alcohols and simple sugars. The risks of leachate generation can be mitigated by properly designed and engineered landfill sites, such as sites that are constructed on geologically impermeable materials or sites that use impermeable liners made of geo membranes or engineered clay. The use of linings is now mandatory within both the United States and the European Union except where the waste is deemed inert. In addition, most toxic and difficult materials are now specifically excluded from land filling. However despite much stricter statutory controls, leachates from modern sites are found to contain a range of contaminants that may either be associated with some level of illegal activity or may reflect the ubiquitous use of a range of difficult materials in household and domestic products which enter the waste stream legally. Landfill dumpsites in rural or developing areas are made up of mainly domestic materials such as nylons, plastics. The water that serves as the transportation medium for contaminants into the groundwater is best described as leachate. When water percolates through the waste, it promotes and assists the process of decomposition by bacteria and fungi. These processes in turn release by-products of decomposition and rapidly use up any available oxygen creating an anoxic environment. In actively decomposing waste the temperature rises and the pH falls rapidly and many metal ions which are relatively insoluble at neutral pH can become dissolved in the developing leachate. The decomposition processes release further water which adds to the volume of leachate. Leachate also reacts with materials that are not themselves prone to decomposition such as fire ash, cement based building materials and gypsum based materials changing the chemical composition. In sites with large volumes of building waste, especially those containing gypsum plaster, the reaction of leachate with the gypsum can generate large volumes of hydrogen sulfide which may be released in the leachate and may also form a large component of the landfill gas. In a landfill that receives a mixture of municipal, commercial, and mixed industrial waste, but excludes significant amounts of concentrated specific chemical waste, landfill leachate may be characterized as a water-based solution of four groups of contaminants; dissolved organic matter (alcohols, acids, aldehydes, short chain sugars etc.), inorganic macro components (common cations and anions including sulfate, chloride, iron, aluminum, zinc and ammonia),heavy metals (Pb, Ni, Cu, Hg), and xenobiotic organic compounds such as halogenated organics, (PCBs, dioxins, etc.). The physical appearance of leachate when it emerges from a typical landfill site is a strongly odoured black, yellow or orange coloured cloudy liquid. The smell is acidic and offensive and may be very pervasive because of hydrogen, nitrogen and sulfur rich organic species such as mercaptans.

Figure 4 Ajakanga Dump site

Figure 5 Ajakanga Dump site

2. Material and methods

2.1. Sampling Source

Agbede, (1998) stated that surface water and ground water are both important sources for community water supply needs. Groundwater is common source for single homes and small towns, rivers and lakes are the usual sources for large cities. **Chatterjee (2001)** explained that any source of water is selected for the purpose of water supply scheme after considering the following points: quality of water source, quality of yield and location of the source. Reconnaissance survey was carried out to identify locations where samples were collected in connection with research work. The sources were limited to wells, stream and boreholes within Ajakanga dumpsite Oluyole L.G.A, Ibadan, Oyo State. Samples used were tagged as Sample 1, borehole, Sample 2, stream, Sample 3, well, Sample 4, well and Sample 5, borehole.

2.2. Sampling Procedure

Samples were collected based on standard procedure with particular emphasis on test carried out. Sterilized glass bottles were used for the sampling containers. The containers were rinsed with warm water, and then filled with water samples that were collected. The container was then filled with water samples. Labels such as sample location, temperature and date are securely attached to the container. The containers were then sealed off. The water samples were taken to the laboratory for subsequent analysis. The tests were carried out at a standard laboratory. The samples were thoroughly analyzed based on the standard methods. The sample collected was analyzed for the following quality parameters. Physicochemical: pH, Temperature, Colour, Turbidity, COD, Total Hardness, Total Dissolved Solids (TDS) and Total Suspended Solids. Biological: BOD, Coliform index, Fungal count, Viable count.

3. Results

Table 2 Physico-chemical and bacteriological analyses of water samples at Ajakanga Dump Site

PARAMETER	1	2	3	4	5	WHO
Colour (Hazen Units)	0.0	1.0	0.5	0.5	0.0	5
	0.5	1.5	1.0	0.5	0.0	5
	0.0	1.5	0.5	0.5	0.0	5
Turbidity (NTU)	0.5	2.5	1.5	1.0	1.0	5
	0.0	2.0	1.5	1.0	0.5	5
	0.5	2.0	1.0	1.5	0.5	5
pH	7.2	7.8	6.2	6.3	6.7	6.5-8.5

	7.2	7.8	6.2	6.3	6.7	6.5-8.5
	7.2	7.8	6.2	6.3	6.7	6.5-8.5
Conductivity (µS/cm)	1010	472	274	1763	2634	400
	1013	474	276	1760	2630	400
	1016	470	277	1758	2632	400
Total Solids (mg/L)	1750	2130	1670	1450	1960	500-1500
	1720	2150	1620	1460	1940	500-1500
	1730	2110	1640	1490	1930	500-1500
Total Dissolved Solids (mg/L)	925	380	215	1480	2325	500
	920	375	210	1475	2320	500
	925	385	215	1470	2320	500
Total Hardness (mg/L)	68.2	82.5	76.6	84.0	72.2	100-150
	68.1	82.4	76.3	84.3	72.8	100-150
	68.7	82.0	76.2	84.6	72.5	100-150
Total Dissolved Oxygen (mg/L)	3.6	1.5	2.4	2.9	3.1	>0.75
	3.4	1.8	2.5	2.5	3.3	>0.75
	3.3	1.9	2.2	2.8	3.0	>0.75
BOD (mg/L)	2.8	11.4	4.5	3.5	1.3	-
	2.5	11.3	4.7	3.8	1.2	-
	2.9	11.6	4.8	3.7	1.6	-
COD (mg/L)	6.2	25.2	9.5	8.4	3.6	5
	5.9	25.1	9.8	8.3	3.2	5
	6.0	25.4	9.6	8.0	3.3	5
Total Viable Count (CFUs/ml)	2.1 x 102	8.9 x 104	1.2 x 103	5.6 x 103	6.2 x 102	6.7 x 105
Organisms Identified	*Bacillus spp; Pseudomonas sp*	*Bacillus spp; Pseudomonas spp; Flavobacterium sp; staphylococcus sp*	*Bacillus spp; Pseudomonas sp; Flavobacterium sp*	*Bacillus spp; Pseudomonas sp; staphylococcus sp*	*Bacillus spp; Pseudomonas spp*	*Bacillius spp;pseudomonas sp;*
Total Coliform Count (CFUs/ml)	Nil	9.5 x 10	7.2 x 10	Nil	Nil	5.4 x 104
Organisms Identified	-	*Aeromonas sp; E coli*	*Aeromonas sp*	-	-	*Aeromonas sp;*
Total Fungal Count (CFUs/ml)	1.1 x 102	9.8 x 103	2.2 x 103	3.9 x 103	1.2 x 103	2.8 x 103

Source: Researcher's fieldwork 2022

Table 3 Colour

Samples	Test result Values	WHO Standards
Samples 1 (Borehole)	0.2	5
Sample 2 (Stream)	1.3	5
Sample 3 (Well)	0.7	5
Sample 4 (Well)	0.5	5
Sample 5 (Borehole)	0	5

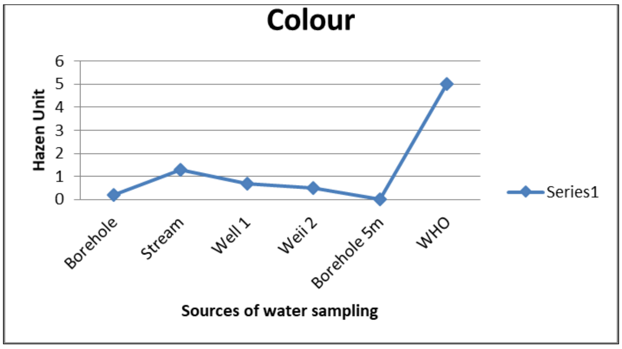

Figure 6 Colour

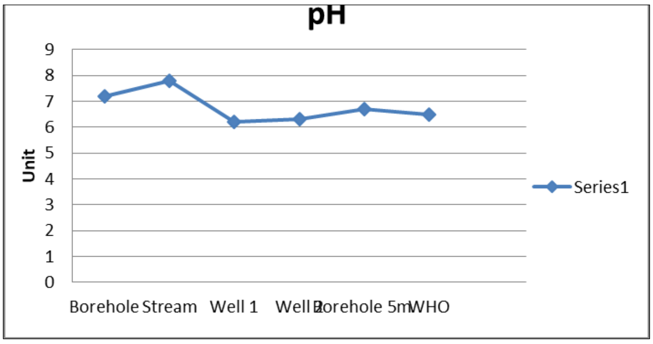

Figure 7 pH

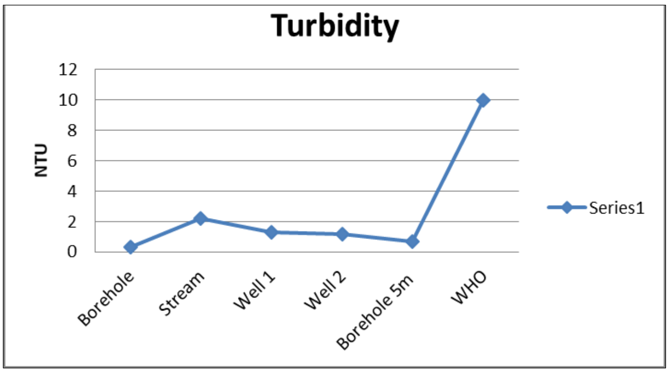

Figure 8 Turbidity

Huang (1994) defined water pollution as the contamination of water by foreign matter such as microorganisms, chemicals, Industrial or other wastes or sewage. Such matter deteriorates the quality of the water and renders it unfit for its intended uses. Polluted water is loaded with waste materials or heat such that its natural ability for self purification can no longer cope with the situation. The quality of water deteriorates as undesirable changes takes place in its physical, chemical and biological properties.

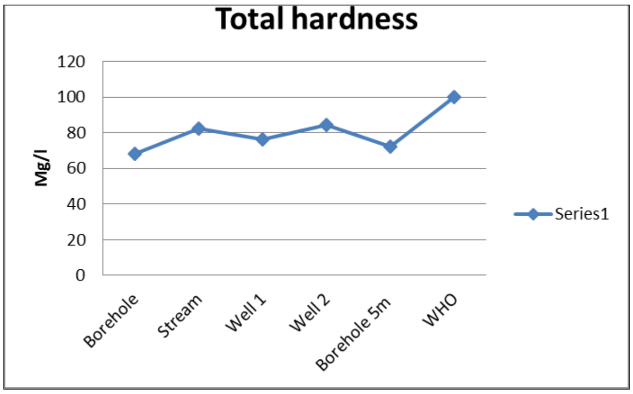

Figure 9 Total hardness

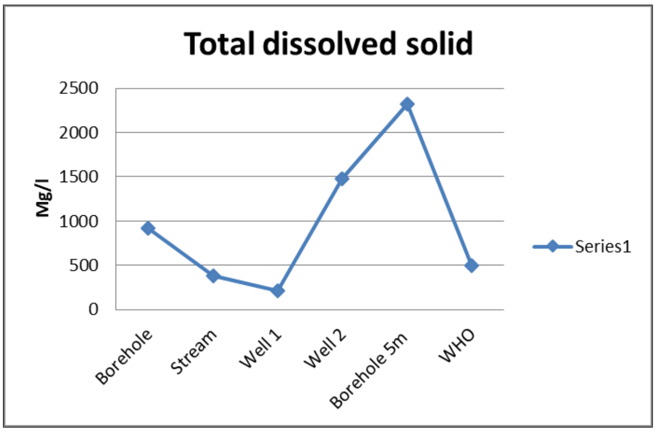

Figure 10 Total dissolved solid

3.1. Physico-chemical and Bacteriological Examination of Water supplies

Full examination water to determine sanitary quality and suitability for general use embraces the following tests: Physical, chemical biological, microbiological (bacteriology and virology), topographical and organoleptic characterization (HMSO, 1994) in tropical developing countries, microbiological examinations and in particular bacteriological analysis is probably more important than the other aspects because of the hazards associated with feacal contamination of water sources. The bacteriological examination of water sample provides essential information about the sanitary quality of a source. According to a HMSO (1994) it is the most rapid and sensitive method of detecting feacal and therefore potentially dangerous pollution.

3.2. Colour

Colour in drinking water is an objectionable characteristic that would make a source of water unacceptable even when it is bacteriological safe. Colour in unpolluted water may be caused by humic and peaty material and naturally occurring metallic salts, usually of iron (gives brown) and manganese (gives black). Colour in water may also be as a result of industrial pollution. The colour of a water sample is usually expressed in Hazen units. Twort et al (1985) opined that colour in water is as a result of material in suspension; therefore, true colour can be determined after an acceptable pretreatment like filtration has been carried out. Apparent colour due to substance in solution in addition to those due to suspended matter is determined on the original sample without filtration or centrifugation. The WHO standards for Drinking water suggest a desirable level of 5 Hazen units with maximum permissible level of 50 units. Apart from the fact that coloured water is aesthetically unacceptable for public use, it is not suitable for laundering dyeing, paper making beverage manufacturing, dairy production and other food procession operation. Therefore, the source of colour in any water source must be adequately investigated. Oloruntoba (2005). The stream had maximum value of colour of 1.3 Hazen Unit.

3.3. pH-value

pH is the hydrogen ion concentration and according to Twort et al (1985) it is a measure of acidity or alkalinity (basicity of water. It is one of the most important determinations in water quality control as an exact pH has implications in terms of other substances present in water sample (for example, various salts weak acids or bases)Changes in pH values are warnings that water quality may be adversely affected by the introduction of contaminants. Twort et al (1985) further stated the pH of unpolluted water is determined by the interrelationship between free carbon dioxide and the amounts of carbonate and bicarbonate present. Thus, the pH values of most natural waters are in the range of 4 to 9. Soft, acidic water from moorland areas have low pH values while hard waters which have percolated through limestone, have high pH values. Water of low ph tend to be corrosive and may have a sour or acidic taste. Therefore, knowledge of the ph of water is essential, since the ph determine whether the water is too aggressive to be used in supply. The guideline value recommended by WHO stipulates a pH range of 6.5–8.5 for potability.

3.4. Turbidity

Turbidity is an indication of the clarity of water. For water that is free from suspended inorganic matter like silt, clay, turbidity is zero. Twort et al (1985) defined it as the optical properties that cause light to be scattered and absorbed rather than transmitted in straight lines through a sample of water. Clarity of water is important for human consumption. Turbidity in water is caused by suspended matters such as clay, silt from soil, finely divided organic matter, plankton and other microscopic organisms in water. In raw water supplies, measurement of turbidity is of prime importance in that when combined with other information, it helps in determining whether a source of water requires special chemical treatment before use. WHO of 5 NTU satisfied by all water samples ranging from 0.3 to 2.2 NTU. High Turbidity level often associated with higher levels of disease causing micro organisms such as viruses, parasites and bacteria which may pose special treats to people with weakened immune systems.

3.5. Total hardness

According to WHO (1996) the presence of a variety of dissolved polyvalent metallic ions predominantly calcium, magnesium and other ions such as manganese, iron zinc barium and strontium have found to contribute to total hardness temporarily (if it contains (HCO_3) and permanently (if it contains SO_4 and CI joins) Hard water wastes soap and destroys electrical heating systems by deposition of scale on heating coils, cooking utensils and other equipment. Hence hardness of 75-100 mg/l $CaCO_3$ in water is generally considered optimal for domestic use. On the other hand, soft water is corrosive and has been implicated in causing cardiovascular disease. Twort et al (1985) classified hardness levels into six categories expressed in mg/l $CaCO_3$ as follows: 0-50 (soft), 50-100 (moderately soft), 100-150 (slightly hard), 150-200 (moderately hard), >200 (hard), >300 (very hard). The permanent hardness causes consumption of more soap, scale formation, food to become tasteless, discoloration of clothing in dyeing industry. Mechenich and Andrews (2002) explained that hard water is beneficial to health in reducing cardiovascular risk, high hardness can cause scaling in pipes and water heaters or kettles. It also resets with soap to forum "scum" which decreases soap's cleaning ability, increases bath tub ring and turns white laundry grey. Hardness ranges between 68.3 minima and 84.3 maxima which are within the specification of WHO 100mg/l $CaCO_3$.

3.6. Total dissolved Solid (TDS)

The value of TDS varied at different point: sample 1, 923 mg/l which is above the recommendation sample 2, , 380 mg/l, sample 3, 213 mg/l, sample 4, 1475 mg/l, and sample 5, 2322 mg/l, WHO limit is 500 mg/l. Water with no dissolved solids usually has flet taste, whereas, water with more than 500mglL Ross et al (2000) opined that high concentrations of dissolved solids may cause adverse taste effects and may also deteriorate household plumbing and appliances

3.7. Electrical Conductivity

It is the measure of the ability of the conductor to convey electricity. Electrical conducted of potable waters is mainly due to dissolve mineral matter. Free carbon iv oxide and ammonia also impart conductivity, but their effect is negligible except in water of very low salinity. Conductivity is the measurement of the ability of a solution to carry electric current. This ability is dependent upon the presence of ions in solution. According to Twort et al (1985) a conductivity measurement is an excellent indicator of the total dissolved solids in water. The unit of conductivity is micro siiemens (μs/cm) Twort et al (1985) conductivity is also temperature dependent and a reference and a reference temperature (usually 20 or 25^0 C) is used in expressing the result. The advantage of conductivity determination is that it can be easily measured in the field or used for continuous monitoring. Changes in conductivity denote a changing composition and, in raw water, indicate that a change in treatment may be required. Only sample 3 with 276 mg/l conformed with WHO limit

3.8. Bacteriological observations

From the microbiological analysis carried out on the samples of water collected from the various sources, it was analyzed that E coli count was Nil which indicated no isolated organism in the sample except for sample 2. The total viable count indicated values of 9.5x10 (cfu/ml) and organisms isolated include Bacillus sp: pseudomonas sp and the coliform bacteria were also detected with 1.2x10 (cfu/ml) colonies. WHO (1996) opined that the presence of faecal material in water (either by direct or indirect means) presents the most common and widespread health risk associated with drinking water. This is because excrement from communicable disease carriers may contain pathogenic microorganisms such as bacteria, viruses, protozoa or parasites, which can cause a wide range of water borne disease such as gastroenteritis, diarrhea, dysentery, hepatitis or typhoid fever.

4. Conclusion

The study exposed the true nature of the water quality as a function of leachate concentration. Concentration of leachates acted to be a major factor responsible for water contamination. According to WHO (1985), sanitary inspections combined with microbiological and physico-chemical analyses would be the first step towards determining the necessary remedial measures. Proper lining of the site would prevent leachate penetration into the groundwater in the area. It may be concluded that the ground water in and around the landfill sites shall not be used for drinking purposes unless it is properly treated in conformity to the drinking water quality standards.

Recommendations

The proximity of wells to the dumpsite promotes their pollution due to leachate migration. This study recommended that wells be dug far away from contamination sources and dumpsite should always be properly lined and covered.

Shallow wells are very susceptible to contaminations as leachate easily gains entrance to the groundwater due to proximity. Most of the analyzed sampled water was shallow and groundwater quality assessment is of utmost importance. In future study on this subject, more wells are recommended to be sampled with more parameters analyzed to give a detailed and comprehensive insight on water quality in the study area. The Federal Environmental Protection Agency must be charged with more responsibilities in order to extend their services to the grass roots.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors have not declared any conflict of interest.

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