Global Scientific JOURNALS

GSJ: Volume 11, Issue 5, May 2023, Online: ISSN 2320-9186
www.globalscientificjournal.com

ENVIRONMENTAL IMPACT OF LEACHATE POLLUTION ON GROUNDWATER SUPPLIES.

T. Aliyu[1], A.B Olahan[2], A. Giwa[3], T.F Komolafe[4], A.B Ahmed[5], A.G Olatunji[6]

[1-6]Department of Civil Engineering,

The Federal Polytechnic Offa, Nigeria

Email: ahmadaliyu0607@gmail.com

ABSTRACT

To determine the extent of dumpsite pollution on groundwater quality, physical, chemical, and heavy metal tests of water samples from one borehole and one open well located close to a landfill at Sango Abattoir, Owode market area, Offa Kwara State, Nigeria, were conducted. The positions of the borehole and open well were 35 meters and 15 meters, respectively, from the landfill. Turbidity, temperature, pH, dissolved oxygen (DO), total dissolved solids (TDS), total hardness, nitrate, chloride, calcium, and heavy metals including copper, iron, and magnesium were among the parameters measured utilizing convectional equipment and conventional laboratory techniques. While the majority of these measures showed traces of contamination, they were below WHO and Nigerian Standard for Drinking Water Quality (NSDWQ) consumption limits. The Ph temperature ranged from 26.5 to 27.50C, turbidity readings were between 1.0 and 412 FAU, and the range of ;;;;ranged from 5.7 to 6.8 indicating harmful contamination. Nitrate, calcium, and calcium concentrations varied from 34 to 61 mg/L, 65 to 70 mg/L, and 65 to 70 mg/L, respectively. Copper ranged from 0.00 to 0.01 mg/L and iron ranged from 0.03 and 0.15 mg/L for heavy metals. Magnesium was found in one of the wells (boreholes) due to a landfill, which could be linked to an abattoir nearby (open well). The findings indicated that one of the samples of water (an open well) was severely contaminated but urgently needed specific levels of treatment before usage. public education regarding waste

sorting, the use of clean technology, and to stop further ground water contamination, it is advised to implement change, mitigation measures, and sanitary landfill usage.

1.1 INTRODUCTION

The process of industrialization and urbanization, which have advanced through time without taking into account the effects on the environment, is mostly to blame for groundwater pollution. Its quality is determined by the factors that are physically and chemically soluble as a result of weathering from the source rocks and human activity. Due to its enormous environmental relevance, the effect of leachate on groundwater and other water resources has recently received a lot of attention. If not properly managed, leachate migration from waste sites or landfills and the release of contaminants from sediments (under certain circumstances) constitute a significant risk to groundwater resources. The relevance of water quality on human health has recently drawn a lot of attention, making groundwater protection a crucial environmental problem. Evaluating the quality of groundwater Planning and building water resources properly requires creating ways to prevent aquifers from becoming contaminated. Open dumps are the oldest and most popular method of getting rid of solid waste, and even though thousands of them have been shut down recently, many are still in operation. The rise in human population, industrialization, and technological advancement have all contributed to the complexity of waste management, and many of the processes that determine how wastes behave in the soil are complicated and poorly understood. Many people lack understanding of issues including the rate at which nutrients and other chemicals are released, the leaching of nutrients, the impact of metals through macropores as suspended solids, and the impact of sludge organic matter on the sorption degradation. Organic substances that are hydrophobic and their long-term bioavailability and destiny to develop a more effective strategy for managing groundwater pollution, required to be explored regarding the metals fixed by soil organic matter. Groundwater and surface water can become contaminated by toxic compounds with high concentrations of nitrate and phosphate that come from garbage in the soil and filter through a dump. Some of the unsightly issues with sanitary landfills are insects, rats, snakes, scavenger birds, dust, noise, and unpleasant odor. The amount of solid garbage produced in the Owode Market in Offa Kwara State.

Nigeria has grown greatly throughout time as a result of the country's growing population, industrialization, and economic growth. According to the overall analysis, plastic and nylon make up around 80% of all garbage, followed by metal at about 1% [5]. Groundwater pollution increased as a result of increased trash generation and disposal. It is uncertain how much the area's water wells have been impacted by the pollution, so this information must be obtained. Therefore, the study's goal was to determine how landfill pollution in Sango Abattior, Owode Market Area, Offa Kwara State, Nigeria, affected groundwater quality.

The study's objective is to determine the impact of dumpsite locations on the quality of the groundwater in Sango Abattior, Offa Kwara State, Owode market region.

The study will focus in particular on:

1. Analyze how far a groundwater sample is from the dumpsite in relation to its physical, chemical, and heavy metal characteristics.

2. Check to see if the quality of the groundwater sources that were sampled varies.

3. Comparing the Nigeria Standard for Drinking Water Quality (NSDWQ) and World Health Organization (WHO) Water Quality Standards will show the differences in the sampled water's quality.

The Sango Abattior landfill leachate in the Owode market area of Offa Kwara State was the sole subject of the investigation.

2.1 Water Development

The planet's freshwater and oceans are connected through the water cycle. Water makes up roughly 70% of the human body, and plant cells make up about 60% to 70%. (Smith and Edger, 2006). The oceans contain 97% of the water on earth, and they also provide almost all of the water that falls as rain and snow on land. Just 0.3% of the limited amount of freshwater that is available surface waters and around a third of it is groundwater (Gleick, 1996).

Water contamination, either naturally occurring or caused by humans, is a big issue, particularly in developing nations. Water, especially groundwater, can become polluted after being contaminated and can continue to be so without remediation. Water in its liquid form is the material that makes life possible on Earth. All types of living things are made up of cells that have at least 60% water content (Jackson, 1985). Because it is the foundation of life, the development of water resources is a crucial part of the comprehensive development of any place.

2.2 Distinctions Between Dump Sites and Landfills

A dump is an arbitrary location that permits the gathering of rubbish, whereas a sanitary landfill is an engineered system. Most of the time, sanitary landfills are built in areas where groundwater and runoff are not an issue. Local governments and citizens must be taken into account. Modern equipment, well-trained staff, and the prevention of burning must be offered.

Emelda (2011) cites trash management as one of the main issues the world is currently experiencing. Man creates waste products in his daily activity that, if not properly managed, might cause environmental and health issues. The challenge for governments is to choose the best waste management and disposal practices. When the human population was not as large as it is today, a few decades ago, trash disposal was a simple process. People stored their waste in dumps, which are simply excavated areas of land or pits.

In conclusion, a dump is an area of land that has been excavated and used to store rubbish, whereas a landfill is an area of land that has been excavated and used to store waste, but is subject to government regulation.

More compact than a landfill, it. Leachate collection and treatment systems are not present in dumps, but they are in landfills. In contrast to a dump, a landfill contains a liner at the bottom to catch the liquid created by solid trash. To ward off pests and stop foul odors from escaping into the air, landfills are routinely covered with soil. Since air and water do not easily access the dump, it also aids in reducing the rate of rot. On the other side, dumps are virtually ever covered, which hastens the decay process and causes harmful gases to be released into the atmosphere. .

2.3 Pollution from landfills and groundwater

According to Taylor and Allen (2006), landfills are most frequently associated with the contamination of groundwater by liquid waste products. But any location where trash is processed, stored, and concentrated, even temporarily, could be a point source of groundwater contamination. Such processing facilities commonly exist in metropolitan or semi-urban areas, where they may have an impact on nearby water supply points. They are also frequently not well controlled or licensed.

2.4 Factors Affecting Groundwater Quality

The evaluation of a groundwater system's hydrochemistry is typically predicated on the availability of a wealth of data about its chemistry. Due to the suitability of water for a variety of uses, the quality of groundwater is just as significant as its quantity. The chemistry of groundwater, in turn, is influenced by a variety of variables, including general geology, the degree of chemical weathering of different rock types, the quality of water and inputs should be replenished from sources other than rock interaction. Complex water quality is the outcome of these elements and how they interact (Aghazadeh & Mogaddam, 2010). Both natural and man-made factors affect groundwater quality.

The geology of the bedrock, the distance from the surface soil, vegetation, climatic variation, the permeability of the sediments, and topography are all factors that affect groundwater. Anthropogenic factors include, among other things, the nature of human activities, urbanization, industrialization, and waste disposal.

2.5.1 Landfill Lifespan: The longevity of the landfill is closely related to groundwater contamination. Due to the length of time and age of the landfills, as well as the kind of the decomposed waste, pollutants produced over years differ significantly in terms of physicochemical composition and heavy metal content.

2.5.2 Leachate Migration: Water flowing through landfills in unsealed landfills atop an aquifer like Solous frequently gathers within or beneath the landfill (Freeze and Cherry, 1979). This is because, in addition to rainwater percolating, degradation processes that are active within the waste also produce leachate, according to Taylor and Allen (2006). Leachate from the landfill or dump flows outward and downward more as a result of the higher hydraulic head. Groundwater resources below the surface are at risk from downward flow. When nearby wells or boreholes have low water quality, leachate is likely being created and migrating. It's possible that the flow direction of groundwater differs from that of surface water. However, groundwater flows

ISSN 2320-9186

continually and slowly through the cracks in the rock and soil. There will be a pollution plume in the groundwater. The wells in that plume will be contaminated, but if other wells, including those near the dump, are not in the plume, they might not be harmed.

2.7 Water Quality Standards in Nigeria

The Nigerian Standard for Drinking Water Quality (NSDWQ), which was established by the Nigerian Standards Organization's Council in 2007, establishes upper and lower limits for contaminants that are known to be dangerous to people's health (NIS, 2007).

3.0 Methodology

3.1 Physical Observation Of The Study Area

There are two main climatic seasons in Offa metropolis: the dry season, which lasts from November through March, and the rainy season, which lasts from April through October. Offa metropolis is located at latitude 8.1493N and longitude 4.7200E. Around 90 thousand people call Offa home.

The enormous population causes a 20% annual growth in garbage production. This suggests that garbage production greatly outpaces population increase. In Nigeria, there are approximately 85 people per square kilometer, however in Offa, the physical strain on the existing land increased in a geometric fashion while the available land itself rose in an arithmetic fashion. The increasing rate of urbanization and disregard for good physical planning and development techniques are the key causes of this process.

ISSN 2320-9186

Figure 3.1 landfill area around Sango Abattior, Owode market

3.2 Methodology

Laboratory testing was done for the heavy metals, chemical, and physical tests.

For the purpose of assessing the quality of the groundwater, a single existing borehole and an open well with an average depth of 40 meters and 6 meters in a basement formation, respectively, were placed 35 meters and 15 meters away from the landfill's center. 5 liters of groundwater samples from each borehole were taken, held at 40°C for analysis, and then put into 600 mL sterile polyethylene bottles. Each borehole's water samples were subjected to physical, chemical, and bacteriological investigations. The Civil Engineering Department of the Federal Polytechnic, Offa (FPO) conducted the qualitative studies in the water laboratories. The following physical characteristics were measured: temperature, taste, color, turbidity, and odor. Chemical variables under study were pH, total dissolved solids (TDS), dissolved oxygen (DO), dissolved oxygen (DO), total hardness, total iron, nitrate, chloride, calcium, and heavy metals like copper and iron. An analog mercury thermometer was used to measure temperature, a Calorometer 700 was utilized to detect turbidity, and a Mettler Toledo (GmbH 8603 Schwerzenbach) pH meter was used to directly measure pH. Additionally, the samples were examined for total dissolved solids (TDS), total hardness, iron, nitrate (NO3), calcium, and chloride using titration techniques at the water laboratories in accordance with industry standards for water testing (APHA). Using a flame ultraviolet spectrophotometer, the levels of heavy metals including copper and iron in water samples were measured. The World Health Organization (WHO) and other organizations were used to compare all of the results to Standard for Drinking Water Quality in Nigeria (NSDWQ).

4.1 Result

Tables 1, 2, and 3 provide the findings and a comparison of the sample parameters with WHO and the Nigerian Standard for Drinking Water Quality (NSDWQ) standards. In table 1, the samples' temperature, turbidity, color, and odor were displayed. The presence of color verified leachate intrusion into the wells and served as a sign of contamination. The recommended limit is five hazen units, but because they are present, they go against the notion of mobility of water. In order to be fit for consumption, potable water must be tasteless, colorless, odorless, and pathogen-free.

The temperatures, which were found to be outside the range of the WHO norm of 25C for residential water, ranged between 26.5 and 27.50C, indicating that there are alien bodies present. The presence of active bacteria, which caused the temperature to rise, was indicated by the high temperature. Similar opinions were noted by in their research. The high values obtained for both color and temperature in the studied water samples may also be due to pollution from a nearby abattoir, particularly W2(open well). The average turbidity values of samples W1 (borehole) and W2 (open well) were 1.0 FAU and 412FAU, respectively, and were below the WHO and NSDWQ criteria (table 1). existing suspended particles and other materials are typically to blame for excessive turbidity readings. Similar high turbidity readings were also reported, suggesting that the wells may not be lined, which would explain the high readings. The shaky side walls of the wells may have allowed soil particles to enter, causing the water's turbidity to rise. Similar findings were made, and the reasons given for the findings were those already described.

Samples W2 (Open well) needed to be treated before use because they were near together.

Tables 2 and 3 display the samples' chemical properties after analysis. The samples had an acidic pH range of 5.68 to 5.72, indicating the presence of metals, especially hazardous metals. This is above the WHO-permitted range of 6.5 to 8.5, which confirmed the water from the open wells' acidic character. After being exposed to air, water, and garbage, metals like zinc, broken battery cells (lead, mercury, and alkaline), improperly discarded old spray cans, and other disinfectants may have made their way into the landfill and given the well water its current hazardous, acidic quality. Though 7.0 is considered neutral, up to 9.2 may be accepted as long as microbiological surveillance shows no decline in bacteriological quality. In this instance, every indicator pointed to a decline in bacteriological quality.

Tables 2 and 3 display the samples' chemical properties after analysis. The pH was acidic, ranging from 5.68 to 5.72, indicating the presence of metals, especially hazardous metals, in the samples. This confirms the acidic character of the well water by going above the WHO permitted range of 6.5-8.5. After being exposed to air, water, and garbage, metals like zinc, broken battery cells (lead, mercury, and alkaline), improperly discarded old spray cans, and other disinfectants may have made their way into the landfill and given the well water its current hazardous, acidic quality. Although 7.0 is the neutral value, it was noted that up to 9.2 may be tolerated under microbiological, no deterioration in bacteriological quality was seen during monitoring. To avoid the impending catastrophe its continuous presence in both the soil and water bodies will pose to the final consumers of these resources, all indicators in this case demonstrated a decline in bacteriological quality (as shown in Table 4). As a result, urgent action is required.

4.2 PYSICAL PARAMETERS

TABLE 4.1: PHYSICAL CHARACTERISTICS OF THE BOREHOLE AND OPEN WELL WATER SAMPLES ANALYZED

Sample	Colour	Odour	Turbidity	Temperature
Borehole	1ptco	Odorless	1.0 FAU	26.5° C
Open well	2ptco	Odour	412 FAU	27.5°C

4.3 CHEMICAL PARAMETERS

TABLE 4.3.1: CHEMICAL CONSTITUENTS IN THE BOREHOLES AND OPEN WELL AND THEIR COMPARISONS WITH THE W.H.O STANDARDS

Sample	Distance(m)	pH	DO	TDS	TH	Ca	NO_3	Cl^-
NSDWQ		6.5-8.5	NS	500	200	75	50	250
WHO		6.5-8.5	NS	500	200	75	50	250
Borehole	35	5.50	0.5	50	120	65	34	ND
Open well	10	6.84	1.9	342	160	70	61	95

The pH is dimensionless; EC is and except otherwise stated, all units are in mg/L

NS- not specified

4.4 HEAVY METALS

TABLE 4.3: HEAVY METAL CONTENTS IN THE BOREHOLE AND OPEN WELL AND THEIR COMPARISONS WITH THE W.H.O STANDARD

Sample	Distance(m)	Fe	Cu	Mn
NSDWQ		0.03	1.0	0.2
WHO		0.3	1.0	0.1
Borehole	35	0.03	ND	ND
Open well	15	0.15	0.01	0.0042

Except otherwise stated, all units are in mg/L
ND – not detected

FINDINGS.

The values are all in 1/100 mg/l. Although all the ions were below WHO and NSDWQ norms, they still need to be treated before they can be used in household settings. While total hardness (TH) levels above 200 mg/l do not have any connected harmful health-related impacts on humans, they are a sign of deposits of Ca and/or Mg ions. Values above 250 mg/l for chloride would result in perceptible taste. They will prevent water from lathering with soap, which will prevent the efficient utilization of water resources. Chloride levels were between 17 and 122 mg L-1, which is below the maximum allowable level of 250 mg L-1 but above WHO and NSDWQ standards. Because its presence suggests pollution, it must be treated before use. The significance of chlorides' high value is the presence of weathered, silicate-rich rocks beneath the overburden, as well as soil leaching brought on by landfill infiltration and other human activities. This supported the findings. Because nitrate is the byproduct of the aerobic decomposition of organic nitrogenous materials, it is frequently found in surface and ground waters. Nitrate is the most highly oxidized form of nitrogen compounds. Natural waterways that have not been contaminated typically only have trace amounts of nitrate. According to Table 2, nitrate and nitrite concentrations ranged from 0.7 to 0.9 mgL-1 and 30 to 61 mgL-1, respectively, indicating a noticeable presence of contaminants in all the water samples. Because airborne bacteria quickly transform nitrates into nitrites, nitrites have a short shelf life. Hemoglobin immediately reacts with nitrates in methemoglobin, which eliminates the capacity of blood cells to carry oxygen, is produced by human blood. Given that it results in methemoglobinemia, sometimes known as "blue baby illness," in infants under three months of age, this condition is particularly dangerous. Nitrite concentrations in water that are more than 1.0 mgL-1 should not be ingested by people, much less given to infants. Rarely do nitrite levels in drinking water reach 0.1 mgL-1. If taken without treatment, it poses a threat because the values are higher than the "safe value." Nitrate is a key component of agricultural fertilizer and essential for crop growth. Following rainfall, agriculture releases different amounts of nitrate through infiltration, percolation, and seepage into surrounding streams as well as into the groundwater table. Nitrates enter streams through leaking septic tanks systems as well, landfill leachate, cattle manure, animal waste, and discharges from automobile exhausts.

5.1 SUMMARY

The level and pace of national development have been linked to waste generation. However, given the aforementioned metropolitan characteristics, Nigeria's states continue to use an outdated and primitive waste management system that has little immediate impact on the quality of the groundwater. The Sango Abattior dumps in the Owode market region of the Offa Local Government Area lack any plan for the residents about groundwater use to prevent water-borne illnesses that could harm human health. It would be ideal if there were a better way to dispose of rubbish that didn't harm the environment. For years, Owode residents have considered landfilling to be the simplest method of getting rid of waste and trash.

In order to compare the quality of the groundwater near the dumpsites, this study looked at its concentration of the investigated variable with respect to the WHO (2004) and NSDWQ (2007) guideline limits.

5.2 CONCLUSSION

The analysis found that the accumulation of rubbish at the dump site had gradually contaminated the soil and groundwater. The study determined that the impact of this pollution decreased as distance increased from the polluting source. This suggested that being close to dump sites had a greater impact on groundwater contamination. Less dependence has been ascribed to the region's hydrogeology and to some extent, its geography, waste disposal system type, and status. However, the findings showed that using the nearby well waters for residential uses would result in extremely poor sanitation and harmful consequences on both human and animal health. The water from the open well contains high amounts of chemical and bacterial contamination, which poses a health risk as typhoid fever and worm infestation are imminent issues if such water is consumed as it currently stands. Due to the leaching of both Ca and Mg into the groundwater table, water hardness was increased. Fe and Cu were found in detectable amounts, which indicates that the groundwater is hazardous and poses a major risk to the ecosystem for people, animals, and even the soil. Increased daytime temperatures, global warming, an increase in crop abortion cases, and a subsequent decline in yield and productivity were all environmental effects.

5.3 RECOMMENDATION

The following suggestions are made to lessen the effect of landfill contamination on groundwater supplies in order to control groundwater vulnerability to pollution from landfills;

I. Strategic management of garbage disposal, as well as adequate and proper planning, design, and construction, are required.

II. To stop the ongoing groundwater contamination, it is necessary to outlaw conventional landfills or dump sites and build modern, hygienic landfills in their place.

III. Governmental regulations for managing and disposing of trash should be adopted and carefully followed.

IV. Waste sorting and treatment before disposal are promoted, as well as the citation of dumpsites far from residential areas to reduce polluting of neighboring well waters.

V. Changing the design of a sanitary landfill to include clay or plastic liners to stop leachate from entering the water table.

VI. It is advised that landfill emissions be recycled using clean technology, and that land management be sustainable with a reclamation plan.

REFERENCES

Adewole, A. T. (2009). Waste management towards sustainable development in Nigeria: A case study of Lagos State. International NGO Journal, 4(4), 173-179

Afolayan, O. S, Ogundele, F. O., Omotayo, A. (2012). Comparative analysis of the effect of closed and operational landfills in groundwater quality in Solous, Lagos, Nigeria. Journal of Applied Technology in Environmental Sanitation, 2(1), 67-76

Baby, J., Raj, J. S., Biby, E. T., Sankarganesh, P., Jeevitha, M. V., Ajisha, S. U. & Rajan, S. S.(2010). Toxic effect of heavy metals on aquatic environment. International Journal of Biological and Chemical Sciences. 4(4), 939-952

Backman, B., Bodis, D., Lahermo, P., Rapant, S., & Tarvainen, T. (1998). Application of a groundwater contamination index in Finland and Slovakia. Environmental Geology, (36), 55-64.

Chapman, D. (1992). Water quality assessments – A guide to the use of biota, sediments and water in environmental monitoring. London: Chapman and Hall

Christensen, T. H., Kjeldsen, P., Albrechtsen, H. J., Heron, G., Bjerg, P.L. & Holm, P. (1994) Attenuation of landfill leachate pollution in aquifers. Critical Reviews in Environmental Science & Technology, 24, 119-202.

Christensen, T. H., Nielsen, P.H. & Bjerg, P.L. (1995). Degradation of organic chemicals in a leachate pollution plume: an in-situ experiment. In:

Duffus, J. H. (2002). Heavy metals" a meaningless term? (IUPAC Technical Report)" pureInternational Applied Chemistry, 74, 793–807.

Dunnette, D. A. (1979). A geographically variable water quality index used in Oregon. Journal of International Pollution, 51(1), 53-61

Journal of International Pollution, 51(1), 53-61

Edet, A.E. & Offiong, O.E (2002). Evaluation of water quality indices for heavy metal contamination monitoring. A study case from Akpabuyo-Odukpani area, Lower cross River Basin (southeastern Nigeria).GeoJournal., (57), 295-304

El-Fadel, M., Findikakis, A. N. & Leckie, J. O. (1997). Environmental impacts of solid waste landfilling. Journal of Environmental Management, 50(1), 1-25

Harter, T. (2003). Groundwater quality and groundwater pollution. [Retrieved December 27, 2013, from http://anrcatalog.ucdavis.edu/pdf/8083.pdf]

Horton, R. K. (1965). An index number system for rating water quality. Journal of Water Pollution, 37(3), 300-305

Jaji, M. O., Bamgbose, O., Odukoya, O. O. & Arowlo, T. A. (2007). Water quality assessment of Ogun River, south west Nigeria. Environmental Monitoring and assessment, 133, 473-482