Effects of Solid Wastes (Leachates) on the Quality of Underground Water

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Original Research Article

ABSTRACT

This study investigates the impact of groundwater pollution in Oyigbo Local Government Area, Nigeria, and the consequences of solid wastes, quality, and its control. The study was inspired by the uncontrolled way that both home and industrial wastes are dumped on the ground, in rivers, burried, burned, and dumped in trash heaps. Papers and polyethene, tin and metals, ashes and dust, texture and rags, aluminum and other minerals are among the primary solid wastes produced in Oyigbo. These wastes form leachates and gases when they degrade and are washed by percolating and infiltrating rain water into the groundwater, according to an examination of the physical, chemical, and biological properties of raw water at ten distinct places in Oyigbo close to disposal grounds. However, while a small number of the water characteristics evaluated did not meet W.H.O. criteria, the majority did. Despite this, recommendations are given to address the issues, including promoting raw water analysis, awareness campaigns, increased groundwater investigation in Oyigbo, and adherence to the resource management principle. From the results obtained, it was discovered that the mean concentration values of TDS, pH, BOD and COD are

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89.24mg/l, 7.62mg/l, 13.87mg/l and 14.58 for leachate samples. Also the mean concentration values for Mn, Cl, Mg in groundwater samples are 62.34mg/l, 22.74mg/l and 2.60mg/l and for well water samples and 57.35mg/l, 28.30mg/l and 1.25mg/l respectively. The characteristics of the domestic well water samples showed a mean concentration of biochemical Oxygen Demand (BOD = 16.26 mg/l), Chemical Oxygen Demand (COD = 18.67 mg/l), Dissolved Oxygen (DO = 4.84 mg/l) and temperature (29.66^{o}C). Also, the characteristics of the groundwater samples showed a mean concentration of biochemical Oxygen Demand (BOD = 13.67 mg/l), Chemical Oxygen Demand (COD = 16.11 mg/l), Dissolved Oxygen (DO = 4.03 mg/l) and temperature (27.16^{o}C). This result shows that there are high level of BOD,COD and DO in Domestic well water than that of groundwater in that location(site).

1. INTRODUCTION

Municipal solid waste (MSW) includes garbage generated by households, hazardous solid waste generated by businesses, institutions, and hospitals, as well as market and yard debris and street sweeping [1]. Solid waste dumps are essential components of the soil's hydrological system and pose a major threat to groundwater and downstream surface waters by contaminating them [2]. In a solid waste dump, there is a danger of environmental pollution due to the high concentrations of components like heavy metals, nutrients, and organic substances.

The quantity and quality of water that percolates through the waste disposal and into the surroundings determines the pollution load to the environment. The greatest local environmental issue associated with solid waste dumps, according to [3], is the release of leachates into the nearby ground and surface waters. In fact, leakage from deposits of municipal solid waste is frequently accompanied by high ion concentrations and, as a result, extremely poor resistance. This makes studying the three-dimensional extent of contamination around landfills using geoelectrical imaging techniques very intriguing [4].

Waste management has become an issue in Nigeria and other developing nations. In our urban cities, it is common to observe sizable garbage dumpsites that require restoration surrounded by residential neighborhoods. Heavy metals are the most common pollutants in these dumpsites. However, it's frequently unknown how much contamination is there [1]. When it rains and water passes through a waste disposal site, leachate, a waste fluid, is produced. Leachate can infiltrate across the unsaturated zone into the water table and pollute the groundwater beneath and nearby. The leachate may contain every imaginable inorganic and organic component that could deteriorate the quality of the groundwater and provide a major health concern to the neighborhood.

Major environmental issues in Rivers State are a result of inadequate waste management, which has led to uncontrolled landfills in some areas of the state. Because of the leachate buildup at the dumpsites, there is a significant risk to the quality of the ground water. Although the layer parameters and local geology are crucial for comprehending how leachate deposition affects groundwater, these details are unknown, necessitating the necessity for this investigation. Additionally, open waste disposal sites frequently lack trustworthy geological or man-made barriers, raising concerns about the possibility of pollutants leaching into groundwater, especially when waste is dumped in erosion gullies and ravines (like in Afam), many of which extend below the groundwater table. Open dumps are the oldest and most common way of disposing solid wastes, and although in recent years thousands of them have been closed, many are still being used E. Alsabahi, S. Abdulrahim, W. Y. Wanzuhairi, F. Alnozaily, and A. Fares [5].

All throughout the world, emphasis is currently being paid to the issue of solid waste and how it affects the quality of subsurface water. The country has seen a significant problem with waste generation recently, making this project necessary. In fact, the existence of wastes dispersed throughout cities, villages, and even in our higher education institutions poses a hazard to public health and lowers the pleasant level anticipated of these places. Because complexity of generated garbage is closely correlated with advancements in science and technology, developed and industrialized countries

experience the greatest threat from solid waste generation. Building and running incineration, recovery, and land filling processes are now exceedingly expensive. It is noticeable that urban populations produce more waste than rural ones. This is due to the many economic and industrial activities taking place in cities, which have increased the quantity and variety of waste that is produced every day across the nation. These have some significant effects on the usage of subsurface water (borehole and well).

The resulting contaminated water is termed "leachate" and can penetrate through the soil and eventually contaminate the groundwater if not adequately managed E. Ugwoha, K.C. Emeka [6]. Such contamination of groundwater resources can pose serious health risks, including waterborne diseases such as typhoid, cholera and infectious dysentery, to the local groundwater users. Improper solid waste management leads to substantial negative environmental impacts (for example, pollution of air, soil and water, and generation of greenhouse gases from landfills), and health and safety diseases associated with different forms of pollution at local and global levels G. Pande, A. Sinha and S. Agrawal [7].

To calculate the amount of waste present within the research areas and to understand the physical, chemical, and biological effects of solid wastes on underground water. Additionally, it will be determined whether water pollution poses a risk to both people and animals living in the research area.The specific objectives are; Determining the type of waste and waste disposal method , Collection of water samples from different boreholes and wells, Laboratory analysis, To ascertain if the quality of underground water in the study area is in consonance with WHO water drinking standards.

This discusses important data on the impact of solid wastes on groundwater quality. Human activity produces waste, and how it is treated, stored, gathered, and disposed of can have an effect on the environment and general welfare. Water is the most abundant environmental resource on earth but its accessibility is based on quality and quantity, as well as space and time. It may be available in various forms and quantity but its use for various purposes is the subject of the quality. About 70% of the human body and about 60-70% of plant cells is made up of water B. Smith, and E. Edger [8]. Groundwater plays a vital role for urban and agricultural water supply. It constitutes a major portion of the earth's water circulatory system known as hydrological cycle and occurs in a permeable geological formation known as aquifers i.e. formations having structures that can store and transmit water rates fast enough to supply reasonable amounts to well O.S. Afolayan, F. O. Ogundele, S.G. Odewumi [9].

The difficulties and problems associated with Municipal Solid Waste Management (MSWM) are of acute concern in metropolitan regions, particularly in the rapidly urbanizing cities of the developing world. Although most governments have acknowledged this, the population is growing faster than most municipal authorities can provide, even the most basic amenities. Between one and two thirds of the solid waste generated is not collected. While urbanization has helped emerging nations accumulate riches, it has also been associated with a startling rise in the prevalence of poverty. Today, one in four city dwellers is considered to be in "absolute poverty," while a further one in four is considered to be in "relative poverty." These urban poor people, who are frequently found in pre-urban settings, are the ones that suffer the most from the potentially fatal circumstances caused by inadequate MSWM throughout the developing globe.

Municipal governments frequently distribute their little financial resources to the wealthier, higher-tax yield districts where residents are subject to greater political pressure. A percentage of a citizen's money is typically used as their income rises to protect them from local environmental problems, but since trash production also rises with wealth, the problems are simply moved. Poor SWM causes environmental deterioration to continue or worsen in cities and regions even while environmental problems at the household or neighborhood level may improve in better-off areas.

Groundwater pollution is caused by the presence of undesirable and hazardous material and pathogens beyond certain limits. Much of the pollution is due to anthropogenic activities like discharge of sewage, effluents and waste from domestic and industrial establishment. Study found that continuous disposal of industrial effluents on land, which has limited capacity to assimilate the pollution load, has led to groundwater pollution S. Mukerjee, and P. Nelliyat. [10].

Groundwater is the major source of potable water in the study area and Rivers state in general. The town relies on boreholes (water wells) as sources of drinking water hence poor drinking water quality may have health consequences. Groundwater recharge is the replenishment of an aquifer with water from the land surface K.A. Bhattacharya. [11]. Groundwater quality comprises the physical, chemical, and biological qualities of ground water. Temperature, turbidity, colour, taste, and odour make up the list of physical water quality parameters T. Harter, [12]. Groundwater chemistry, in turn, depends on a number of factors such as general geology, degree of chemical weathering of various rock types, quality of recharge water and inputs from sources other than rock interaction. Such factors and their interaction result in a complex water quality N. Aghazadeh, and A. A. Mogaddam [13]. Groundwater quality is determined by natural and anthropogenic factors. The prospect of an arsenic contamination crisis has particularly caught the attention of leaders and expert. Sources of major concern to groundwater pollution include leachate from pit latrines, solid waste dumpsites, industrial effluents, domestic wastes, sea water intrusion, agricultural chemicals, and oil spillage. The greatest contamination threat to groundwater comes from the leachate generated from the material which often contains toxic substances especially when wastes of industrial origins are land filled P. Vasanthi, S. Kaliappan, And R. Srinivasaraghavan [14]. However, it has been widely reported that leachates from landfills for non-hazardous waste could as well contain complex organic compound, chlorinated hydrocarbons and metals at concentrations which pose a threat to both surface and groundwater. The impact of dumpsite leachate on the surface and groundwater has given rise to a number of studies in recent years E.O. Longe, L.O. Enekwechi, [15]. Leachate from dumpsite has been reported as a significant threat to groundwater even if it does not contain hazardous wastes. Leachate derived from waste deposits (landfills, refuse dumps) includes a wide range of contaminations, depending on the types of waste deposited.

2. MATERIALS AND METHODS

2.1 Sample Collection

Using disposable bottles, I collected samples. Before collecting the samples, the container of the samples was cleaned with soap solution and thoroughly rinsed with distilled water.

2.2 Ground Water Samples

In the research area at Oyigbo Local Government Area in Rivers State, water was collected from the vicinity of the dumpsite from existing boreholes and from a significant hand-dug well. Three distinct areas that are extremely near to the landfill for garbage. The samples must be preserved using preservation techniques, such as pH regulation, refrigeration, and protection from sunlight penetration, in order to keep the samples' original chemistry.

2.3 Leachate Characteristics and Groundwater Parameters Measured

For this investigation, data on the following leachate and groundwater parameters were gathered. Temperature, pH, Total Dissolved Solids (TDS), Total Suspended Solids (TSS), Nitrate (as N), Ammonia (N), Electrical Conductivity (EC), Total Hardness, Biochemical Oxygen Demand (BOD), and Chemical Oxygen Demand (COD) are to be considered. Chloride, Magnesium, Iron, Sulfate, Color, Odor, Faecal Coliforms, Oil & Grease, and Manganese (Mn).

Before bringing the sample containers to the stations, they were carefully cleaned with detergents, rinsed with distilled water, and allowed to dry. Each container was thoroughly cleaned with distilled water at the collection site before sampling. The American Standard Methods for Examination of Water and Wastewater served as the foundation for the determination of all physiochemical parameters. The mentioned normal operating procedures and equipment were employed. Distilled water, a pH meter, and a conductivity meter are some of the tools and materials used. Beakers, a volumetric flask, a pipette, a spectrum analyzer, and a turbidimeter. The adopted methods of analyses for the examination of all parameters in potable and wastewater were in accordance with the procedure recommended in standard Methods for the examination of water APHA [16]. All samples were analyzed for selected physical, chemical and heavy metals parameters.

2.3.1 Determination of electrical conductivity

A conductivity meter was used to conduct this experiment. The conductivity meter was turned on after measuring a portion of the material into a

beaker. The electrode of the conductivity meter was inserted into the sample. The result was read and recorded once the conductivity reading was presented on the conductivity meter's screen. After that, the electrode is taken out of the beaker containing the sample and given a thorough rinsing with distilled water. For further samples to be gathered, the same process must be followed, and the findings must be read.

2.3.2 A laboratory investigation to determine the use of ph apparatus

Electrode pH meter, thermometer, beaker, and stirrer. The pH meter was used in this experiment; It was activated, calibrated, and standardized using buffer solution at pH 7 at 25 °C, which symbolizes complete neutrality.. The electrode was taken out and given a distilled water rinse. A portion of the sample in the beaker was immersed with the electrode. The pH meter's screen showed the reading of the outcome, which was computed. After being removed, the electrode was rinsed with distilled water. Other samples went through the same process again. After the calibration, It was ensured that buffer solutions of pH 7 and pH 1 were used to normalize the pH meter.

2.3.3 Determination of total dissolved solid (TDS)

Instruments used in the experiment include a conductivity meter and a beaker. The beaker was filled with a measured amount of the sample for this experiment using the conductivity meter. The electrodes were cleaned with distilled water when the meter was turned on. The sample solution was then applied to the conductivity electrode. The conductivity of the waste water will determine, the exact conductivity is displayed right away on the meter. After pressing the conductivity meter's total dissolved solids button, the measurement that appeared on the screen was read and the result was recorded. The conductivity meter's electrode was taken out and thoroughly cleaned with distilled water. Other samples went through the same process again.

2.3.4 Determination of iron (FE)

In order to carry out this experiment, a spectrometer was used. 50 ml of the sample, The sample was placed in a volumetric flask together with 100 ml of distilled water, 2 ml of diluted hydrochloric acid (HCL), 2 ml of hydroxyl

amine hydrochloric acid, and 5 ml of ammonia acetate was then added to the mixture. A repeat of this procedure was performed on the extra samples. Each of these materials was introduced in small amounts to the convex or absorption cells inside the spectrophotometer, which was then assembled. On the meter's screen, the reading of the results was afterwards recorded and presented.

2.3.5 Determination of total hardness

Beakers, a 500 ml burette that is graduated in 0.5 ml, a rubber-tipped stirring rod, and burette support comprise the experimental apparatus and process. Distilled water is one of the reactants used. EDTA titrates, indicator, buffer solution Procedures: A 250 ml beaker was filled with 50 ml of each water sample, which was then diluted to around 100 ml with distilled water. The beaker containing the water samples received 0.5 ml of ammonium buffer, which was added and thoroughly mixed. The beaker was filled with It was swirled after eriochrome black t was added in 2 to 3 drops. After that, it was titrated with EDTA titrate and bestirred repeatedly until the indicator's color changed. Despite the fact that incandescent lighting often cause the finished product to have a reddish colour, the color gradually shifts from reddish to light brown.It was noted how much EDTA titrant was needed to reach the target. A measurement of hardness was made (as ppm CaCO3)

2.3.6 Chloride determination

Burette, pipettes, Erlenmeyer flasks, and measuring cylinders are the equipment and technique. The material was mixed with 1ml of potassium dichromate indicator solution. Drop a small amount of silver nitrate (AgNO3) from a burette and titrate the solution until the yellow tint turns brownish. The solution was continually stirred while being diluted nitrate solution and titrated until only the tiniest noticeable brownish coloration remained. Before titration, add 50 ml of the sample and dilute it to 100 ml. To account for the solubility of silver chromate and the presence of chloride in any reagent, On a blank of 100ml distilled water, all procedures were repeated.

Calculation:

$$Chloride\ as\ CL- = \frac{100\ (V1-V2)mgl}{Volume\ of\ sample}$$

Where: V2 = the amount of silver nitrate the blank needs (ml)

V1 the amount of silver nitrate the sample needs

2.3.7 BOD determination by biochemical means

The procedure and tools include 300 ml BOD bottles, an air incubator (20 °C + 1 °C), stir plates, stir bars, ring stands, burettes, 200 ml beakers, burette holders, and 500 ml cylinders. The following solutions were combined with 100ml of water to create diluted water: calcium chloride solution, ferric chloride solution, magnesium sulphate solution, and phosphate buffer solution. Following that, samples were put into 300 ml reagent amber bottles, poured into a 500 ml measuring cylinder, and the cylinder was then filled with diluted water.Following the procedure outlined on the dissolved oxygen (DO) determination, The combined water samples were placed in the bottles..The bottle was cleaned before the remaining mixture of sampled water was added. This was tested for dissolved oxygen after being incubated for five days at 20°C.

2.3.8 Dissolved oxygen (DO) determination

2.3.8.1 Apparatus and procedure

Burette, burette stand, conical flaks, measuring cylinder, and little funnel. 285 ml of each of the freshly opened samples was measured into a bottle with a label. Accordingly, 1 ml of manganous sulphate solution, 1 ml of alkali iodine azade solution, and 1 ml of concentrated H_2SO_4 were added. The mixture was then thoroughly swirled. With the aid of three drops of starch indicator, A colorless solution was created by measuring and titrating 200 ml of each of the treated samples against Na_2SO_3, $5H_2O$.. Readings were taken and kept track of. Other samples went through the same process again. Identical titre values are used.

2.3.9 Determination of chemical oxygen demand (COD)

2.3.9.1 Apparatus

Heat-resistant gloves, Additionally, a 100 ml volumetric flask and two 150 ml beakers are provided, along with a COD reactor with cover and test tube rack, pipettes (5 and 10 ml) and pipette bulbs.

2.3.9.2 Reagents and chemicals

12.259g of $K_2Cr_2O_7$ were weighed and dried, and a standard potassium dichromate solution of 0.0417m (0.25N) was used to dissolve it. 100ml of distilled water should be diluted for 2 hours at 103°C. After two hours, the $K_2Cr_2O_7$ solution was dissolved in 100ml of distilled water, transferred to a reagent bottle, and stored in the refrigerator.

Standard ferrous ammonium sulfate (FAS), sometimes known as ammonium iron sulfate (11), is a titrant that measures at around 0.25m (0.25N) and is made by dissolving 98g of $FeSO_4$, $(NH_4)_2SO_4$, and $6H_2O$ in 1000ml of purified water. into a bottle of reagent was transferred the solution. Put 20ml of the concentrated in. After adding HS0, cool (with a specific gravity of 1.84), The solution was given time to cool.. 1000ml of the solution was saturated, then it was put in the fridge.Standardize as follows every day using $K_2Cr_2O_7$ solution. Dilute the standard 10.0 ml. $K_2Cr_2O_7$ to approximately 100ml, 30ml of concentrated H_2SO_4, and allow to cool. Use 0.10 to 0.15 ml (2 to 2 drops) of ferron indicating to titrate FAS totrant. Mercuric sulfate, either in crystal or powder form. The sulfuric acid (specific gravity 1.84). Silver sulfate solution in sulphuric acid 30ml of concentrated H_2SO_4 Phenanchroline Ferrous Sulphate Indicator is to be used to dissolve 15g of powdered silver sulphate (Ag_2SO_4) (i.e., ferrocene indicator). You need to weigh 1.48g of phenanthroline and 0.70g of ferrous sulfate were used.The mixture was put in an indicator bottle after being dissolved in 100ml of distilled water.

2.3.9.3 Procedure: open reflux method

A Conical flask was filled with 50ml of distilled water to serve as the blank. Each sample's 50ML were measured and then put into labelled conical flasks. To each flask, 25ml of the $K_2Cr_2O_7$ solution was added. Mercuric sulphate (Hg_2SO_4) was added in amounts of around 1g. Additionally, 5ml of concentrated H_2SO_4 with Ag_2SO_4 was added. For the duration of the sample (in a bowl of water to avoid excessive heat loss). Boiling beeds were added, along with 70ml of concentrated H_2SO_4 supplied through the condensers of the reflux device. The exposed condensers were covered with little beakers. and the mixture was allowed to reflux for two hours to prevent the introduction of foreign materials.

Each sample must be refrigerated before being transferred to a 500 ml beaker with the combination being built up to 300 ml with distilled water. Conical flasks were properly washed. The

solutions were cooled to room temperature under a faucet, thoroughly mixed, and titrated against ferrous ammonium sulphate (FAS).The goal of the observation is to demonstrate a sudden transition from blue-green to reddish brown.

3. RESULTS AND DISCUSSION

Standard instruments were used in the lab to conduct temperature, pH, electrical conductivity, magnesium, ammonium, manganese, iron, chloride, and sulfate analyses on the leachate and groundwater. The leachate was determined to have a temperature of 31°C, which is close to the ambient temperature, while the samples of well water and spring water had temperatures of 30.5°C and 31°C, respectively. In the laboratory tests, the pH levels of leachate, well water, and borehole water (spring water) were 7.12, 6.68, and 6.78, respectively. The quality of water can limit its usefulness and make it unsuitable for a

certain purpose. As a result, determining the quality of the water is crucial to determining both its value and the general level of living.The study of groundwater (well and borehole water) and leachate samples collected from various locations close to various trash dumpsites within the Oyigbo Local Government Area in Port Harcourt, Rivers State, is summarized below. The physiochemical properties, nutrient concentrations, and certain significant trace metal concentrations were shown in Tables 1, 2, and 3 along with the corresponding samples.The study of groundwater (well and borehole water) and leachate samples collected from various locations close to various trash dumpsites within the Oyigbo Local Government Area in Port Harcourt, Rivers State, is summarized below. The physiochemical properties, nutrient concentrations, and certain significant trace metal concentrations were shown in Tables 1, 2, and 3 along with the corresponding samples.

Table 1. Leachate Samples from Site 1, 2 and 3 Measured in mg/L

who standard	Mean + SD	Site 3	Site 2	Site 1	Parameter
7.5	7.62±0.55	7.85	8.04	6.95	pH
2000	89.24±5.84	92.37	82.53	92.88	TDS
250	27.94±1.63	28.04	29.65	26.19	Chloride
250	0.38±0.06	0.47	0.27	0.36	Sulphate
50	13.87±1.55	12.06	14.87	14.56	BOD
400	14.58±1.27	15.06	15.54	13.17	COD
0.02	0.69±0.67	0.26	0.16	1.38	NH^4
75	394±9.49	389	407	392	Total Hardness
0.05	51.68±8.4	57	56	45	Manganese
5	51.57±8.7	0.32	0.2	0.19	Oil & Grease

Table 2. Domestic Well Water Samples from Site 1, 2 and 3 measured in mg/L

| WHO standard	Mean+SD	Site 3	Site 2	Site 1	Parameter
6.5-8.5	6.41±0.28	6.47	6.79	6.35	pH
500	17.78±0.67	16.97	18.26	18.03	TDS
250	28.30±0.85	28.05	28.95	27.39	Chloride
300	0.06±0.07	0.03	0.15	0.04	Sulphate
10	16.26±1.10	15.97	15.72	17.26	BOD
10	18.67±0.36	18.96	18.45	18.48	COD
10	4.84±0.06	4.97	4.85	6	DO
10	0.24±0.05	0.11	0.14	0.16	NH^4
1000	25±5.13	36	36	27	Total Hardness
10	58.35±4.14	57	65	55	Manganese
10	1.25±0.13	1.05	1.07	1.26	Magnesium
30	29.66±1.13	28.7	30.9	29.6	Temperature (ºC)
0-2	4.02±1.04	6	6	4	T. Coli

Table 3. Ground Water Samples from Site 1, 2 and 3 measured in mg/L

WHO standard	Mean+SD	Site 3	Site 2	Site 1	Parameter
6.5-8.5	6.96±0.31	6.97	6.74	6.57	pH
500	0.36±0.16	0.43	0.35	0.67	TDS
250	22.74±1.42	26	23.37	20.97	Chloride
300	0.27±0.16	0.47	0.16	0.25	Sulphate
10	13.67±2.56	10.97	14.14	15.98	BOD
10	16.11±0.81	15.97	16.87	15.27	COD
10	4.03±0.12	4.15	3.87	4.06	DO
10	0.16±0.03	0.29	0.26	0.28	NH^4
1000	10.01±1.10	8	10	11	Total Hardness
10	62.34±2.56	67	68	61	Manganese
10	2.6±0.35	2.37	2.74	3.05	Magnesium
30	27.16±2.96	25	27	30.8	Temperature (ºC)
0-2	1.36±0.57	2	2	2	T. Coli

Source:2 - Drinking Water Quality Standard by World Health Organization Guidelines (WHO) for Drinking-water Quality in third edition (2008) and fourth edition (2011)

Table 4. Leachate sample variance compared to WHO standard analysis

FERIT	P-value	F	MS	df	SS	Source variation
3.178893	0.473906	1.045886049	198923.3119	9	1790309.8	Rows
5.117355	0.243027	1.561047837	296905.008	1	296905.01	Columns
			190195.9703	9	1711763.7	Error
				19	3798978.5	Total
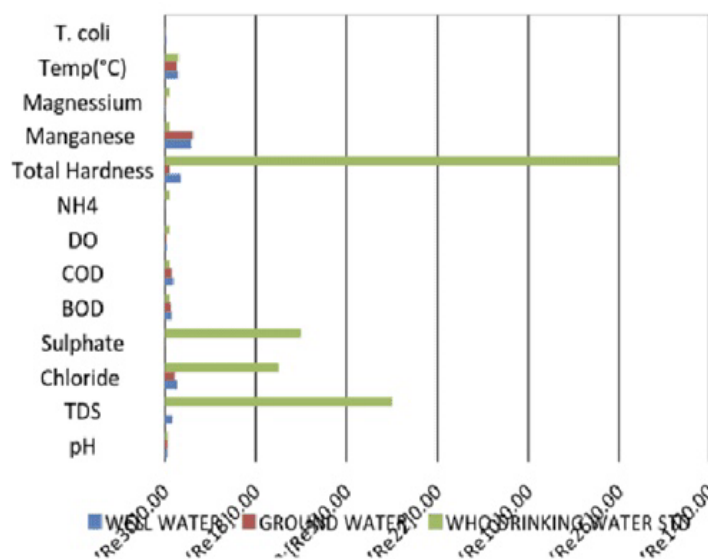
Fig. 1. Comparing Ground Water and Domestic Well Water With WHO Standard

In order to assess if the tested sample conforms with the drinking water standard, the World Health Organization has provided the tables. The physical and chemical parameters of leachate and groundwater were analyzed, and the results were compared to the (ASTM) standard as recommended by the World Health Organization to evaluate whether the water is safe to drink (WHO).

According to the study, the water is unfit for drinking because the water quality metrics are beyond the permitted limits at the area. According to one theory, the presence of various soil layers serves as a filter to reduce the amount of suspended impurities in groundwater. But because groundwater is usually isolated from the atmosphere, toxins are preserved by it. Once contamination has begun, it moves slowly,

remediation is expensive, and in some cases it is impossible. It is without a doubt true that open garbage generally has a negative impact on ground water supplies. Groundwater, especially that from deep wells, is pure, flavorless, and odorless. The ground water's temperature regime was between 30 and 31 degrees Celsius. This is dependent on the environmental circumstances at the time the samples were collected.The pH level is typically between 6.68 and 6.78, with little change. Incompatible for human consumption, the pH ranges from 7.12 to 6.68 to 6.78. According to Table 3, the World Health Organization (WHO) suggests a higher desired range of 6.5 to 8.5. Organ waste may be the reason of the groundwater's lower pH of 6.68 and 6.78 (well and borehole water), as organic wastes cause water's pH to drop to an acidic level. This acidity is typically caused by the presence of weak acids, especially carbon (IV) oxide (CO_2), although it can also occur when proteins and fatty acids are present. From one sample to another, different additional parameters are examined.However, this may rely on the depth of the boreholes, their distance from the dumpsite, and the drilling method used, which may differ from one location to another.

3.1 FEPA Adopts WHO Standard

Leachate and well water both have high levels of contaminants. However, the BOD and COD of the spring water were higher than those of the neighboring wells, which may have been caused by the stagnation and contamination of its catchment region. Higher concentrations of pollutants were found in leachate and well water during sampling, especially in terms of productivity, suspended particles, total dissolved solids, and phosphate. This may be due to the dumping site's groundwater and surface water intrusion, which encourages the volatilization of pollutants from the waste mass's active degradation into leachate that is emitted from the disposal site and into a nearby groundwater source.

3.2 Turbidity

The presence of organic and inorganic solids that could serve as an adsorptive site for specific chemicals and/or biological agents was indicated by turbidity, as seen in the sample bottles and suspended solids in well water.

3.3 Dissolved Oxygen

Since there was no evidence of dissolved oxygen in the leachate and very little was found in the groundwater, the study site cannot support the necessary aerobic organisms. This could upset the ecosystem, promote the growth of septic conditions, and promote the growth of anaerobic bacteria, which could result in anaerobic condition in the groundwater.

3.4 Iron (Fe)

Iron is present in trace amounts in almost all sediments and rock formations, and all the samples that were evaluated had small concentrations of iron (ranging from 0.01 to 00.5 mg/L). The iron concentration of groundwater is significant because even tiny levels can have a significant impact on how valuable water is for various home and industrial uses. The iron content in Oyigbo Local Government Area is within WHO norms, according to the findings of the borehole analysis. The World Health Organization (WHO) suggests limiting the amount of iron in drinking water to 0.3 mg/L.

3.5 Nitrate (NO^3)

Since plants absorb the majority of the nitrogen at the ground surface before it can reach the water table, nitrate concentrations in groundwater are extremely low nationwide. At the dumping site, background nitrate levels in the leachate and surrounding well were relatively high (0.1 to 0.4 mg/L). The application of fertilizers from the residents' farmed land may have contributed to the concentration of leachate nitrate that has contaminated the area, which may help to explain this.

Because nitrate does not break down quickly in the soil and does not adhere to soil particles, it poses a risk because it can leak far from its source and move quickly through groundwater. Numerous plants, including legumes, are one source of nitrate that seeps into the groundwater. Additional sources of soil nitrate include decaying plant material, animal waste, human waste, and home solid waste. Groundwater naturally has nitrate amounts between 0.1 and 10 mg/L. (Adeyemo et al. 2002). In home water supplies, nitrate concentrations more than 45 mg/L are not desired.

3.6 Phosphorus

There was no evidence of the groundwater's baseline phosphorus level. The leachate and well water phosphorus concentrations in and around

the dumping site are 6 and 2 mg/L, respectively, which is significantly higher than the reference value of 0.15 mg/L.

There is little chance that phosphorus will enter groundwater through soil. This is due to the high amount of phosphorus that soil particles can fix in forms that are stationary in soil. As water moves through the soil profile and into the groundwater, the majority of soils remove soluble phosphorus. There is no proof that the amount of phosphorus leached is increasing when waste is put to the landfill because there may be a source of phosphorus from nearby agricultural land.

3.7 Chloride

When chloride comes into touch with rainwater and enters the aquifer, it can enter the groundwater from open trash disposal. The three different samples' chloride analysis results ranged from 21.27 to 28.36 mg/L, which is also within WHO recommendations.

Additional data analysis shows that total hardness ranges from 12, 34, and 352mg/CaCO3 and that total dissolved solid (TDS) ranges from 0.442, 17.407, and 94.974mg/L. Dissolved oxygen (D0) ranges from 4.075, 5.42, and 4.71mg/L. However, the majority of the water parameters fall within the acceptable range as set forth by the World Health Organization (WHO).

Because they produce gases during their decomposition and are cleaned by rainwater trickling through them, open rubbish dumps are known to reduce the quality of ground water.

The amounts of trace elements like cadmium (Cd), chromium (Cr), lead (Pb), and copper in ground water and leachate were measured for this investigation in the unit operating department of the chemical/petrochemical engineering laboratory. These analyses are included in Table 4 along with a number of potential major groundwater and risk issues that demand immediate attention and further research. Table 4 provides information on the concentrations for these studies in groundwater and leachate. The study's surrounding well depths' water tables are 1.8 meters deep. Because these elements could not be distinguished at the laboratory in question, mercury (Hg) and arsenic (As) were not included in the table. When compared to the nearby hard-

dug well, the levels of lead (Pb) in the leachate and groundwater were higher than the WHO worldwide standard. This might be as a result of pollution from leachate at the disposal location. The quantities of lead (Pb), chromium (Cr), and cadmium (Cd) in spring water exceed WHO standard-based drinking water requirements, according to these heavy metals studies.

4. CONCLUSION AND RECOMMENDA-TION

4.1 Conclusions

Large-scale combinations of potentially dangerous chemicals have been found in open garbage disposal sites adjacent to residential areas, raising serious issues with groundwater quality and public health. Concerns about the quality of ground water and the effects of open waste dumping sites have prompted a thorough research. One might infer from this study that the alleged increased risk to ground water near the open trash disposal site of Oyigbo is real. The results showed a high danger of groundwater (well and borehole water) pollution and public health issues close to a disposal site. In general, Oyigbo open trash disposal facility is of little value to the environment or the locals' health. Most of the parameters are within WHO drinking water standards, according to the analysis that was done.

However, as illustrated in Table 4, some agents, including dissolved oxygen, total dissolved solids, chloride, nitrate, iron, hardness, phosphates, and sulfate concentrations, vary from one sample to another. However, there are no substantial health risks associated with their presence in the ground water in Port Harcourt's Oyigbo Local Government Area. Techniques for handling, regulating, and monitoring open garbage must be geared toward producing a healthy environment for many people to live in. This will significantly contribute to the preservation of natural resources like water that are harmed by these open wastes. From this framework, a perspective on complete environmental management practices to safeguard ground water resources in the Oyigbo Local Government Area may be articulated. The outcome showed that using the dumping site as a dump is totally undesirable because it is producing numerous powerful toxins that are harmful to the environment and the local population.

4.2 Recommendation

The following are suggested. Recommendations In light of the threats to public health and ground water, the government should prioritize addressing the issue of open dump sites in conjunction with other environmental and public health-related groups. Unless the Ministry of Environment and the Garbage Management Board are officially recognized as the waste collection and management authorities, open waste should be recycled rather than taken to dump sites. There is a need for environmental awareness through education campaigns, deep groundwater investigation, and open waste management that abides by the principles of resource management (reduce, reuse, recycle, and responsible disposal). It should be advised that thorough ground water monitoring be done, especially throughout the two seasons (Dry and Wet) of the equipment. Water from the study area's borehole needs to be properly treated to remove salt, excessive iron level, and acidity. Environmental sanitation authorities and other regulatory agencies like the Rivers State Minister of Environment should keep an eye on enterprises and guarantee good waste management practices. There should be laws, guidelines, and scientific standards pertaining to well-engineered landfill designs and other types of open waste disposal technology. The operation of the dump site must be stopped as soon as is practical to address groundwater and public health concerns, and a new designed landfill should be constructed with appropriate leachate collection and treatment. Consider temporary disposal methods that don't endanger the environment or the public's health before closing the current dump site.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/95945