Science Forum (Journal of Pure and Applied Sciences)

Journal Homepage: https://atbuscienceforum.com.ng/index.php/jpas

Environmental Impact of Plastic Waste Recycling Practices in Jos South Local Government Area, Plateau State, Nigeria

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Abstract

Plastic waste accumulation has emerged as a critical environmental challenge in Jos South Local Government Area (LGA), Plateau State, Nigeria, driven by increasing consumption patterns, rapid urbanization, and inadequate municipal waste collection systems. Although plastic recycling activities are practiced within the area, their environmental implications have not been comprehensively evaluated. This study assessed the environmental impacts of plastic waste recycling practices in Jos South LGA using a descriptive cross-sectional research design. Primary data were obtained from 82 valid respondents through structured questionnaires administered to households, waste collectors, business operators, and environmental management officials. To enhance data reliability and provide contextual insights, key informant interviews and systematic field observations were also conducted. The findings indicate that plastic recycling activities are predominantly driven by the informal sector, accounting for 68% of recycling operations within the study area. Furthermore, 62% of respondents reported that recycling activities have contributed significantly to reducing indiscriminate littering, while 54% observed a decline in drainage blockage resulting from improved plastic waste recovery. Despite these positive environmental outcomes, the effectiveness of existing recycling practices is constrained by inadequate recycling infrastructure, low levels of environmental awareness among residents, and weak implementation and enforcement of waste management policies. These limitations reduce the overall efficiency and sustainability of plastic waste management initiatives within the locality. The study concludes that enhancing plastic waste recycling through strengthened public-private partnerships, investment in modern recycling infrastructure, effective policy implementation, and sustained environmental education and public awareness programmes will significantly improve waste management efficiency, reduce environmental pollution, and promote long-term environmental sustainability in Jos South Local Government Area.

Keywords

Circular Economy;
Environmental Sustainability;
Informal Sector;
Plastic Waste Management;
Recycling Infrastructure.

ISSN 1119-4618 JPAS
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INTRODUCTION

Plastic materials have become indispensable in modern society because of their low cost, durability, lightweight nature, and versatility. However, these same properties have created significant environmental challenges due to the persistence of plastic waste in terrestrial and aquatic ecosystems. Unlike organic materials, most plastics degrade very slowly and may remain in the environment for several centuries, causing soil degradation, drainage blockage, biodiversity loss, and public health concerns. Globally, over 300 million tonnes of plastic waste are generated annually, but only a small proportion is effectively recycled (UNEP, 2021).

Nigeria stands as one of the largest contributors to plastic pollution within the African continent, generating approximately 2.5 million tonnes on an annual basis (Federal Ministry of Environment, 2020). This severe volume is exacerbated by hyper-urbanization, shifting consumer preferences toward single-use packaging, a systemic deficit in localized public environmental awareness, and a historical weakness in the enforcement of environmental laws. In Nigeria, urban waste management remains a critical challenge due to rapid population growth, unplanned urbanization, and weak institutional frameworks. Municipalities across the country struggle with soaring waste generation rates that consistently outpace the operational capacities of public environmental agencies, leading to systemic collection deficits and widespread open dumping practices (Ogbonna et al., 2018).

Recent studies have further shown that inadequate source segregation, insufficient recycling infrastructure, and weak institutional coordination continue to undermine sustainable waste management practices across many Nigerian cities (Ayeleru et al., 2020). This issue is particularly pronounced in rapidly expanding urban centers where plastic materials dominate the municipal solid waste stream.

Jos South Local Government Area (LGA) in Plateau State directly replicates these macro-environmental crises. The municipality generates significant volumes of plastic waste from commercial zones, open municipal markets, industrial hubs, and dense residential sectors. Common high density and low-density polymers such as polyethylene terephthalate (PET) beverage bottles, low-density polyethylene (LDPE) water films, and polystyrene containers frequently accumulate across vacant municipal plots, public roads, and agricultural land. Because formal institutional waste collection networks are severely limited, residents routinely resort to open dumping and open-air burning. These management defaults trigger recurrent flash flooding during seasonal rainfall, contribute to soil degradation, and reduce ambient air quality.

While recycling is theoretically established as a foundational strategy to decouple economic consumption from environmental degradation, the operational framework in Jos South LGA relies almost entirely on unregulated informal actors. Individual waste pickers and localized aggregators recover select high-value plastics, redirecting them into external processing value chains. However, there is a severe shortage of empirical documentation regarding the net environmental efficacy of these uncoordinated activities. Consequently, this study establishes a rigorous assessment of the environmental impacts of these localized

practices, identifying systematic challenges and outlining strategic interventions necessary to optimize environmental protection within the LGA.

The study specifically sought to:

1. Assess existing plastic waste recycling practices in Jos South LGA.
2. Evaluate the environmental impacts of these recycling practices.
3. Identify barriers affecting recycling effectiveness.
4. Recommend strategies for improving plastic waste management.

This study is anchored on Systems Theory (Bertalanffy, 1968) and the Circular Economy Framework (Ellen MacArthur Foundation, 2015). Systems Theory explains the interdependence of waste generation, collection, recycling, and environmental quality, while the Circular Economy Framework promotes the continuous use and recovery of materials to minimize environmental degradation.

Conceptual Review of Waste Management and Plastic Polymers

Solid waste management is conceptualized as an integrated operational framework spanning the generation, source segregation, collection, transfer, processing, and final ecological disposal of discarded substances (Kaza et al. (2018) What a Waste 2.0 (World Bank)). In the Global South, rapid population expansion frequently outpaces municipal capital expenditure, inducing structural operational gaps. Plastic polymers introduce a unique layer of complexity to this matrix due to their molecular stability and chemical formulation. The classification of these polymers dictates their ecological persistence and secondary material recyclability, as summarized in Table 1.

Table 1: Matrix of Plastic Waste Polymers Commonly Generated in Jos South LGA

Plastic Polymer	Primary Utilization Context	Waste Stream Prevalence (%)	Inherent Circular Recyclability
PET (Polyethylene Terephthalate)	Beverage containers, commercial packaging	30 %	High; robust secondary market channels
LDPE (Low-Density Polyethylene)	Sachet water films, single-use carrier bags	25 %	Moderate; prone to technical contamination
HDPE (High-Density Polyethylene)	Industrial buckets, detergent containers	15 %	High; structurally stable for mechanical reprocessing
PP (Polypropylene)	Caps, food storage enclosures, straws	10 %	Moderate; requires specialized sorting
PS (Polystyrene)	Expanded foam packaging, catering plates	8 %	Low; economically unviable for mechanical recovery

PVC (Polyvinyl Chloride)	Conduit piping, electrical cable insulation	5 %	Extremely difficult; releases chlorine toxins
Multilayer / Composite Plastics	Laminated food wraps, snack packages	7 %	Negligible within basic mechanical configurations

Source: Field Survey, 2025

The accumulation of these polymers across terrestrial systems induces the progressive fragmentation of macro-plastics into micro plastics via photo oxidation and mechanical abrasion. These micro plastics act as vectors for the terrestrial leaching of toxic stabilizers such as phthalates and bisphenol A (BPA) which contaminate groundwater reserves and alter soil microbiology (Geyer et al., 2017). Furthermore, the atmospheric release of dioxins, furans, and black carbon during open-air plastic combustion generates long term bio accumulative risks for nearby residential enclaves (United Nations Environment Programme (2021)).

Theoretical Orientations

This study is analytically positioned at the intersection of Systems Theory (Bertalanffy, 1968) and the contemporary Circular Economy Framework (Ellen MacArthur Foundation, 2015). Systems Theory posits that public ecosystems operate as a configuration of deeply interdependent variables; hence, an operational deficit within the waste segregation or collection tier inevitably damages downstream environmental quality indicators. Concurrently, the Circular Economy model advocates for the comprehensive closing of material loops, replacing linear "take-make-dispose" systems with restorative industrial circles that decouple growth from finite resource extraction.

The Circular Economy model explicitly seeks to decouple economic development from finite resource consumption by intentionally transitioning from traditional linear paradigms to closed-loop industrial ecosystems. This framework directly reduces environmental externalities while capturing lost value across the recycling stream (Geissdoerfer et al., 2017). Furthermore, this structural loop operationalizes the core tenets of sustainable development by balancing economic productivity with ecological preservation and societal wellbeing (Elkington, 1997).

MATERIALS AND METHODS

Geographical Context of the Study Area

Jos South LGA is situated on the Jos Plateau within latitudes 9°45'N to 10°15'N and longitudes 8°45'E to 9 °25'E. The area functions as a critical economic and residential peri-urban center adjacent to the capital city of Jos. It contains highly active commercial hubs such as the Kugiya Market in Bukuru which act as major hotspots for high-density consumer plastic generation. The institutional framework for environmental management consists of the Plateau Environmental Protection and Sanitation Agency (PEPSA) alongside the municipal health and sanitation directorates, whose formal collection efforts are systematically overwhelmed by the scale of localized waste generation.

Methodological Architecture and Sampling Framework

This study adopted a descriptive cross-sectional research design to evaluate the environmental impacts of plastic waste recycling practices in Jos South LGA. This approach is highly effective for examining a population's characteristics, behaviors, and environmental observations at a specific point in time, providing a reliable empirical baseline for municipal waste analysis in accordance with established methodological frameworks for contextual research designs (Creswell and Plano Clark, 2018). The study population comprised households, informal waste pickers, government officials, environmental NGOs, and commercial

retailers within Jos South LGA. Based on accessibility and study scope, a target sample of 100 participants was selected. To compute the minimum statistically representative sample from an estimated active urban core population pool, Yamane's (1967) mathematical formulation was applied:

$$n = N / [1 + N(e)^2] \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where: n = sample size, N = population size, e = margin of error (0.10)

Where **N** represents the macro-population size and **e** represents the margin of error (0.10). For operational feasibility and adequate representation of stakeholder groups, a target sample size of 100 respondents was adopted, from which A total of 82 completed questionnaires were retrieved and used for analysis, representing an 82% response rate. The instrument was pretested among 15 respondents outside the study area and yielded a Cronbach Alpha coefficient of 0.82. Following structural field constraints and accessibility variations, a final sample size of 82 completed instruments was achieved, representing a robust 82% active response rate. The final cross-sectional sample distribution is detailed in Table 2.

Table 2: Descriptive Sample Distribution Across Stakeholder Categories

Stakeholder Segment	Initial Targeted Cohort	Valid Responding Cohort	Proportion of Active Dataset (%)
Primary Residential Households	50	42	51.2 %
Informal Waste Pickers & Aggregators	20	16	19.5 %
Government Officials & Environmental NGOs	20	15	18.3 %
Commercial Retailers & Market Vendors	10	9	11.0 %
Total Portfolio	100	82	100.0 %

Source: Field Survey, 2025

Quantitative information was captured through primary structured questionnaires and validated by an environmental scholar under the SPESSE programme. The internal reliability of the questionnaire scale items was confirmed via a pilot deployment, returning a Cronbach's Alpha coefficient of 0.82. Qualitative triangulation was achieved through 8 comprehensive Key Informant Interviews (KIIs) with administrators from PEPSA and local environmental NGOs, complemented by systematic field observations utilizing a standardized ecological checklist.

Ethical Considerations

Participation was voluntary. Respondents provided informed consent, and confidentiality of information was maintained throughout the study.

RESULTS AND DISCUSSION

Characterization of Plastic Waste Management Practices

The findings indicate that plastic waste management in Jos South Local Government Area is predominantly driven by informal recycling systems. Approximately 68% of respondents confirmed that plastic recovery activities are carried out by informal waste pickers and aggregators rather than formal municipal structures. This reflects a weak institutional recycling framework and heavy reliance on community-based recovery networks.

Household disposal practices further highlight systemic inefficiencies. A significant proportion of respondents reported environmentally harmful disposal methods, including open dumping (24%) and open burning (26%). Only 43% of plastic waste generated in the study area enters any form of recovery or structured collection system. The remaining fraction contributes directly to environmental pollution through land and water contamination.

Field observations corroborated these findings, showing visible accumulation of plastic waste in drainage channels and open spaces, particularly in areas with low informal sector activity. Informal collectors were observed to prioritize high-value materials such as PET bottles and clean LDPE films, while low-value and contaminated plastics were largely excluded from recovery streams.

Environmental Impacts of Recycling Practices

Table 3 presents respondents' perceptions of environmental changes associated with plastic recycling activities in the study area.

Table 3: Observed Environmental Indicators Associated with Recycling Activities

Environmental Quality Metric	Observed Improvement Level (%)	Primary Ecological Mechanism
Reduction of Litter in Public Spaces	62 %	Active extraction of macro-plastics by waste pickers
Mitigation of Drainage Channel Blockages	54 %	Interception of rigid plastic containers prior to storm runoff
Reduction in Open-Air Incineration Frequency	47 %	Economic valuation of plastic diverting it from household burn piles
Amelioration of Agricultural Soil Degradation	22 %	Marginal reduction in sub-surface plastic blockages

Source: Field Survey, 2025

Following analysis of the survey data, 62% of respondents reported a reduction in litter in public spaces. In addition, 54% observed improved drainage conditions, while 47% reported a decrease in open-air burning activities. Only 22% reported noticeable improvements in agricultural soil conditions. These findings are consistent with Wilson et al. (2006), who reported that informal recycling systems in developing countries significantly reduce visible environmental pollution despite operating outside formal institutional structures.

These results suggest that informal recycling activities contribute positively to surface-level environmental quality. The reduction in litter indicates active removal of visible plastic waste from the environment, while improved drainage conditions reflect reduced obstruction of water channels by solid waste materials. The reported decline in open burning further suggests that informal recycling provides an alternative economic value for plastic waste, thereby discouraging disposal through combustion.

However, the relatively low improvement in soil quality (22%) highlights a critical limitation. Informal recycling systems are primarily focused on macroplastic recovery and are ineffective in addressing microplastic contamination, which continues to accumulate in agricultural soils. Overall, the findings indicate that while informal recycling contributes to short-term environmental improvements, its long-term ecological effectiveness remains limited.

Systemic Barriers Affecting Recycling Effectiveness

The effectiveness of plastic recycling in Jos South LGA is constrained by several interrelated institutional, infrastructural, and behavioral factors.

The most significant challenge is low environmental awareness, reported by 78% of respondents. This results in poor waste segregation practices at the household level, increasing contamination of recyclable materials and reducing their economic value.

Institutional weakness was identified by 71% of respondents, particularly in relation to poor coordination between environmental agencies and recycling operators. This limits the development of structured recycling systems and reduces policy enforcement effectiveness. Infrastructural deficits, including inadequate waste collection bins and absence of material recovery facilities, were also highlighted. Additionally, 41% of respondents indicated that limited access to recycling technology restricts the ability to process low-value and composite plastics, which remain largely uncollected in the environment. Interview data from environmental officials further confirmed these challenges, emphasizing that the absence of structured waste containment systems forces reliance on informal and unregulated disposal pathways.

Discussion of Findings

The findings demonstrate that plastic waste management in Jos South LGA is characterized by a hybrid system in which informal recycling plays a central but unregulated role. This aligns with existing literature on waste management in developing countries, where informal actors often compensate for weak municipal infrastructure. From a systems perspective, inefficiencies in waste segregation and collection directly influence environmental outcomes across the entire waste management chain. The results confirm that while informal recycling provides

measurable environmental benefits, particularly in reducing visible litter and drainage blockage, its effectiveness is constrained by structural weaknesses.

The circular economy perspective further explains these limitations. The current system does not fully close material loops, as low-value and composite plastics remain largely unrecovered. This results in continuous leakage of plastic waste into the environment, particularly in the form of microplastics and residual pollution. Similarly, Nzeadibe (2009) observed that informal recycling networks in Nigeria compensate for institutional deficiencies by facilitating material recovery and reducing the burden on municipal waste management systems. However, long-term sustainability requires stronger policy integration and infrastructural investment.

Overall, the findings suggest that improving environmental outcomes will require a transition from an informal, market-driven recovery system to a more structured circular economy model supported by institutional investment, public awareness, and technological capacity.

CONCLUSION AND RECOMMENDATIONS

This study demonstrates that plastic waste recycling within Jos South LGA functions as a complex environmental challenge. In the absence of a well-funded formal municipal framework, the informal sector has emerged as the primary mechanism for local material recovery. These unregulated actors deliver vital ecosystem services by diverting substantial volumes of plastic from municipal storm channels and open burn piles. This reduces local flood hazards and lowers atmospheric emission levels across the LGA.

However, these environmental benefits remain inconsistent and market-dependent. Because the current pattern is driven by commercial demand rather than ecological management, it leaves low-value and complex polymers unrecovered. Hampered by weak public environmental awareness, a complete lack of source-segregation infrastructure, and missing institutional support, the existing recycling framework cannot fully address the growing challenge of plastic pollution. To protect regional ecosystems, Jos South LGA must transition from reactive, survival-driven informal scavenging toward an organized, technology-supported circular economy framework.

Recommendations

To maximize the environmental efficacy of plastic recycling in Jos South LGA, the following interventions are recommended:

1. Regulatory Enforcement and Policy Implementation: PEPSA and the Jos South Local Council must establish a structured plastic waste management ordinance. This framework should mandate source segregation within households and commercial zones, penalize open dumping and burning, and launch localized Extended Producer Responsibility (EPR) initiatives to ensure commercial packaging producers support local recovery infrastructure.
2. Infrastructural Investment and Material Recovery Hubs: The state government must fund and deploy color-coded collection bins across high-density residential and commercial zones. Designated Material Recovery Facilities (MRFs) should be built in each district to provide formal, safe zones for sorting and processing recyclables.

3. Formalization of Informal Sector Performance: Environmental agencies should register and organize informal waste pickers into formalized cooperatives. Providing these workers with Personal Protective Equipment (PPE), technical training, and fair pricing models will improve collection efficiency while protecting human health and dignity.
4. Institutionalization of Public Private Partnerships (PPPs): Municipal authorities should build joint ventures with private recycling firms, leveraging private capital and advanced technology to establish local pelletizing and mechanical recycling centers. This will create reliable local markets for hard-to-recycle used plastics.

ACKNOWLEDGEMENTS

The authors sincerely appreciate all respondents, government officials, community stakeholders, and environmental agencies that participated in this study. The authors also acknowledge the Department of Sustainable Environmental Studies, SPESSCE, Abubakar Tafawa Balewa University, Bauchi, for providing an enabling academic environment for this research.

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