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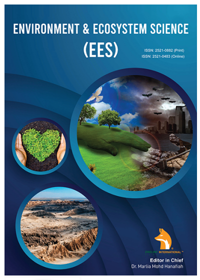

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RESEARCH ARTICLE

IMPACTS OF DUMPSITE ON SOIL AND GROUNDWATER QUALITY: A CASE STUDY OF ERINFUN COMMUNITY, ADO EKITI, SOUTHWESTERN NIGERIA

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ABSTRACT

Groundwater pollution has increased as a result of poor waste disposal practices in developing countries. The purpose of this study was to determine the levels of physicochemical parameters and heavy metal concentrations in order to investigate the impact of dumpsites on groundwater and soil quality in Erinfun community. Four (4) water samples were collected hand dug well and four (4) soil samples designated Ss1 to Ss4 were collected at distances of 10, 20, 30 and 40 m, respectively, away from the waste dumpsite. Physicochemical parameters and traces such as odour, colour, taste and temperature, as well as Biochemical Oxygen Demand, Chemical Oxygen Demand, Dissolve Oxygen, Total Dissolve Solid, pH, and chloride were measured in collected water samples. Collected soil samples were also analyzed for heavy metals such as Magnesium, Zinc, Iron, Chromium, and Lead. All the physical parameters of the water samples analysed were found not to be within the acceptable limit of World Health Organization and Nigerian Standard of Drinking Water Quality standards. The chemical constituents tested were within the acceptable limit of World Health Organization and Nigerian Standard of Drinking Water Quality except for the Biochemical Oxygen Demand, Chemical Oxygen Demand and Dissolve Oxygen of water samples 1 and 2, respectively. The concentration of trace metals in water sample test were within health limit except for Magnesium and Iron which has the highest concentrations in water sample 1 at 10 m away from dumpsite (61.00 mg/l and 0.46 mg/l). Consequently, open dumpsites are discouraged, and constructed standard landfills with appropriate monitoring guidelines are recommended.

KEYWORDS

Groundwater, Dumpsite, Water quality, Soil, World Health Organization.

1. INTRODUCTION

Groundwater is an essential source of freshwater for the survival of life on Earth (Mukherjee and Singh, 2020). Groundwater is used for numerous purposes around the world, including drinking, farming, and manufacturing activities. Globally, approximately 2.5 billion people depend entirely on groundwater resources to meet their daily water needs (Mukherjee and Singh, 2020; UNESCO, 2015). Human activities on Earth generate residual materials that are not immediately useful where they are generated. These residual materials may be recycled, reclaimed, or reused; otherwise, they constitute waste which will ultimately be released to the environment in mobile form (USEPA, 2008). Waste is defined as unwanted or undesired materials that accumulate after a process is completed (Cointreau, 2001). They are classified as items with hazardous properties which include household dump items, sewage, sludge, waste from manufacturing industries etc. (Obeka, 2005).

Wastes generally exist as solid, liquid and gas. Groundwater contamination has primarily happened as a result of solid waste dumping on land. Landfill waste disposal method has polluted groundwater resources all over the world under a variety of conditions (Afzal and Elahe, 2008). According to a study, solid wastes are classified as domestic, residential, agricultural, municipal, pesticides, industrial, and hazardous wastes (Adebibu, 2011). Furthermore, solid waste can be characterized soluble or not soluble, plant - based or synthetic, biodegradable or non-biodegradable, and hazardous or nonhazardous (Kostawa, 2006; Ajadike, 2007). Regardless of the various classes of solid waste, most waste produced in urban areas can be decomposed and degraded by microbes, accelerating the creation of leachate and their subsequent migration. On the other hand, non-biodegradable wastes can last for a long time without being decomposed by microbes.

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As a result, leachate formed from decomposed discarded materials can migrate to the landfill's base. Today, urban areas in Nigeria are experiencing an increased rate of pollution problems, with refuse being dumped along drainage channels. Most cities in Nigeria are faced with waste Management problems, which Ado-Ekiti is not an exemption (Ipinmoroti et al., 2007). The environmental impact assessments of heavy metals present in our environment have been well documented (Ipinmoroti et al., 2007). However, continued monitoring of the source and distribution of these heavy metals in our environment is required. Most heavy metals are found in varying amounts in all aspects of the environment. Heavy metals pollution of the environment does not mean unusual occurrence of a metal within a component; rather it represents the occurrence of that metal relative to the natural occurrence.

They are present in trace concentrations in soil and vegetation and much more prominent in solid wastes containing non-biological and used products (Thomton, 2012). Open dumpsite approach as solid waste disposal method is a primitive stage of solid waste management in many parts of the world. This approach, which is mostly used in developing countries, is non-scientific, obsolete, and ineffective. They are uncontrolled and thus pose significant health risks, as well as affecting the urban landscape (Sood, 2004). In many developing countries, solid waste disposal sites are found on the outskirts of developing urban areas. These areas are major sources of contamination and contagious diseases, particularly for people, due to the growth and propagation of flies, mosquitoes, and rodents.

They, in turn, are disease transmitters that affect population's health, which has its organic defenses in a formative and creative state. The said situation produces gastrointestinal, dermatological, respiratory, genetic, and several other kinds of infectious diseases (Salem et al., 2011). The global increase in human population, as well as increased demand for food and other necessities, has increased the amount of waste generated from each home on a regular basis. These wastes are dumped on dumping sites, which eventually become a source of environmental and health hazards for those who live nearby. According to many cities in developing countries face serious environmental degradation and health risks use to the weakly developed municipal solid waste management system (Nguyen et al., 2016). Several studies have been conducted to investigate the health and environmental effects of waste dumps, with the results indicating a link between the two (Aatamila et al., 2010). A group researcher found that exposure to hazardous waste in dumpsites can harm human health, with children being the most vulnerable to these pollutants (Yongsi et al., 2008).

Chemical poisoning can occur as a result of direct exposure and result in disease. Agricultural and industrial wastes can be hazardous to one's health. Other than this, co-disposal of industrial waste with municipal waste can expose people to chemical and radioactive hazards. Medical waste and other medical waste disposed of in landfills with domestic waste raises the risk of infection with Hepatitis B and HIV, as well as other related diseases (Fadipe et al., 2011). In many developing countries, the use of landfill as a waste disposal method deviates from standard recommendations (Mull, 2005; Adewole, 2009). A group researchers stated that one of the most pressing environmental issues today is ground water contamination, and that among the many contaminants affecting water resources, heavy metals are of particular concern due to their high toxicity even at low concentrations (Vodela et al., 1999).

Landfills are sources of groundwater and soil pollution due to the production of leachate and its migration through refuse (Ikem et al., 2002). Leachates and other pollutants from landfills and sediments can pollute groundwater resource if not adequately managed (Ikem et al., 2002). Because of its polarity and hydrogen bonds, water has unique chemical properties that allow it to dissolve, absorb, adsorb, or suspend a wide range of compounds (WHO, 2007). Thus, water in nature is not pure because it picks up contaminants from its surroundings as well as those emitted by humans, animals, and other biological activities (Mendie, 2005). The purpose of this research was to determine the impact of a dumpsite's leachates on the groundwater and soils around it.

To accomplish this goal, the physicochemical results of nearby groundwater were compared to the World Health Organization standard for drinking water and the Nigerian Standard of Drinking Water Quality, with the aim of predicting their level of pollution and/or contamination, as applicable (World Health Organization, 2004; Nigerian Standard of Drinking Water Quality, 2007). Furthermore, the physicochemical results of nearby soils were assessed to determine the level of contamination that could affect their use for agricultural purposes. This paper therefore sought to present findings of a study carried out in Erinfun Community, Ado Ekiti, Ekiti State to determine the environmental and health impact of solid waste disposal at dumpsite on its surrounding human settlements. The findings presented could be of relevance for many communities in the state and other states in the country and waste management researchers.

2. Methodology

2.1 Study Area

The study area is Erinfun community, via Ado Ekiti, which lies on 7.6007° N latitude and 5.3010° E longitude with elevation of 456 m above mean sea level (a.m.s.l.) (Figure 1). The area is part of Ado Ekiti Capital city and it is located at off Odo-Ado Road. Erinfun is majorly populated by students of the Federal Polytechnic, Ado Ekiti (FEDPOADO) and Ebira people. Erinfun has witnessed rapid growth in population due to the increasing number of students in the community. The community's main occupation is subsistence agriculture. The activities of the students and the local people have led to generation of solid wastes through agricultural production, engineering construction, local industries, institutions and household uses.

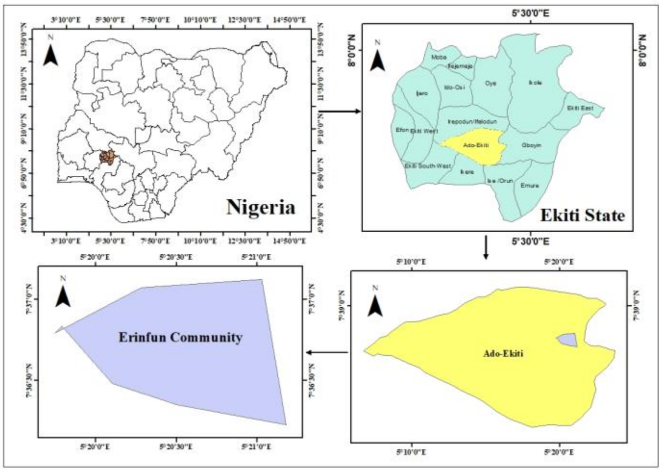

Figure 1: Location Map of the study area

2.2 Collection of Sample and Laboratory Analysis

The study was carried out in a dumpsite which is located within the Erinfun community. The community is located in the outskirt of Ado Ekiti, the capital city of Ekiti State, Southwestern part of Nigeria. The community has no specific method for solid waste disposal used in the Erinfun Community dumpsite. As a preparation for the study, a reconnaissance survey was undertaken to properly study the area before starting the full research. The objectives were to obtain available relevant information on the environment of the study area, intimate and seek cooperation of residents residing around the dumpsites and to select the wells that water samples were to be collected from for detailed investigation through laboratory analysis. Field measurements such as physical parameters including: water level, depth to bottom of the well, distance between wells and to the dumpsite were measured. The experimented was carried out between June and July, 2019. After collection of soil and water samples from the dumpsites, laboratory analysis was performed.

2.2.1 Water analysis

Four well were sampled away from the dumpsite at Erinfun community of Ado Ekiti. For each well, 2500 ml of the water samples were collected in sterilise polyethylene bottles, stored at 4°C and analysed. The analysis includes physico-chemical parameters of water samples from each well. The qualitative analysis was carried out at the laboratories of Sustainable Laboratory Limited, Akure. The physical parameters tested for include; Odour, Taste, Colour, and Temperature. Chemical parameters analysed were Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Dissolve Oxygen (DO), Total Dissolve Solid (TDS), and Chloride for chemical and the concentration of heavy metals such as Iron (Fe), Magnesium (Mg), Zinc (Zu), Lead (Pb), and Chromium were determined. Cations and heavy metals analyses were carried out using Atomic Absorption Spectrophotometer (Oyelami et al., 2013). All parameters were analysed using standard methods and procedures (APHA, 2005). All the result were compared with the World Health Organisation (WHO) and Nigeria Standard Drinking Water Quality (NSDWQ).

2.2.2 *Soil sampling and analysis*

Soil sample were collected from the Erinfun dumpsite area of Ado-Ekiti, representatives' sample which were twelve were collected at four different aligned location of 10 m distance with each other location having three samples at various depths 0-10, 10-20, 20-30 cm in depth. Sample were collected with specification of predetermined distance and depths using soil augur, air dried sieved through 2 mm mesh and stored in polythene bags for analysis. Soil analysis was carried out on the samples to determine the composition of the following heavy metals; Iron (Fe), Magnesium (Mg), Zinc (Zu), Lead (Pb), and Chromium in the samples. Heavy metals were determined using the Flame Photometric Detector. This was accomplished through the use of standard laboratory procedures and analytical methods. The values were compared with the food and Agriculture Organization (FAO) of the United Nations values.

3. Results and Discussion

3.1 Physico-chemical parameters of water samples

Table 1 showed the result of the physico-chemical parameters of the collected water samples. In all the parameters; odour, colour, taste and temperature, under odour water sample one, two, three and four have odour which is not within WHO standard and may not be safe for both animal and human health. Under colour, all water samples have colour which is not within WHO standard and may not be safe for both man and animal health (WHO 2011). Under taste, all the water samples are tasty which is not within WHO standard and may not be safe for both man and animal health (WHO 2011). Under temperature water samples 1, 2, 3 and 4 are 24.2°C, 24.0°C, 25.1°C and 26.2°C respectively which are not within WHO standard and may not be safe for both man and animal health (WHO 2011). Which indicated the well around the dumpsite may be unsafe for domestic use.

Table 1: The result of analysis of ground water samples analysed and compared with WHO.

WATER SAMPLE	ODOUR	COLOUR	TASTE	TEMPERATURE
1	ODOUR	COLOURED	TASTY	24.2
2	ODOUR	COLOURED	TASTY	24.0
3	ODOUR	COLOURED	TASTY	25.1
4	ODOUR	COLOURED	TASTY	26.2
WHO	ODOURLESS	COLOURLESS	TASTELESS	22

The chemical parameters readings BOD, COD, DO, TDS, pH, CHLORIDE of the collected water samples are shown in Table 2. BOD has (36.20, 15.46, 3.68 and 1.40) mg/l respectively, water samples 1 and 2 are not within the WHO standard which indicate that water around these areas are not safe for domestic use (WHO 2011). On the water samples, COD has (69.62, 29.78, 7.08 and 2.69) mg/l respectively, water samples 1 and 2 are not within the WHO standard which indicate that water around these areas are not safe for domestic use (WHO 2011). On the water samples, DO has (5.65, 4.60, 3.80 and 2.20) mg/l respectively water samples 1, 2 and 3 are not within the WHO standard which indicate that water around these areas is not safe for domestic use (WHO 2011). On the water samples, TDS has (368.00, 267.00, 212.00, 202.00) mg/l respectively, all the water samples are within the WHO standard which indicate that water around these areas are safe from effect of TDS (WHO 2011). On the water samples, pH has (5.8, 5.9, 6.4 and 5.1) respectively, all the water samples are within the WHO standard which indicate that water around these areas are safe from effect of pH (WHO 2011). On the water samples, TDS has (84.97, 49.98, 45.01 and 44.99) mg/l respectively, all the water samples are within the WHO standard which indicate that water around these areas are safe from effect of CHLORIDE (WHO 2011). The topography of the area and the nearness to the dumpsite affect the readings.

Table 2: The result of analysis of chemical constituent in the ground water compared with WHO (2011) and NSDWQ (2007).

WATER SAMPLES	BOD (mg/l)	COD (mg/l)	DO (mg/l)	TDS (mg/l)	pH (mg/l)	CHLORIDE (mg/l)
1	36.20	69.62	5.65	368.00	5.8	84.97
2	15.46	29.78	4.60	267.00	5.9	49.98
3	3.68	7.08	3.80	212.00	6.4	45.01
4	1.40	2.69	2.20	202.00	5.1	44.99
WHO	≤5.00	≤10.00	≤3.00	≤500.00	6.5-8.5	≤200.00
NSDWQ	NS	NS	NS	≤500.000	6.5-8.5	≤250.00

NS-Not Safe

3.2 Heavy metal concentrations in water samples

The heavy metal concentration readings Mg, Zn, Fe, Cr and Pb of the collected water samples are shown in Table 3 and Figure 2. From the table, the Mg content of Samples 1, 2, 3 and 4 are 61.00, 30.00, 41.00 and 12.00 mg/l respectively. Only water samples 1 is not within the WHO standard and NSDWQ which indicate that water around the area is not safe for domestic use (WHO 2011; NSDWQ 2007). On the water samples, the Zn content of Samples 1, 2, 3 and 4 are 0.30, 0.26, 0.33 and 0.15 mg/l respectively (Figure 2). All the water samples are within the WHO standard and NSDWQ which indicate that water around these areas is safe from the effect of Zn (liver and kidney diseases, high blood pressure, heart failure and in some cases death) (WHO 2011; NSDWQ 2007). The Fe concentration for Samples 1, 2, 3 and 4 are 0.46, 0.35, 0.34 and 0.24 mg/l respectively. Water samples 1, 2 and 3 are not within the WHO and NSDWQ standard which indicate that water around these areas is not safe for domestic use which can cause liver and kidney diseases, high blood pressure, heart failure and in some cases death (WHO 2011; NSDWQ 2007).

On the water samples, Cr has 0.01, 0.00, 0.00 and 0.00 mg/l respectively, for water samples 1, 2, 3 and 4. The Cr concentration are within the WHO standard and NSDWQ which indicate that water around these areas is safe from effect of Cr (skin rashes, stomach upset, respiratory problem, kidney and liver damage and weakling immune system) (WHO 2011; NSDWQ 2007). On the water samples, the Pb concentration for Samples 1, 2, 3 and 4 are 0.00, 0.00, 0.00 and 0.00 mg/l respectively. All the water samples are within the WHO standard and NSDWQ which indicate that water around these areas is safe from effect of Pb (brain damage, hearing loss, damage of sense organ, reproduction problem and increases blood problem) (WHO 2011; NSDWQ 2007).

Table 3: Heavy metal concentration in the water sample compared with WHO (2011) and NSDWQ (2007).

WATER SAMPLE	Mg (mg/l)	Zn (mg/l)	Fe (mg/l)	Cr (mg/l)	Pb (mg/l)
1	61.00	0.30	0.46	0.01	0.00
2	30.00	0.26	0.35	0.00	0.00
3	41.00	0.33	0.34	0.00	0.00
4	12.00	0.15	0.24	0.00	0.00
WHO	50.00	5.50	0.30	0.50	0.01
NSDWQ	50.00	5.50	0.30	0.50	0.01

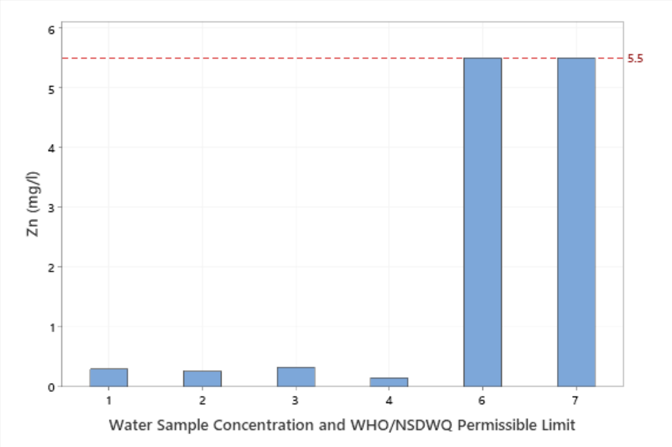

Figure 2: Chart of Zinc concentration in the water sample compared with WHO (2011) and NSDWQ (2007) (Red line shows the permissible limit by WHO/NSDWQ).

3.3 Heavy metal concentrations in soil samples

The heavy metal concentration readings of Mg, Zn, Fe, Cr and Pb are shown in Table 4 and Figure 3 for soil samples 1, 2, 3 and 4. The Mg concentration for Samples 1, 2, 3 and 4 are 53.00, 33.00, 17.00 and 8.00 mg/l respectively. All soil samples are within the FAO limit which indicate that soil around the area is safe for agricultural purpose (FAO 2007). On the soil sample, Zn has (1.13, 038, 0.30 and 0.33) mg/l respectively (Figure 3). All the soil samples within the FAO limit which indicate that soil around these areas is safe from the effect of excess Zn concentration (liver and kidney diseases, high blood pressure, heart failure and in some cases death) (FAO 2007). The Fe concentration for Samples 1, 2, 3 and 4 are 1.59, 1.38, 1.28 and 1.01 mg/l respectively. Soil samples 1, 2 and 3 are not within the FAO limit (FAO 2007). On the soil samples, Cr has (0.02, 0.00, 0.01 and 0.02) mg/l respectively, all the water samples 1, 2, 3 and 4 are within the FAO limit which indicate that soil around these areas are safe from effect of excess Cr (FAO 2007). On the soil samples, Pb has (0.01, 0.00, 0.00 and 0.00) mg/l respectively, all the soil sample 1, 2, 3 and 4 are within the FAO limit which indicate that soil around these areas is safe from effect of excess Pb and thus the soil around the dumpsite is safe for agriculture practice (FAO 2007).

Table 4: The result of analysis of heavy metal concentration in the soil samples compared with FAO (2007) standard

Soil sample	Mg (mg/l)	Zn (mg/l)	Fe (mg/l)	Cr (mg/l)	Pb (mg/l)
Ss1	53.00	1.13	1.59	0.02	0.01
Ss2	33.00	0.38	1.38	0.00	0.00
Ss3	17.00	0.30	1.28	0.01	0.00
Ss4	8.00	0.33	1.01	0.02	0.00
FAO	Ns	2.0	5.0	0.10	5.0

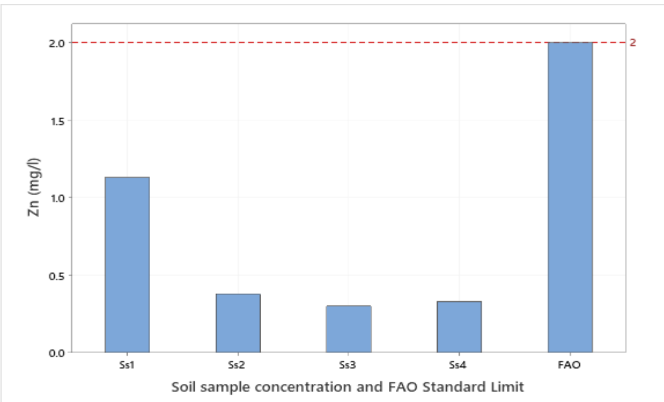

Figure 3: Chart of Zinc concentration in the soil samples compared with FAO (2007) standard (Red line shows the permissible limit by FAO)

4. Conclusion

The impact of a waste landfill site on well water and soil quality in the Erinfun community area of Ado City was investigated in this study. According to the findings, the measured soil and water parameters exceeded the standard limits, posing potential health and safety risks to local residents. The study area's pollution effect indicates that leachate occurs on the dumpsite according to the topography of the area, polluting the ground water. The closer the dumpsite, the more contaminated the groundwater and soil. The impact of a dumpsite on ground water and soil is determined by the area's terrain, method of waste disposal, and hydrogeology. The odour which is not within WHO standard may not be safe for both animal and human health. The concentration of BOD, COD and DO in the water samples from the nearby wells were above recommended limits which indicate that water around these areas are not safe for domestic use. Finally, the findings indicated that very poor waste management in the study area could have a negative impact on human and animal health if surrounding well waters were used for domestic and agricultural purposes that necessitate a certain level of hygiene.

Recommendations

Government should start enforcing waste disposal and management, citing of dumpsites far away from residential areas to minimize pollution of nearby well waters. Sorting of waste and treatment before disposal should be encouraged. To prevent leachates from entering the water table, sanitary landfills should be redesigned with clay or plastic liners. Adoption of green technology for recycling greenhouse gases emitted by landfills and implementation of sustainable land management program is recommended. People should be enlightened on the best way and method of disposing wastes materials to prevent well water from contamination.

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