

Assessment of Municipal Solid Waste Management in Oyo State, Nigeria: Challenges and Solutions

Alaka, S. A.

School of Engineering and Built Environmental.
University of Bolton, England, United Kingdom
Corresponding Author Email: Alakasodiq@gmail.com.

Osman, Y.

School of Engineering and Built Environmental.
University of Bolton, England, United Kingdom.

D.O.I: 10.56201/ijgem.v9.no6.2023.pg78.90

ABSTRACT

Municipal solid waste (MSW) disposal is a significant concern in many developing nations, including Nigeria, where open dumpsites are often a standard sight within urban locales such as Oyo state. Such dumpsites pose serious threats to public and environmental health, including the contamination of both surface and groundwater sources. This study aimed to delve into the root causes and inherent challenges in the management and disposal of MSW in Oyo state, Nigeria. To accomplish this, we employed a multifaceted methodology involving on-site observations of notable dumpsites, stakeholder interviews, households interview, and an extensive literature review. The results of the findings revealed several key issues. These include a pronounced lack of public awareness campaigns, insufficient access to and implementation of effective waste policies, a scarcity of trained waste management personnel, inadequate funding, an absence of biological and mechanical waste treatment infrastructure, and a neglect in harnessing community-based strategies for a comprehensive solution. To truly evolve the current system, it's imperative to embrace novel methodologies that not only support the government's endeavors in refining waste management in Nigeria but also lead to sustainable outcomes in the realm of MSW management.

Keywords: Solid Waste Management, Household waste, Pollution

1.0 INTRODUCTION

The human footprint on the environment has reached a staggering level of intensity, affecting every corner of the globe, because of the ever-growing population and their elevated consumption patterns (Khitoliya, 2004). The degradation of the environment is being exacerbated by various factors, with population growth and industrialization playing a significant role. This widespread phenomenon is not only impacting natural surroundings, but it is also leading to an enormous production of solid waste that further burdens our planet (Rao, 2006). The cities are facing a formidable issue of solid waste accumulation, which stems from the influx of people from rural areas to urban centres in search of employment and improved living conditions (Promise I, et al., 2023). However, the haphazard disposal of this waste has led to significant environmental problems, such as pollution of the air, soil and land, thereby affecting the standard of living in these areas (Promise I, et al., 2023).

Solid waste management has been a major topic of discussion recently because of its effects on the attainment of the Sustainable Development Goals. Solid waste management has both direct and indirect impacts on all 17 sustainable development goals. As a result, all hands must be on deck to control how we manage our waste, as it is a driving force in achieving the SDGs 11 and 12, to be specific. The vast volume of solid waste generated sub-Saharan African ends up in an uncontrolled open landfill or open dumpsite, posing a significant health and environmental concern to those who live nearby (Godfrey, et al., 2019). Due to cost constraints, most developing countries are unable to adopt sanitary landfills (Nevzorova & Kutcherov, 2019). Krystosik, et al., (2020) concluded that more waste is dumped in open dumpsites rather than in supervised landfills, putting locals at danger of contracting diseases. On the cities' roadsides, you can find these kinds of open dumpsites, which are breeding grounds for mosquitoes. Solid waste has become one of the most prominent environmental problems in Nigeria's cities because of inefficient waste management systems (Ozoh, et al., 2021). Garbage litters the highway, streams, and rivers, as well as several other urban open places (Ozoh, et al., 2021).

According to (Navarro & Torretta, 2019), hardly one-third to half of developing-country solid waste is collected and disposed of appropriately. The remaining waste is either littered on the street or ends up in an uncontrolled landfill or dumpsite. (Omolawal & Shittu, 2016) observed that, despite the need of appropriate solid waste disposal in cities, emerging nations such as Nigeria lag in this regard. (Okwesili, et al., 2016) concluded that most of the waste in Nigerian cities is always disposed of in an unsustainable manner, sometimes in an open dumpsite, on the streets, in rivers, and in the water drainage system, which might contaminate the water source and have an adverse effect on the health of the residents.

Nigeria is a prime example of countries in Sub-Saharan Africa (SSA) struggling with persistent waste management challenges (Adedara, et al., 2023). With a population of over 210 million individuals, as projected by the World Bank (The Worldbank, 2022) Nigeria's population growth rate stands at a staggering 2.4% annually - higher than the global average. The country's rapid pace of urbanization, coupled with an unequal distribution of wealth, brought on by its

vast oil wealth, are contributing factors to the increasing waste problem (The Economists, 2023). This study focuses on examining the management of Municipal Solid Waste (MSW) in Oyo State, Nigeria.

In Oyo State, Nigeria commonly referred to as "the pacesetter state", there is a prevailing issue of uncontrolled solid waste disposal, with unsightly piles of garbage strewn across various parts of the state. A substantial portion of the waste generated within the state is inappropriately discarded along roadsides, unauthorized dumping grounds, water channels, and open spaces, leading to detrimental environmental consequences (Agwu, 2012). Such mismanagement not only poses a threat to public health but also disrupts biodiversity and ecological balance, particularly when waste is not properly collected and disposed of (Agwu, 2012). The subpar waste management techniques prevalent in Oyo State can be ascribed to limited governmental funding, insufficient facilities, ineffective execution of environmental safeguard policies, and widespread poverty (Omolawal & Shittu, 2016). Consequently, environmental dilemmas such as contamination of water, air, and soil have arisen. Open-air dumpsites, widespread in numerous localities, pose a significant environmental and health risk to their inhabitants. Against this backdrop, the current research endeavors to delve into the obstacles faced in materializing sustainable waste management in Oyo State, Nigeria. The study further seeks to offer data-driven recommendations to guide future waste management strategies and policies in the state, ultimately fostering an environment that is clean and conducive to the health and well-being of its inhabitants.

2.0 MATERIALS AND METHODS

2.1 Study Area

Oyo State, is situated in the southwestern region of Nigeria, stands as an inland state renowned for its historical and cultural eminence (The Wikipedia, 2023). Nestled within its borders lies the capital city of Ibadan, an urban centre that holds the notable distinction of being the third most densely populated city in Nigeria and, in bygone eras, ranked as the second most populous city across the entire African continent (Golub, 2019). Sharing its borders with Kwara State to the north, Osun State to the east, and Ogun State as well as the Republic of Benin to the southwest, Oyo State occupies a strategically significant location in the heartland of the nation (Golub, 2019). Remarkably, it stood as the fifth most populous state in Nigeria, boasting a projected populace of 7,840,864 inhabitants in the year 2016 (The Wordbank, 2023). Oyo State encompasses 33 Local Governments (Figure 2.9) and 29 Local Council Development Areas (The Wikipedia, 2023). The State encompasses a total landmass of 28,454 square kilometres. Oyo State exhibits an equatorial climate characterized by alternating dry and wet seasons, accompanied by relatively high humidity levels (The Wikipedia, 2023). The dry season endures from November to March, while the wet season commences in April and culminates in October. The average daily temperature ranges between 25 °C (77.0 °F) and 35 °C (95.0 °F), almost uniformly throughout the year (The Wikipedia, 2023).

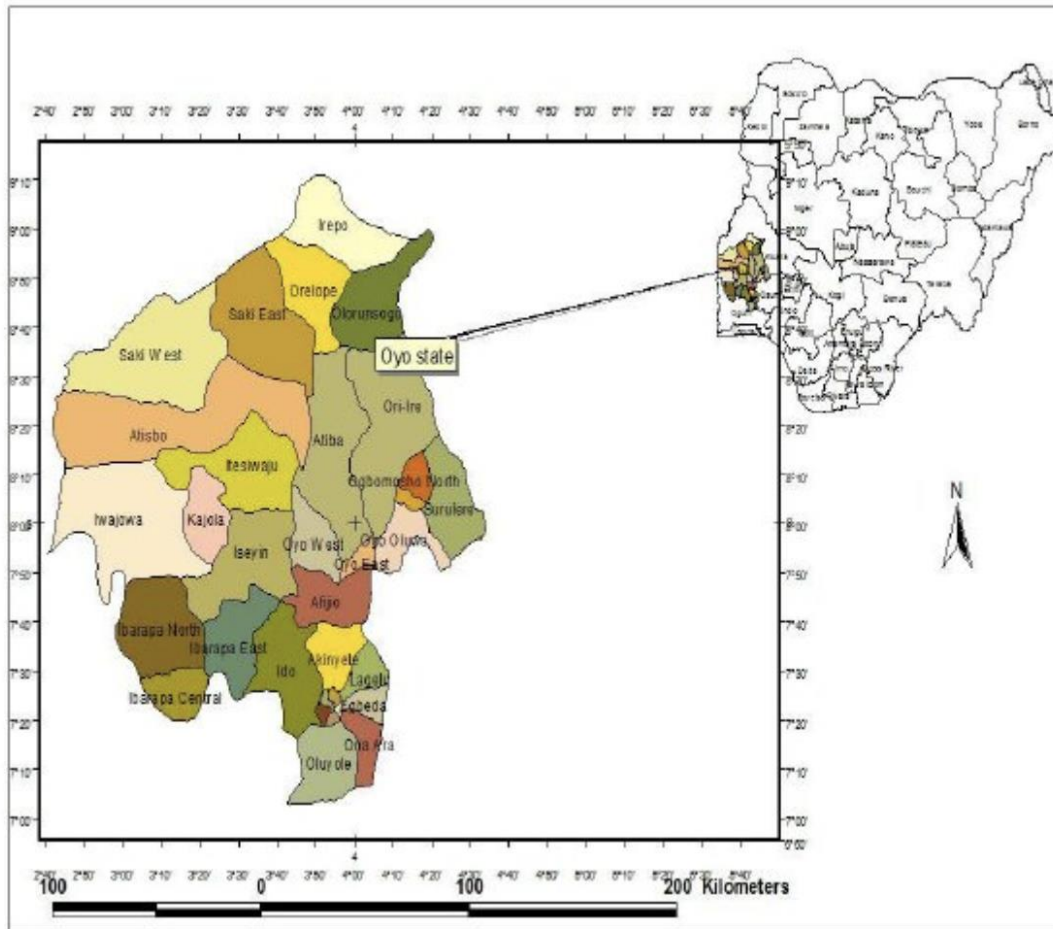


Figure 1: Map of Oyo State showing 33 Local Government. Source: (Bello, et al., 2016)

2.2 Data Collection and Analysis

For this research, data and insights were gleaned from two distinct categories of sources, namely primary and secondary.

- i. **Primary Sources:** Field visits to the study area played a crucial role in the primary data collection process. Comprehensive field inspections of the predominant waste dumpsites in the designated area were executed, during which visual documentation was carried out through photography. In addition, primary data were collected by the used of questionnaire from the households within the study area.
- ii. **Secondary Sources:** Apart from the direct data garnered from primary sources, the study also leveraged insights from dialogues with a diverse set of stakeholders encompassing environmental specialists and policy makers. Additionally, a compendium of written resources—encompassing academic journals, conference transcripts, educational books, and similar literature—formed an integral part of the secondary data compilation.

3.0 RESULTS AND DISCUSSION

The study reveals that the primary factors contributing to the difficulties in managing municipal solid waste (MSW) in Nigeria include the absence of individual waste bins in households, the reluctance to practice composting, the non-enforcement of laws against littering, and the insufficient promotion of partnerships between the public and private sectors. Consequently, the research categorizes its core insights into the obstacles faced and potential repercussions, alongside proposing viable strategies for waste management. Recognizing the implications for soil and water conservation is critical, especially considering that waste in landfills can pose severe risks to public and environmental health. These risks range from groundwater contamination and soil pollution with toxic metals to the escalation of greenhouse gas emissions and the release of volatile organic compounds (VOCs).

Urban centers in developing nations often struggle with the pollution of ground and surface water due to organic, inorganic, and microbial contaminants from landfill leachate. This is a pressing concern. The creation of leachate, a landfill byproduct, happens when the moisture level in the waste exceeds the field capacity, which is the maximum amount of water that waste material can absorb (Kamaruddin et al., 2017). The feedback from study participants sheds light on these challenges and the corresponding countermeasures, which will be further explored in the discussion section.

3.1 Challenges

In Oyo State and Nigeria at large, the hierarchy of Solid Waste Management (SWM) practices, which prioritizes reduction, reuse, recycling, and composting, is overshadowed by the predominant reliance on landfilling. Despite the commendable efforts of the Oyo State Solid Waste Management Authority (OYOWMA) in maintaining cleanliness, Nigeria lacks a comprehensive waste management policy. This absence has led to the ubiquity of open dumps in urban areas as shown in Figure 1. Waste accumulation at various public places becomes a temporary fixture, inviting pests and contributing significantly to urban air pollution (See figure 2).

Research, such as that by Adeloju et al. (2018), has delved into the hazards associated with landfill operations, focusing on diverse pollutants through various methodologies. The study by Adeloju et al. (2018) specifically investigated the concentration of heavy metals in landfills. Singh et al. (2016) warn of the potential threat these landfills pose to groundwater, soil, and vegetation due to heavy metals, along with their role in greenhouse gas emissions. These metals persist in landfills for extended periods—potentially up to 150 years at a leaching rate of 400mm/year—since they do not biodegrade.

Further research by Vaccari et al. (2018) and Alizamir et al. (2023) indicate that rainfall significantly influences the migration of heavy metals by affecting leachate production. The implication is that the farther from the landfill, the lesser the risk of pollution. Landfill leachate is primarily produced when rainwater filters through waste layers, accumulating at the landfill's base. The organic portion of municipal solid waste stands out as the most nutrient-dense part

of the leachate, according to studies by Alizamir et al. (2023).

Ibadan, among other Nigerian cities, is grappling with the acute issue of pollution in its ground and surface waters, with pollutants of varied nature infiltrating these vital resources as a result of leachate seepage, a situation that has become critical and necessitates prompt action (Egbinola & Amanambu, 2014). Therefore, it is paramount for the state authorities to develop controlled and scientifically designed landfill sites to prevent the spread of this contamination, which not only threatens water sources but also compromises the soil's integrity and its ecological functions.

While Nigeria's legal framework acknowledges the imperative of managing hazardous waste responsibly, the reality calls for a comprehensive national plan to tackle such waste. Present disposal practices, which include incineration, chemical treatment, and landfilling, often overlook recovery and recycling methods. Those residing in impoverished rural communities, who frequently come into contact with hazardous substances, are particularly vulnerable due to their socioeconomic conditions, the absence of stringent regulatory mechanisms, illiteracy, and a dearth of vital information and training. Dangerous practices, such as repurposing containers that once held hazardous materials for everyday storage, are widespread and pose additional health risks (Abba et al., 2020).

Hazardous waste, encompassing a wide range of potentially dangerous materials, including solids, liquids, gases, or sludges, can come from discarded commercial products or manufacturing by-products. Such materials are identified by characteristics like flammability, reactivity, corrosivity, and toxicity, making them a significant concern for public health and environmental safety (Abba et al., 2020).

Medical facilities produce waste that can include toxic substances, potentially causing disease if mishandled. Collaboration between hospital administrations and waste management entities is crucial to ensure proper handling, transport, and disposal of such biomedical waste to prevent the spread of infections. While incineration is a viable treatment method, improperly managed incinerators could exacerbate the problem by releasing harmful emissions into the air, thus contributing to severe pollution.

With regards to preserving soil and water quality, indiscriminate and unregulated disposal of industrial waste, such as sewage or untreated effluents into water bodies, poses a severe threat by polluting them, thereby harming aquatic ecosystems and rendering the water unsuitable for consumption or agricultural use.

In Oyo State, the current approach to managing city waste involves depositing all sorts of refuse into widespread informal dumps. These are often found in depressions or low-lying areas within communities, where trash accumulates without proper containment, leading to numerous ecological hazards. The proximity of these dumps to living spaces is particularly concerning. The ideal waste management hierarchy, which prioritizes processing, recycling,

and composting, is unfortunately not the norm. Instead, due to the absence of such facilities, the bulk of waste in Oyo State appears to be funneled directly to these rudimentary dumpsites, a trend mirrored in many Nigerian urban centers.

The best practices for waste disposal involve the use of structured landfills, designed to securely contain waste after it has been treated biologically or thermally at specialized plants and deemed irreducible or non-recyclable. These sophisticated landfills are engineered to minimize environmental impact, unlike the open, unregulated sites currently in use.



Figure 1: Solid waste dumped at middle of the road in Dugbe Market Ibadan, Oyo State.



Figure 2: Over filled waste container in Akesan Market Oyo.

3.2 Mitigation Measures

To address the environmental challenges and solid waste management in Nigeria, the government and stakeholders must implement multifaceted strategies. These strategies should encompass:

- **Educational and Behavioral Change Initiatives**

Ongoing efforts should be made to conduct educational programs aimed at both urban and rural populations, emphasizing the importance of a clean environment and proper waste management. Key points for these educational campaigns include:

1. **Enhancing Public Understanding:** It is crucial to raise awareness about the entire spectrum of solid waste management. The public needs to be informed about the processes involved in waste handling, from domestic segregation to the economics of disposal, including the necessity of supporting these systems financially and collaborating with sanitation workers.
2. **Institutional and Legislative Frameworks:** Understanding existing and forthcoming environmental legislation is essential. This calls for a collaborative approach between government agencies and private entities in the implementation and adherence to these laws.

These seminars should also serve as platforms for capacity building for those directly involved in waste management, such as environmental engineers and public health professionals. The involvement of legislative bodies, non-governmental organizations, and religious institutions is vital in these educational endeavors.

- **Innovative Problem-Solving through Stakeholder Engagement**

Bringing together residents, community leaders, government officials from various levels, and legislative representatives can foster the exchange of innovative ideas and the development of effective waste management strategies at all government levels.

- **Responsibility and Accountability in Waste Generation**

Industry leaders and community heads should enforce accountability in waste generation, ensuring proper segregation and transportation to designated disposal sites, especially for non-biodegradable materials. This also applies to hazardous waste, where improper handling poses significant environmental threats.

- **Advocacy for Composting**

Composting is a process that has been used effectively in the agricultural sector for centuries. It involves the biological breakdown of organic matter into a nutrient-rich substance that can enhance soil quality. Despite the high percentage of biodegradable material in urban waste, much of it ends up in landfills, causing sanitation and environmental issues.

The benefits of composting are manifold, including reducing waste volume, saving transportation and disposal costs, and mitigating the negative impacts of landfills such as groundwater pollution and methane emissions. Encouraging local composting can greatly alleviate these issues.

In places like India, numerous cities have adopted composting with varying degrees of success. However, composting should ideally be done separately from mixed waste to avoid contamination and ensure the quality of the compost produced.

- **Support for Community-based Solutions**

There is a need for government bodies and non-profit organizations to provide the necessary resources for community-based composting facilities. This includes land, water, electricity, and training for proper operation and maintenance. Establishing these facilities can significantly aid in the reduction of waste and improve soil health in urban areas.

- **Economic Opportunities through Waste Management**

Waste management can create job opportunities in areas such as collection, sorting, composting, and selling recycled materials to businesses like farms and fertilizer manufacturers. It is important for the government to facilitate these economic incentives to promote sustainable waste practices.

- **Advocating for waste recycling**

Sanitation workers can play a pivotal role in waste management by sorting recyclable materials and selling them to either middlemen or directly to recycling plants. Globally, especially in industrialized nations, municipal authorities often spearhead recycling initiatives with support from national legislation. Economic incentives are tailored to encourage segregation and recycling, adhering to the principle of "the polluter pays". This means that costs escalate with the amount of waste produced, incentivizing waste minimization and recycling through financial benefits.

In line with this, if the infrastructure is conducive, residents are likely to engage more actively in sorting and recycling if it leads to savings on waste disposal fees. The European Union, for example, has made significant strides in reducing reliance on landfills, treating them as a last-resort option. The push for recycling has seen substantial growth, with the recycling rate climbing from 7% in 1990 to 15% in 2002, with notable success in materials like paper, metal, glass, and rubber. Plastics remain a challenge due to technical and financial hurdles. This approach to recycling can significantly reduce the volume of waste that ends up in landfills—potentially by up to 25%. Additionally, steering organic waste away from landfill sites could lower the overall volume of landfill waste by an additional 15%.

4.0 CONCLUSION

Emphasizing the importance of a clean urban environment and the achievement of Sustainable Development Goal 11 requires a collective effort from both the government and its citizens. In Nigeria, especially in economically vibrant states like Oyo, there's an urgent need to address the inefficiencies in municipal solid waste management that accompany rapid urban growth.

The negative impacts of poor waste disposal, from health crises to environmental pollution, are well-documented.

This paper has tackled the pressing issues of waste management in Oyo State and Nigeria at large, proposing practical solutions for enhancing the region's waste management systems. Effective waste management is a collective responsibility that extends beyond individual actions to encompass community-wide engagement, with oversight from relevant governmental bodies.

Public participation is crucial in the execution of waste management strategies. This study aims to raise awareness among all stakeholders about the severity of the waste management crisis and to offer viable solutions. The implementation of the recommended strategies is expected to significantly mitigate the prevalent practices of unsafe, unsound, and unsanitary waste disposal in Nigerian cities.

Throughout this discourse, the study has offered insights into improving waste handling by advocating for the recycling of non-biodegradable materials, composting organic waste, and utilizing incineration for waste-to-energy conversion. It stresses the importance of segregating waste at the source to prevent the co-disposal of biodegradable and non-biodegradable waste in landfills. The study argues against current disposal methods, suggesting that composting could enhance soil fertility through carbon and nutrient-rich compost, countering the negative effects of greenhouse gases associated with landfilling organic matter.

Research, including Song et al. (2009) work, indicates that landfills containing biodegradable waste pose a significant challenge due to the production of methane, a potent greenhouse gas. Nonetheless, this landfill gas can be harnessed for energy, presenting an opportunity to transform a problem into a beneficial resource.

5.0 RECOMMENDATIONS

In line with practices from advanced countries such as United Kingdom, the following actions could substantially enhance the management of Municipal Solid Waste (MSW) in Oyo State and across Nigeria:

- **Introduction of Segregated Waste Bins:** Encouraging homes to use separate bins for different types of waste: one for compostable food scraps, another for recyclables, and a third for hazardous materials.
- **Household Composting Initiatives:** Advocating for the composting of organic waste like kitchen scraps, yard leaves, and vegetable peels, particularly in homes with available outdoor space.
- **Ban on Street Waste Disposal:** Implementing strict regulations to prevent the disposal of waste in public areas, instead establishing a systematic door-to-door collection or centralized bin collection system to maintain cleanliness and prevent pollution of land and water sources, which can lead to issues such as eutrophication.

- **Fostering Public-Private Partnerships:** Encouraging collaborations between governmental bodies and private sector entities to enhance waste management infrastructure and services.
- **Development of Advanced Landfill Sites:** The construction of modern, scientifically managed landfill sites is crucial. These sites should be designed with impermeable liners at the base to prevent leachate from contaminating groundwater systems. Additionally, the collected leachate, rich in vital plant nutrients, could be processed and repurposed as a fertilizer, contributing to more sustainable agricultural practices.

By adopting these measures, not only would waste management be more efficient, but it would also turn potential pollutants into valuable resources, aligning with global environmental management practices.

REFERENCES

- Abba, S., Yusuf, A. R., & Kabir, N. (2020). Management of Hazardous Waste in Nigeria, a proposed strategy for regulators, operators and businesses. *Journal of Scientific and Engineering Research*, 7(2), 89–96.
- Adedara, M. L., Taiwo, R., & Bork, H.-R. (2023). Municipal Solid Waste Collection and Coverage Rates in Sub-Saharan African Countries: A Comprehensive Systematic Review and Meta-Analysis. *Waste*, 1(2), 389–413. <https://doi.org/10.3390/waste1020024>
- Adelopo, A. O., Haris, P. I., Alo, B. I., Huddersman, K., & Jenkins, R. O. (2018). Multivariate analysis of the effects of age, particle size and landfill depth on heavy metals pollution content of closed and active landfill precursors. *Waste Management*, 78, 227–237. <https://doi.org/10.1016/j.wasman.2018.05.040>
- Agwu, M. (2012). Issues and Challenges of Solid Waste Management Practices in Port-Harcourt City, Nigeria- a behavioural perspective. *American Journal of Social and Management Sciences*, 3(2), 83–92. <https://doi.org/10.5251/ajsms.2012.3.2.83.92>
- Alizamir, M., Kazemi, Z., Kazemi, Z., Kermani, M., Kim, S., Salim Heddami, Özgür Kisi, & Chung, I.-M. (2023). Investigating Landfill Leachate and Groundwater Quality Prediction Using a Robust Integrated Artificial Intelligence Model: Grey Wolf Metaheuristic Optimization Algorithm and Extreme Learning Machine. *Water*, 15(13), 2453–2453. <https://doi.org/10.3390/w15132453>
- Bello, K. O., LA Alebiosu, Lala, A. O., Irekhore, O. T., & Oduguwa, O. O. (2016). *Characteristics of commercial poultry and spatial distribution of metabolic and behavioural diseases in Oyo State, Nigeria*. 13(3), 31–31. <https://doi.org/10.4314/sokjvs.v13i3.6>
- Egbinola, C. N., & Amanambu, A. C. (2014). Groundwater contamination in Ibadan, South-West Nigeria. *SpringerPlus*, 3(1). <https://doi.org/10.1186/2193-1801-3-448>
- Godfrey, L., Tawfic Ahmed, M., Giday Gebremedhin, K., H.Y. Katima, J., Oelofse, S., Osibanjo, O., Henning Richter, U., & H. Yonli, A. (2019). Solid Waste Management

- in Africa: Governance Failure or Development Opportunity? *Regional Development in Africa* . <https://doi.org/10.5772/intechopen.86974>
- Golub, K. (2019, January 8). *Which is the largest city in Africa: Lagos vs. Ibadan city*. Legit.ng - Nigeria News. <https://www.legit.ng/1212538-is-ibadan-largest-city-africa.html>
- Kamaruddin, M. A., Yusoff, M. S., Rui, L. M., Isa, A. M., Zawawi, M. H., & Alrozi, R. (2017). An overview of municipal solid waste management and landfill leachate treatment: Malaysia and Asian perspectives. *Environmental Science and Pollution Research*, 24(35), 26988–27020. <https://doi.org/10.1007/s11356-017-0303-9>
- Khitoliya, R. K. (2004). *Environmental Pollution Management and Control for Sustainable Development*. S. Chand and Company, New Delhi, 309 p.
- Krystosik, A. R., Njoroge, G., Odhiambo, L., Forsyth, J. E., Mutuku, F. M., & A. Desiree LaBeaud. (2020). *Solid Wastes Provide Breeding Sites, Burrows, and Food for Biological Disease Vectors, and Urban Zoonotic Reservoirs: A Call to Action for Solutions-Based Research*. 7. <https://doi.org/10.3389/fpubh.2019.00405>
- Navarro Ferronato, & Torretta, V. (2019). *Waste Mismanagement in Developing Countries: A Review of Global Issues*. 16(6), 1060–1060. <https://doi.org/10.3390/ijerph16061060>
- Nevzorova, T., & Kutcherov, V. (2019). Barriers to the Wider Implementation of Biogas as a Source of energy: a state-of-the-art Review. *Energy Strategy Reviews*, 26, 100414. <https://doi.org/10.1016/j.esr.2019.100414>
- Okwesili, J., Chinyere, N., & Chidi Iroko, N. (2016). Urban Solid Waste Management And Environmental Sustainability In Abakaliki Urban, Nigeria. *European Scientific Journal, ESJ*, 12(23), 155. <https://doi.org/10.19044/esj.2016.v12n23p155>
- Omolawal, S. A., & Shittu, O. S. (2016). *CHALLENGES OF SOLID WASTE MANAGEMENT AND ENVIRONMENTAL SANITATION IN IBADAN NORTH LOCAL GOVERNMENT, OYO STATE, NIGERIA*. ResearchGate; ResearchGate. https://www.researchgate.net/publication/307510197_CHALLENGES_OF_SOLID_WASTE_MANAGEMENT_AND_ENVIRONMENTAL_SANITATION_IN_IBADAN_NORTH_LOCAL_GOVERNMENT_OYO_STATE_NIGERIA
- Ozoh, A. N., Longe, B. T., Akpe, V., & Cock, L. E. (2021). *Indiscriminate Solid Waste Disposal and Problems with Water-Polluted Urban Cities in Africa*. ResearchGate; ResearchGate. https://www.researchgate.net/publication/357447861_Indiscriminate_Solid_Waste_Disposal_and_Problems_with_Water-Polluted_Urban_Cities_in_Africa
- Promise I, E., Gideon W, K., & Ruth I, D. (2023). Suitability mapping of solid waste disposal sites in Obio/Akpor local government area: rivers state of Nigeria. *MOJ Ecology & Environmental Sciences*, 8(1), 1, 2. <https://doi.org/10.15406/mojes.2023.08.00266>
- Rao, C. S. (2006). *Environmental pollution control engineering*. New Age International.
- Singh, S., Raju, N. J., Gossel, W., & Wycisk, P. (2016). Assessment of pollution potential of leachate from the municipal solid waste disposal site and its impact on groundwater quality, varanasi environs, india. *Arabian Journal of Geosciences*, 9(2). <https://doi.org/10.1007/s12517-015-2131-x>

- Song, J. H., Murphy, R. J., Narayan, R., & Davies, G. B. H. (2009). Biodegradable and compostable alternatives to conventional plastics. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 364(1526), 2127–2139. <https://doi.org/10.1098/rstb.2008.0289>
- The Economist*. (2023). The Economist; The Economist. <https://www.economist.com/search?q=Nigeria>
- The Wikipedia. (2023). *Oyo state*. Wikipedia; Wikimedia Foundation. https://en.wikipedia.org/wiki/Oyo_State
- The Worldbank. (2022). *Population, total - Nigeria | Data*. Worldbank.org. <https://data.worldbank.org/indicator/SP.POP.TOTL?locations=NG>
- Vaccari, M., Vinti, G., & Tudor, T. (2018). An Analysis of the Risk Posed by Leachate from Dumpsites in Developing Countries. *Environments*, 5(9), 99. <https://doi.org/10.3390/environments5090099>