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# Evaluation of Solid Waste Generation Trends Across Nigeria for Sustainable Management

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## Abstract

*This study presents an extensive review of literature on solid waste management trends in Nigeria and also an in-depth assessment of solid waste generation across Nigeria's 36 states, with estimates based on 2023 population data and state-specific factors such as urbanization, industrial activity, and economic status. Using World Bank estimates of 0.51 kg/person/day as a baseline, per-capita waste generation rates were adjusted for each state. Highly urbanized and industrialized areas like Lagos, Rivers, Kano, and FCT were assigned higher rates (0.60–0.65 kg/day), while moderately urbanized states such as Delta, Enugu, and Edo received lower rates (0.53–0.55 kg/day). Less urbanized or rural states, including Yobe, Taraba, and Jigawa, were assigned the lowest rates (0.43–0.45 kg/day). The daily waste generation for each state was calculated by multiplying its population by the adjusted per-capita waste rate, and the total was converted from kilograms to tonnes. Annual waste generation was then derived by multiplying daily waste output by 365 days. This method provided detailed estimates of waste generation across the country, reflecting both population size and state-specific characteristics.The results revealed that states like Lagos, Kano, and the FCT stand out as the highest waste-generating regions, followed by Rivers and Oyo which are moderate; states such as Yobe, Taraba, and Bayelsa generate significantly lower volumes of waste. The study recommended the development of state-specific waste management plans, prioritize the establishment and expansion of recycling programs and waste-to-energy technologies while encouraging private sector involvement in waste management through public-private partnerships (PPPs) among others*

**Keywords**: solid waste, generation, Nigeria, management, states

## INTRODUCTION

Solid waste management is a critical global environmental challenge. Poor handling poses severe health and environmental risks, undermining sustainability (Yusuf et al., 2019; Faridah et al., 2024). Effective waste management involves generation, collection, processing, transportation, and disposal to safeguard public health (Ali & Yusuf, 2021). The United Nations Sustainable Development Goal (SDG) 12 underscores waste management as a key driver of sustainability, advocating reduction, prevention, recycling, and reuse (SDG, 2019; Adedara et al., 2023). Several factors shape waste management efficiency in developing countries (Orhorhoro & Oghoghorie, 2019; Nwosu & Chukwueleka, 2020).

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Uncontrolled waste accumulation threatens health, economy, and environment. Dumping and open defecation contribute to air pollution and attract disease-carrying vectors like flies and mosquitoes, leading to outbreaks of cholera, malaria, and typhoid (United Nations Environment Programme, 2020). Okafor et al. (2022) highlight that poorly managed household waste fosters disease transmission. Increasing waste generation, driven by consumption patterns, urbanization, and industrialization, exacerbates these risks, including environmental degradation and flooding (Zhang et al., 2021). The World Bank (2019) estimated global solid waste production at 1.3 billion tons in 2012, rising to 2.01 billion in 2018, with a projected increase to 3.4 billion tons by 2050.

Waste generation correlates with economic development, population growth, and industrialization (Orhorhoro & Oghoghorie, 2019). Many developing nations lack clear regulations, causing inconsistent enforcement (Ifeoluwa, 2019; Stanley & Owhor, 2018). In Nigeria, ineffective policies and weak enforcement result in waste accumulation in urban areas (Somorin et al., 2017; Ezeah & Roberts, 2014). The Federal Environmental Protection Agency (FEPA), established in 1988, aimed to ensure safe waste disposal, environmental monitoring, and compliance enforcement (Nduka, 2021). However, waste mismanagement persists, with up to 40% of urban waste left uncollected, clogging drainage systems and polluting water sources (Aliu et al., 2014).

In response, Nigerian states established waste management agencies, such as Lagos State Waste Management Agency (LAWMA) and Kano State Refuse Management Board (Gani et al., 2013). These agencies implement strategies including traditional collection and disposal, waste minimization (reduction, reuse, recycling), and technological interventions (GIS, GPS, remote sensing) (Yan & Waluyo, 2020; Yusuf et al., 2019). However, scholars identify persistent challenges—bureaucracy, financial constraints, and inadequate coverage—limiting their effectiveness (Nwosu & Chukwueleka, 2020; Ikelle et al., 2023; Ali & Yusuf, 2021).

Nigerian cities remain among the world's dirtiest due to indiscriminate waste disposal (Ezeah & Roberts, 2014). Studies reveal illegal dumpsites in Ibadan undergoing hazardous transformations due to high temperatures (Faridah et al., 2024). Similarly, inadequate collection systems in Asaba result in unregulated waste dumping (Ifeoluwa, 2019; Stanley & Owhor, 2018). Addressing these issues requires a thorough understanding of waste generation trends.
This study estimates solid waste generation across the 36 states and the Federal Capital Territory (FCT). Identifying state-specific waste production rates will provide insights for policymakers, urban planners, and environmental agencies to develop effective strategies, mitigate health risks, and promote sustainability.

## METHODOLOGY

This study is quantitative descriptive research, using secondary data from the National Population Commission and World Bank to estimate the daily and annual solid waste generation for each state in Nigeria. The study first gathered the most recent population figures for each of Nigeria's 36 states and per capita waste generation from the World Bank, the study assigned a rate for each state, considering factors such as urbanization, industrial activity, and economic status. These rates were based on World Bank estimates (0.51 kg/person/day) and adjusted for each state's characteristics. Highly urbanized and industrialized states like Lagos, Rivers, Kano, and the Federal Capital Territory (FCT) were assigned higher rates (0.60–0.65 kg/day), while moderately urbanized states like Delta, Enugu, and Edo were given slightly lower rates (0.53–0.55 kg/day). Less urbanized or rural

states like Yobe, Taraba, and Jigawa were assigned lower rates (0.43–0.45 kg/day). The daily waste generation for each state was then calculated using the formula

$$\text{Daily Waste Generation (tonnes)} = \frac{\text{Population} \times \text{Per Capita Waste (kg/day)}}{1000}$$

*Source*: Worldbank 2023; NPC 2023

This calculation converts the waste generated per person per day from kilograms to tonnes. The annual waste generation was calculated by multiplying the daily waste generation by 365 days to get the total annual waste for each state. This method provided a detailed estimate of solid waste generation across Nigeria, taking into account the variations in population size and state-specific characteristics. Among the most solid waste generated across the country, there are biodegradables, mostly from domestic; non-biodegradables, such as plastic waste, mostly from industries; construction waste; medical waste; and others mixed waste such as papers, textiles, e-wastes among others (Ali & Yusuf, 2021)

## RESULTS AND DISCUSSION

### Results

The table 1 presents the annual waste generated by each state (as at 2023) of Nigeria, derived from the daily per capital solid waste generation from Worlbank and National population commission.

*Table 1:* Solid Waste Generation in Nigeria as at 2023

| SN | States | Population | Per Capita Waste (kg/day) | Daily Waste (Tonnes) | Annual Waste (Tonnes) |
|---|---|---|---|---|---|
| 1. | Kano | 16,253,549 | 0.60 | 9,752.13 | 3,559,527.23 |
| 2. | Lagos | 15,772,884 | 0.65 | 10,252.37 | 3,742,116.73 |
| 3. | Katsina | 9,300,382 | 0.51 | 4,743.19 | 1,731,266.11 |
| 4. | Kaduna | 8,324,285 | 0.58 | 4,828.09 | 1,762,251.13 |
| 5. | Bauchi | 7,540,663 | 0.44 | 3,317.89 | 1,211,030.48 |
| 6. | Oyo | 7,512,855 | 0.57 | 4,282.33 | 1,563,049.48 |
| 7. | Anambra | 5,299,910 | 0.51 | 2,702.95 | 986,578.25 |
| 8. | Rivers | 7,234,973 | 0.62 | 4,485.68 | 1,637,274.39 |
| 9. | Jigawa | 6,979,080 | 0.44 | 3,070.80 | 1,120,840.25 |
| 10. | Niger | 6,720,617 | 0.44 | 2,957.07 | 1,079,331.09 |
| 11. | Benue | 6,687,706 | 0.5 | 3,343.85 | 1,220,506.35 |
| 12. | Borno | 6,651,590 | 0.43 | 2,860.18 | 1,043,967.05 |
| 13. | Ogun | 6,445,275 | 0.54 | 3,480.45 | 1,270,430.85 |
| 14. | Sokoto | 6,163,187 | 0.44 | 2,711.80 | 989,807.42 |
| 15. | Delta | 6,107,543 | 0.55 | 3,358.15 | 1,225,424.75 |
| 16. | Imo | 6,067,722 | 0.54 | 3,276.47 | 1,195,891.55 |
| 17. | Kebbi | 6,001,610 | 0.43 | 2,580.69 | 941,938.85 |
| 18. | Ondo | 5,469,707 | 0.53 | 2,899.94 | 1,058,478.10 |
| 19. | Akwa Ibom | 5,780,581 | 0.53 | 3,063.91 | 1,118,333.77 |
| 20. | Zamfara | 5,517,793 | 0.43 | 2,372.65 | 865,997.49 |
| 21. | Plateau | 5,400,974 | 0.52 | 2,808.51 | 1,024,107.52 |
| 22. | Enugu | 5,396,098 | 0.55 | 2,967.85 | 1,083,262.76 |
| 23. | Adamawa | 5,236,948 | 0.51 | 2,670.84 | 974,857.87 |
| 24. | Edo | 5,161,137 | 0.53 | 2,734.40 | 998,056.10 |
| 25. | Kogi | 5,053,734 | 0.50 | 2,526.87 | 922,304.85 |
| 26. | Abia | 4,841,943 | 0.50 | 2,420.97 | 883,654.60 |
| 27. | FCT | 4,802,443 | 0.63 | 3,025.54 | 1,104,321.77 |
| 28. | Gombe | 4,623,462 | 0.44 | 2,034.32 | 742,528.00 |
| 29. | Yobe | 4,350,401 | 0.45 | 1,957.68 | 714,553.36 |
| 30. | Taraba | 4,331,885 | 0.45 | 1,949.35 | 711,512.11 |

| | | | | | |
|---|---|---|---|---|---|
| 31. | Kwara | 4,259,613 | 0.49 | 2,087.21 | 761,831.79 |
| 32. | Osun | 4,237,396 | 0.49 | 2,076.32 | 757,858.27 |
| 33. | Cross River | 4,175,020 | 0.48 | 2,004.01 | 731,463.50 |
| 34. | Ebonyi | 4,007,155 | 0.47 | 1,883.36 | 687,427.44 |
| 35. | Nasarawa | 3,632,239 | 0.46 | 1,670.83 | 609,852.93 |
| 36. | Ekiti | 3,398,177 | 0.46 | 1,563.16 | 570,553.92 |
| 37. | Bayelsa | 2,394,725 | 0.47 | 1,125.52 | 410,815.07 |
| | Total | 227,135,262 | | 117,847.33 | 43,013,003.18 |

*Source*: Author's analysis based on Worldbank, 2022; NPC, 2023 data

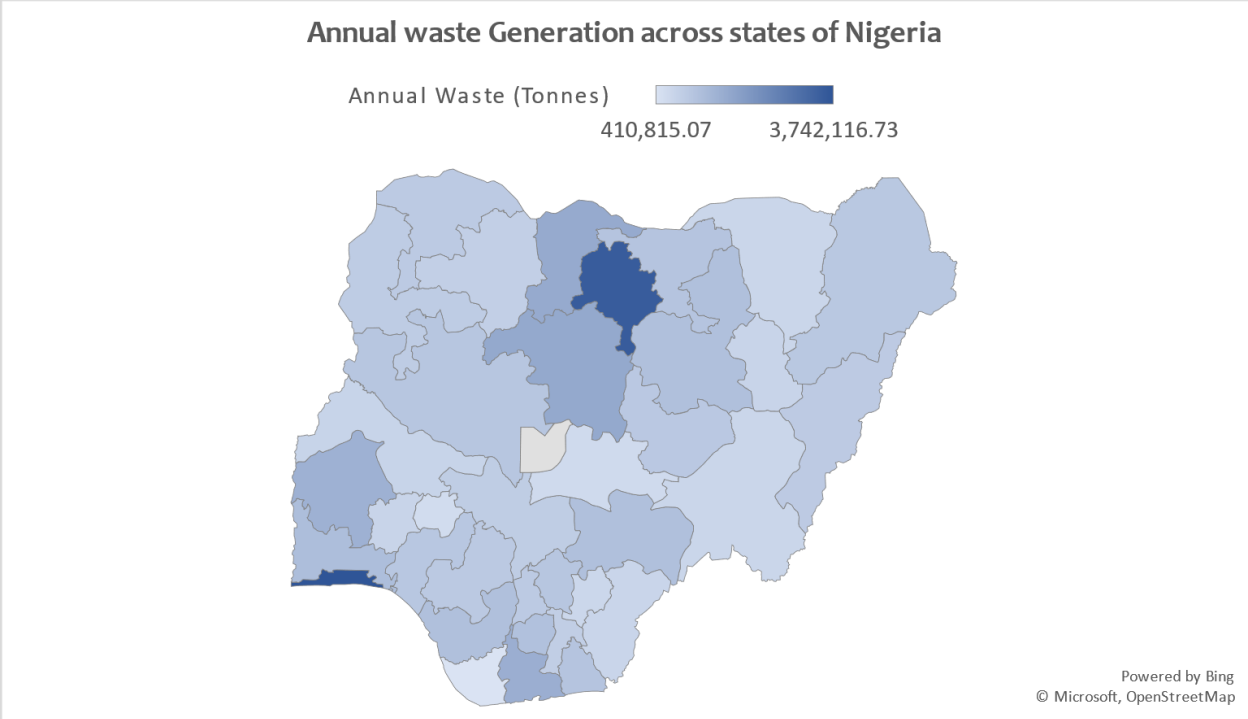


*Figure 1:* Waste generation map across states
*Source*: Author's analysis based on Worldbank, 2022; NPC, 2023 data

## DISCUSSION

The analysis of annual waste generation across the 36 Nigerian states and the Federal Capital Territory (FCT) reveals significant variations in waste production, largely driven by population size, levels of urbanization, and economic activity. States like Lagos, Kano, and the FCT stand out as the highest waste-generating regions, showing a strong correlation between urbanization, industrial activities, and population density. Lagos State leads the country, generating an estimated 3.74 million tonnes of waste annually. This is due to Lagos being Nigeria's largest city, with high levels of consumption and extensive industrial and commercial activities. Similarly, Kano State, a major commercial hub in northern Nigeria, generates around 3.56 million tonnes of waste per year. The Federal Capital Territory (FCT), despite its smaller population, produces a significant 1.10 million tonnes annually, reflecting its modern urban infrastructure and higher consumption patterns. This result is in accordance with Odiana and Ikudayisi (2021) ranking Lagos with the highest waste generation followed by Kano.

Moderately urbanized states, such as Rivers and Oyo, produce substantial waste, generating 1.64 million tonnes and 1.56 million tonnes, respectively. Rivers, being an oil-producing state, has a higher per capita waste generation rate due to industrial activities, while Oyo's major city, Ibadan, contributes to its moderate waste output. Other states like Delta, Enugu, and

Kaduna also show similar trends, with their annual waste generation ranging from 1.08 million tonnes to 1.22 million tonnes. These states are experiencing growing urbanization and industrialization, which directly influence their waste production.

In contrast, rural and less urbanized states such as Yobe, Taraba, and Bayelsa generate significantly lower volumes of waste, with annual outputs ranging between 410,815 tonnes and 711,512 tonnes. These states have lower population densities, less industrial activity, and lower consumption rates, which result in lower waste generation. Other agrarian states like Jigawa, Sokoto, and Zamfara produce similar amounts, generating less than 865,997 tonnes annually, reflecting the lower urbanization and economic activity in these areas. This finding also conformed with that of Odiana and Ikudayisi (2021) placing these states among the lowest solid waste generation.

The data highlight the urgent need for region-specific waste management strategies. In highly urbanized states like Lagos, Kano, and Rivers, large-scale, technologically advanced waste collection and recycling systems are essential to manage the high volumes of waste and prevent negative environmental impacts (Omole et al., 2016). These states require efficient systems for waste collection, recycling, and disposal, alongside public awareness campaigns to reduce waste generation at the source. Moderately urbanized states could benefit from improving their existing waste infrastructure and implementing localized recycling programs and waste-to-energy initiatives, helping them manage rising waste volumes more effectively (Yusuf et al., 2018 & Yan, et al., 2020).

In rural states, lower waste generation presents an opportunity to focus on sustainable, community-based waste management solutions, such as composting and small-scale recycling. These areas can benefit from decentralized waste management systems that focus on organic waste and low-cost technologies, which would be more suitable for the lower waste volumes they produce. This approach can help these regions manage their waste more sustainably and reduce environmental pressures.

The results also underscore the environmental and health risks associated with high waste generation in Nigeria's most urbanized areas. Poor waste management in cities like Lagos can contribute to land, air, and water pollution, leading to public health risks and the spread of infectious diseases. High waste output, if not properly managed, can also exacerbate flooding in urban areas as waste blocks drainage systems, leading to frequent waterlogging and associated health hazards. This conformed with the study of Aderemi Falade (2012) on the health implications of open dumpsites in Lagos.

## CONCLUSION

The patterns of waste generation across Nigerian states reflect variations in socio-economic conditions, levels of urbanization, and industrial activities. Urban centers with high population densities, such as Lagos, Kano, and Rivers, generate significant waste volumes, necessitating urgent improvements in waste collection, transportation, and disposal infrastructure. In contrast, rural areas produce lower waste volumes and can adopt more cost-effective, community-based solutions such as composting and small-scale recycling. A tailored approach that aligns waste management strategies with the specific needs and capacities of each region is crucial to ensuring environmental sustainability, public health protection, and efficient resource utilization. Without such region-specific interventions, waste accumulation will continue to pose serious environmental and health risks, especially in rapidly growing urban areas.

To improve waste management, state governments should develop comprehensive, region-specific waste management plans that integrate modern technologies and sustainable practices. Expanding recycling programs and waste-to-energy (WTE) technologies, particularly in high-waste-generating urban areas, can reduce landfill pressure and create economic opportunities. Public awareness campaigns focusing on the importance of proper waste disposal, recycling, and waste reduction can foster behavioral change, while schools, businesses, and communities should actively participate in waste education initiatives. Encouraging private sector involvement through public-private partnerships (PPPs) can enhance infrastructure development and operational efficiency, ensuring more sustainable waste management solutions. Additionally, stronger enforcement of waste management policies, including stricter penalties for illegal dumping and clear guidelines for waste segregation, will enhance compliance. Investing in digital waste monitoring systems will also provide accurate data for effective planning and resource allocation, ultimately leading to a cleaner and healthier environment for all.

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