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Environmental and Public Health Impacts of Polythene Waste Disposal in Maisandari Ward, Damaturu, Yobe State, Nigeria

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Abstract

Plastic waste pollution represents a rapidly intensifying environmental and public health challenge in urban centers across Sub-Saharan Africa, particularly where municipal waste management infrastructure has not kept pace with population growth and consumption patterns. This study assessed the spatial distribution, disposal practices, and environmental and health risk awareness associated with polythene waste in Maisandari Ward, Damaturu, Yobe State, Nigeria. A cross-sectional mixed-methods design was employed, combining field-based quadrat sampling (2 m²; three replicates per site across four stratified sub-locations) with a structured household survey (n = 142; 94.7% response rate). Sachet water plastics composed primarily of LDPE (Low-Density Polyethylene) and VLDPE (Very Low-Density Polyethylene) constituted the dominant waste fraction (43%). Waste density varied spatially, ranging from 1 item/2 m² in Benkalio Estate to 4 items/2 m² in Maisandari South. Only 16.2% of respondents reported access to formal waste collection systems, and open burning was the predominant disposal method (59%). Although environmental awareness was high (97.9%), health risk awareness was markedly low (14.1%). The findings demonstrate a significant gap between environmental recognition and health literacy, suggesting that visible environmental degradation does not necessarily translate into perceived personal health risk. The convergence of sachet plastic dominance, infrastructure deficits, and hazardous disposal practices amplifies environmental exposure pathways in semi-arid urban settings. Integrated interventions combining infrastructure development, regulatory enforcement, circular economy strategies, and targeted health communication are urgently required.

Keywords: Polythene Waste, Sachet Water Plastics, Environmental Pollution, Waste Management, Public Health, Damaturu.

INTRODUCTION

Global Context of Plastic Waste

Plastic production has expanded exponentially since the mid-twentieth century, rising from approximately 2 million metric tons in 1950 to over 400 million metric tons annually (Jerumeh *et al.,* 2020). The majority of this growth is attributed to single-use plastic products, including packaging films, bags, and sachets. These materials are valued for durability, flexibility, and low cost; however, the same properties contribute to their environmental persistence.

Globally, only about 9% of plastic waste is recycled, while the remainder is landfilled, incinerated, openly dumped, or mismanaged (Organization for Economic Co-operation and Development [OECD], 2022). Mismanaged plastic waste is disproportionately concentrated in low- and middle-income countries where waste collection coverage remains inadequate (Kaza *et al*., 2018).

Plastic Waste in Sub-Saharan Africa

Sub-Saharan Africa has experienced rapid urbanization without commensurate infrastructure development. Municipal solid waste generation has increased significantly, yet formal collection services often cover less than half of urban populations (World Bank, 2018). In many cities, open dumping and burning remain common disposal methods.

Nigeria, the most populous country in Africa, generates approximately 32 million tonnes of solid waste annually. Plastic materials constitute a substantial fraction of urban waste streams, particularly in cities where sachet water is widely consumed due to unreliable potable water supply systems (UNEP, 2021).

Environmental and Public Health Pathways

Polythene waste influences environmental and health systems through multiple interconnected pathways:

1. **Hydrological pathway:** Plastic litter blocks drainage channels, exacerbating flooding events (Jerumeh *et al.,* 2020).
2. **Soil pathway:** Accumulated plastic reduces soil porosity, disrupts microbial communities, and alters water infiltration (Rillig & Lehmann, 2020).
3. **Atmospheric pathway:** Open burning releases particulate matter (PM2.5), polycyclic aromatic hydrocarbons, and dioxins (Wiedinmyer *et al*., 2014; WHO, 2021).
4. **Vector pathway:** Discarded sachets trap stagnant water, creating breeding habitats for mosquitoes.
5. **Chemical exposure pathway:** Plastic additives such as bisphenol A and phthalates pose endocrine and carcinogenic risks (Agada & Yakubu, 2023).

Despite recognition of environmental impacts, public awareness of health consequences is often limited. This disconnect may reduce motivation for behavioral change.

While several studies have investigated waste management. While several studies have investigated waste management in major

Nigerian cities such as Lagos, Ibadan, and Kano, empirical data from semi-arid secondary cities remain limited (Mohammed & Isa, 2025; Agada & Yakubu, 2023; Usman *et al.*, 2019). Damaturu presents unique ecological and socio-economic characteristics, including:

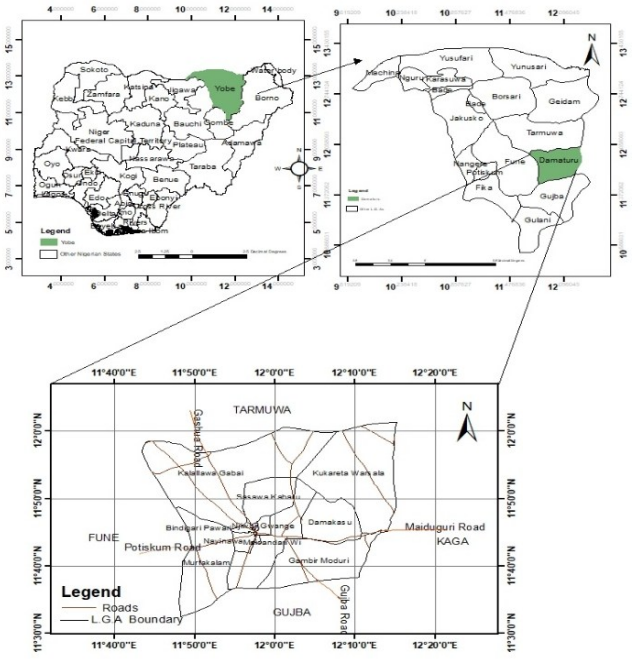
- Semi-arid climate influencing waste degradation dynamics
- Rapid urban expansion
- Limited municipal infrastructure
- High reliance on sachet water

This study integrates environmental quantification and health awareness within a unified analytical framework. Anchored in Environmental Risk Theory and the Waste Management Hierarchy Model, it addresses existing gaps by quantifying polythene waste distribution, examining disposal practices, assessing associated environmental and health impacts, and evaluating public awareness.

MATERIALS AND METHODS

Study Area

The study was carried out in Maisandari Ward, within Damaturu Local Government Area of Yobe State, northeastern Nigeria. Situated in the Sudan–Sahel ecological zone, Damaturu experiences a semi-arid savannah climate, with mean annual rainfall between 500 and 1,000 mm, prolonged dry periods, and temperatures often exceeding 40°C during the dry season. These conditions produce sandy terrain in the dry season and muddy surfaces during the rainy season (Gana & Sa'id, 2026). The metropolis is bordered by Tarmuwa LGA to the north, Gujba LGA to the south, Fune LGA to the west, and Kaga LGA (Borno State) to the east.



Source: (Gana and Sa'id, 2026)

Figure 1: Map of Damaturu Showing the Study Area (Maisandari ward)

Rapid urbanization, population growth, and increased consumption of sachet-packaged products have led to higher municipal solid waste generation. Limited waste management infrastructure and prevalent informal disposal practices make the area particularly relevant for studying polythene waste distribution and its environmental and public health impacts.

Study Design

A cross-sectional descriptive design was adopted to assess polythene waste distribution, disposal practices, environmental impacts, and health awareness within the study area.
The study combined:

- Field-based environmental assessment (waste quantification using quadrat sampling)
- Structured household survey (behavioral and perception data)

This mixed-method approach enabled triangulation of physical waste measurements with self-reported disposal practices.

Population and Sampling Strategy

Four sub-locations within Maisandari Ward were stratified based on residential density and activity patterns:

- Maisandari South
- Maduri
- Waziri Ibrahim
- Benkalio Estate

Household Survey

150 questionnaires were distributed; 142 were valid (94.7% response rate). Inclusion criteria:

- Resident of study area
- Aged ≥18 years
- Provided informed consent

Field Waste Quantification

A 2 m^2 quadrat was randomly deployed three times per site. All visible polythene waste was:

- Collected
- Counted
- Categorized (LDPE, VLDPE)

The average count per quadrat was computed to estimate relative waste density across locations.

Data Collection Instruments and Procedures

Questionnaire Survey

A structured, closed-ended questionnaire was developed to collect primary data from residents of Maisandari Ward. The instrument was organized into four distinct sections:

- Section A: Socio-demographic characteristics (sex, age, educational attainment, occupation)
- Section B: Polythene waste generation and types (sachet water plastics, packaging materials, bags)
- Section C: Disposal practices (availability of collection points, methods of disposal including burning, incineration, landfill, littering)
- Section D: Awareness assessment (perception of environmental consequences and knowledge of health risks associated with improper disposal)

Ethical Considerations

Participation was entirely voluntary. Respondents were informed of the study objectives and assured of confidentiality. No personally identifiable information was collected. Verbal informed consent was obtained prior to questionnaire administration.

Data Analysis

Descriptive statistics were computed using frequency distributions and percentages. Spatial variation was analyzed through mean item counts per quadrat. Interpretation focused on identifying exposure gradients and behavioral correlations.

RESULTS

Socio-Demographic Characteristics of Respondents

Gender Distribution:

Out of 142 respondents, 122 (85.92%) were male and 20 (14.08%) were female. This gender disparity reflects socio-cultural norms limiting female participation in public surveys within the study area. The male predominance suggests that environmental practices in Maisandari Ward are largely influenced by male household members (Table 1).

Table 1: Sex/Gender Structure

Sex	Frequency	Percentage
Male	122	85.92 %
Female	20	14.08 %
Total	**142**	**100 %**

Educational Level:

Respondents exhibited a relatively high literacy level: 49.29% had tertiary education, 40.84% had secondary education, 3.52% had only primary education, and 6.35% had religious education. Over 93% had some form of Western education, which may positively influence environmental awareness and waste disposal practices (Table 2).

Table 2: Level of Literacy of the Respondents

S/No	Educational level	No. of Male Respondents	No. of Female Respondents	Total no. of Respondents	Percentage (%)
1.	Primary	4	1	5	3.52 %
2.	Secondary	49	9	58	40.84 %
3.	Tertiary	60	10	70	49.29 %
4.	Religion	9	0	9	6.35 %
	Total	**122**	**20**	**142**	**100%**

Occupational Structure:

The majority of respondents were students (48%) and civil servants (32%), followed by businessmen (11%) and unemployed individuals including housewives and youth (9%). This distribution suggests that educational interventions targeting students and public employees could effectively influence community waste management behavior (Figure 2).

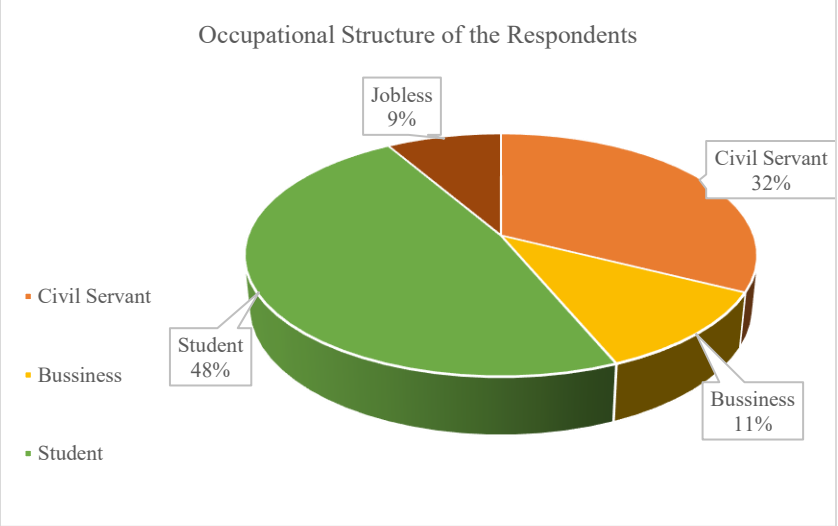


Figure 2: Occupational Structure of the Respondents

Polythene Waste Distribution

Type and Density of Polythene Waste:

Quadrat sampling revealed that Maisandari South had the highest polythene density, averaging 4 items per 2 m², followed by Maduri (3 items), Waziri Ibrahim (2 items), and Benkalio Estate (1 item). The most common polymers were VLDPE and LDPE, used for water sachets, packaging, and plastic bags. This indicates concentrated waste accumulation in more densely populated or high-activity areas (Table 3).

Table 3: Average number of polyethene's and attributes at study site

Sample Site	Number of throws at each site	Average number of Polythene	Type of Polythene
Maisandari S.	3	4	VLDPE/LDPE
Maduri	3	3	VLDPE/LDPE
Waziri Ibrahim	3	2	VLDE/LDPE
Benkalio Estate	3	1	VLDPE

Legend: **LDPE**: Low density polythene; **VLDPE**: Very low-density polythene

Waste Composition:

Sachet water plastics constituted the largest proportion of waste (43%), followed by vegetable waste (35%). Tetra packs and food remnants were less prevalent. This confirms the dominance of single-use non-biodegradable plastics in the local waste stream and underscores the urgency for targeted reduction and recycling interventions (Figure 3).

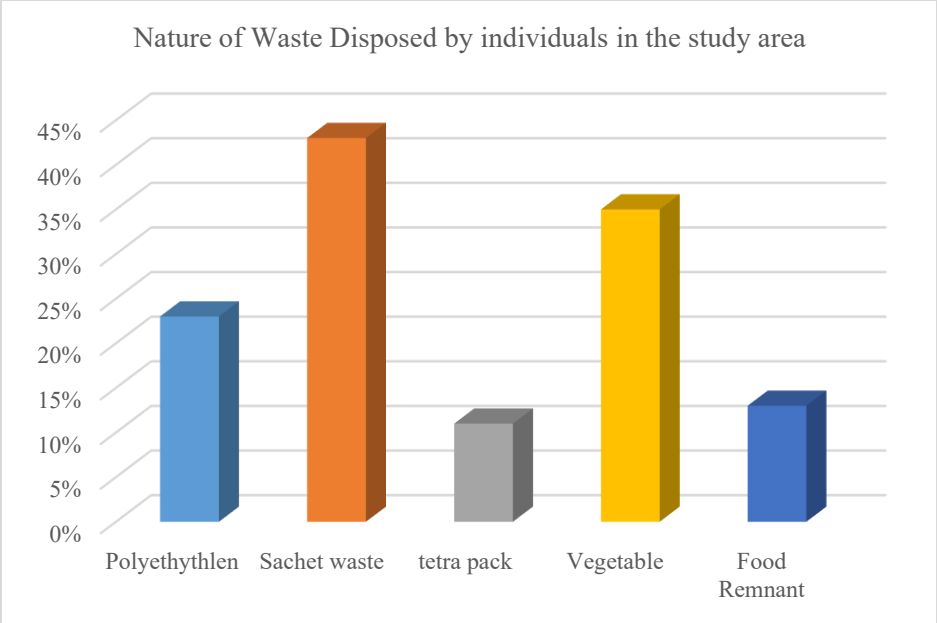


Figure 3: Nature of Waste disposed

Polythene Waste Disposal Practices

Availability of Designated Dumping Sites:

Only 23 respondents (16.20%) reported access to formal waste collection points, while 119 respondents (83.80%) lacked such infrastructure. This absence drives reliance on informal and environmentally harmful disposal methods (Table 4).

Table 4: Availability of Dumping Site in the Study Area

S/No	Method of disposal	No. of Male Respondent	No. of Female Respond.	Frequency	Percentage
1.	Yes, we have	20	3	23	16.20 %
2.	No, we don't	105	17	119	83.80 %
	Total	**122**	**20**	**142**	**100%**

Methods of Disposal:

Burning was the predominant disposal method, practiced by 59% of respondents. Incineration (23%) and landfill disposal (18%) were also reported, while littering and disposal into water bodies accounted for 2%. The dominance of open burning reflects convenience, inadequate infrastructure, and limited awareness of associated health risks (Figure 4).

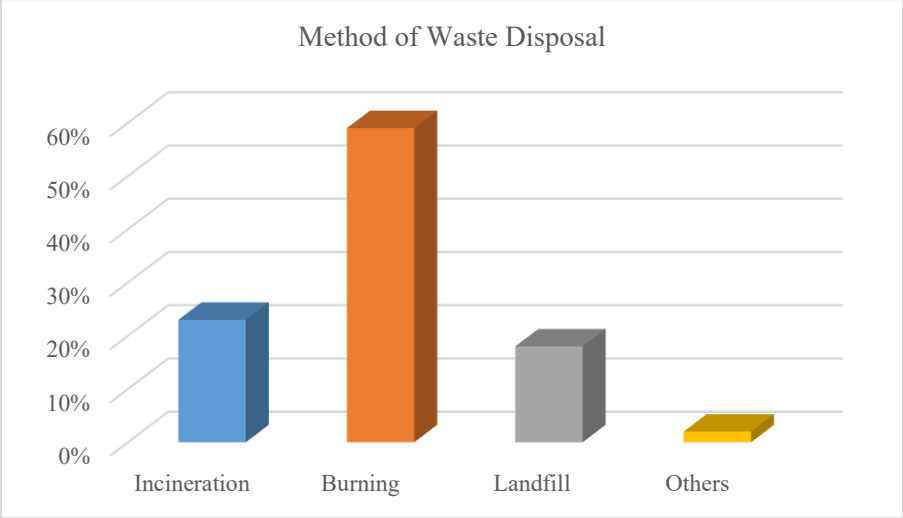


Figure 4: Method of Waste Disposal

Environmental and Health Awareness

Environmental Impact Awareness:

An overwhelming majority (97.89 %) of respondents demonstrated awareness of the environmental consequences of improper polythene disposal, including drainage blockage, soil degradation, and visual pollution. This indicates that environmental awareness is high within the community (Table 5 and Figure 5).

Table 5: Awareness of Peoples on Environmental Impact of polythene leather disposal

S/No	Awareness	No. of Male Respond.	No. of Female Respond.	Total No. of Respondent	Percentage
1.	Yes	119	20	139	97.89 %
2.	No	3	0	3	2.11 %
	Total	**122**	**20**	**142**	**100%**

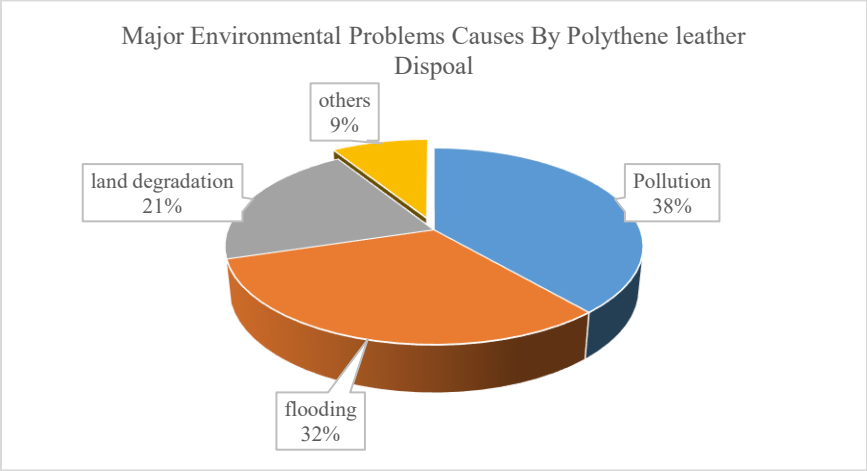


Figure 5: Environmental Problems Caused by Improper Disposal of polythene Waste

Health Impact Awareness:

In stark contrast, only 20 respondents (14.08%) were aware of the health risks associated with improper polythene waste disposal. Among those aware, 44% identified malaria transmission from stagnant water in discarded plastics, 39% recognized respiratory hazards from burning, and 17% linked water contamination to cholera and diarrhea. This reveals a critical awareness gap and underscores the urgent need for targeted health education (Table 6 and Figure 6).

Table 6: Awareness of People on Health Impact of Polythene leather disposal

S/No.	Awareness	No. of Male Respond.	No. of Female Respond.	Total No. of Respondent	Percentage
1	Yes	18	2	20	14.08 %
2	No	104	18	122	85.92 %
	Total	**142**	**20**	**142**	**100%**

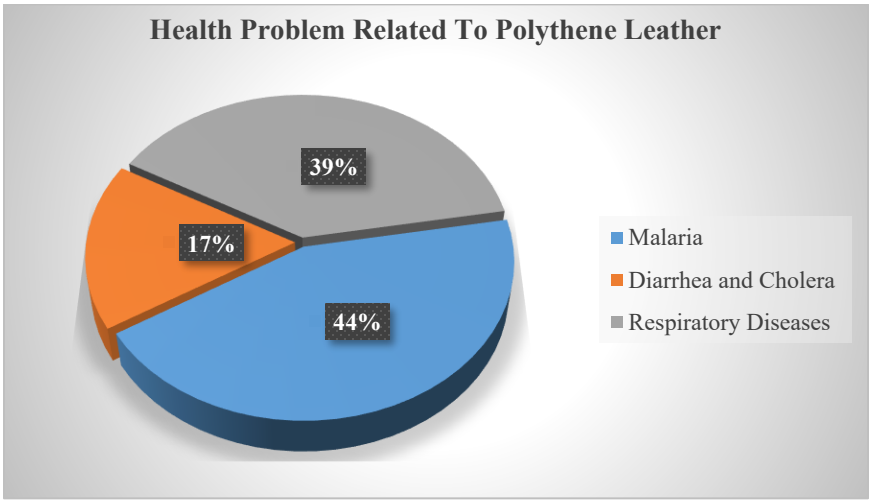


Figure 6: Health Problem Caused due to the Indiscriminate Disposal of polythene leather

The findings highlight a paradox: while environmental awareness is high, health awareness related to waste mismanagement is low. The dominance of sachet water plastics and prevalence of burning practices suggest significant potential for air pollution, vector breeding, and soil contamination. Spatial variation in waste density emphasizes the need for localized interventions in high-density zones like Maisandari South. Collectively, the descriptive data provide a clear picture of disposal behaviors and their environmental and public health implications, forming a basis for policy development and community-based interventions.

DISCUSSION

This study provides empirical evidence on the distribution, disposal practices, and awareness gaps associated with polythene waste management in Maisandari Ward, Damaturu. The findings reveal a critical disconnect between high environmental awareness and low health risk perception a paradox with significant implications for policy and community intervention.

Socio-Demographic Context and Waste Generation Patterns

The male predominance (85.9%) among respondents reflects persistent socio-cultural norms limiting female participation in public surveys across Northern Nigeria (Ngamdu *et al.*, 2025). This gender skew, while methodologically limiting, indicates that environmental decision-making and waste disposal practices are predominantly influenced by male household heads. The relatively high literacy level (93% with formal education) presents an opportunity for behavior change interventions, as educational attainment positively correlates with adoption of sustainable waste practices (Olayiwola *et al*., 2023).

The dominance of sachet water plastics (43%) in the waste stream aligns with national trends. Nigeria consumes approximately 50 million sachets daily, with the majority improperly discarded (UNEP, 2021). Similar studies in Maiduguri and Kano (Mohammed & Isa, 2025) reported sachet water proportions of 41% and 46%, respectively, confirming a regional pattern across northeastern Nigeria's semi-arid urban centres. The spatial variation in waste density with Maisandari South exhibiting the highest accumulation corresponds with population density and commercial activity gradients documented in Damaturu.

Disposal Practices and Infrastructure Deficits

The finding that 83.8% of residents lack access to designated waste collection points represents a more severe infrastructure deficit than previously reported for Damaturu (Ngamdu *et al.*, 2025). This deterioration over the past decade reflects rapid urbanization outpacing municipal service delivery a pattern observed across secondary cities in Sub-Saharan Africa (World Bank, 2018). The absence of formal collection systems forces reliance on convenience-driven disposal methods, predominantly open burning (59%).

The prevalence of burning in Maisandari Ward (59%) exceeds rates reported in comparable Nigerian cities: 47% in Abeokuta (Olayiwola *et al*., 2023), and 51% in Ilorin (Ogungbade *et al.,* 2020). This elevated rate may reflect the semi-arid ecology where rapid drying of organic

waste facilitates combustion, combined with deeply entrenched cultural acceptance of burning as "cleansing" (Ezeah & Roberts, 2012).

The Awareness Paradox: Environmental vs. Health Literacy

The most striking finding is the extreme divergence between environmental awareness (97.9%) and health risk awareness (14.1%). This awareness paradox has been inadequately addressed in the literature. While numerous studies document low environmental awareness in Nigerian communities (Gana & Sa'id, 2026), this study reveals a distinct phenomenon: communities recognize visible environmental deterioration (blocked drains, unsightly litter, flooding) but remain cognitively disconnected from the invisible, delayed health consequences.

Recent studies confirm this pattern. Ekwueme and Nwosu (2024) found that 91% of residents in Enugu identified plastic waste as an "environmental problem," yet only 18% could name a single disease associated with it. Similarly, Mwangi *et al.* (2025) in Nairobi reported 94% environmental awareness versus 22% health literacy. This suggests a global South phenomenon where environmental education campaigns have successfully communicated aesthetic and ecological impacts but failed to translate these into personal health risk perception.

The specific health awareness deficits identified 44% recognition of malaria transmission, 39% awareness of respiratory hazards, 17% knowledge of waterborne diseases reveal critical intervention entry points. The role of discarded sachets as "Aedes" and "Anopheles" breeding vectors is well-established (WHO, 2021), yet remains unrecognized by 86% of this population. Similarly, the cardiotoxic and carcinogenic effects of emissions from open plastic burning are extensively documented (Wiedinmyer *et al.*, 2014), but health literacy lags decades behind the evidence.

Environmental and Public Health Consequences

The convergence of sachet plastic dominance, burning prevalence, and health awareness gaps creates a syndemic synergistic epidemics of environmental degradation and disease. Drainage blockage from sachets directly contributes to seasonal flooding, which Damaturu experiences with increasing frequency and severity (Jerumeh *et al.,* 2020). Floodwaters contaminated with faecal matter from overwhelmed sanitation systems compound waterborne disease risks (Olayiwola *et al*., 2023).

Atmospheric emissions from plastic burning in Damaturu warrant urgent investigation. Recent air quality monitoring in similar Sahelian cities (Zinder, Niger; Ndjamena, Chad) detected elevated concentrations of particulate matter (PM2.5), dioxins, and furans during evening hours coinciding with waste burning. The prevalence of burning in Maisandari Ward suggests comparable exposures, with attendant risks of childhood respiratory infections, cardiovascular mortality, and adverse pregnancy outcomes (WHO, 2021).

Soil contamination from non-biodegradable plastic films reduces agricultural productivity a critical concern in Yobe State, where farming is the primary livelihood. Rillig & Lehmann (2020) demonstrated that macroplastic and microplastic contamination reduces soil water-holding capacity by 15–25% in sandy Sahelian soils, directly threatening food security in climate-vulnerable regions.

Policy Implications and Intervention Pathways

The findings strongly support the Waste Management Hierarchy and Extended Producer Responsibility (EPR) frameworks articulated in national policy. However, implementation remains paralyzed by institutional fragmentation, inadequate enforcement capacity, and political economy barriers. Damaturu's situation reflects what Okafor and Ugwu (2026) term "policy-practice decoupling" the gap between progressive legislation and street-level implementation.

Effective interventions must address both structural deficits and cognitive gaps. Infrastructure investments communal waste skips, transfer stations, scheduled collection services—are prerequisites for behavior change. However, infrastructure alone is insufficient. The awareness paradox demonstrates that environmental education without explicit health messaging fails to motivate behavior change. Community-based participatory approaches integrating visual demonstrations of mosquito breeding in sachets, respiratory impacts of smoke, and cholera transmission pathways have demonstrated efficacy in similar contexts (Hyun *et al.*, 2019).

Limitations and Future Research Directions

This study has several limitations. The cross-sectional design captures associations but cannot establish causality. Self-reported disposal practices may be subject to social desirability bias. The gender imbalance limits generalizability to female perspectives on waste management. Future research should employ longitudinal designs to evaluate intervention effectiveness, incorporate air and water quality monitoring to quantify health exposures, and utilize qualitative methods to explore cultural and cognitive barriers to behavior change.

Conclusion

This study demonstrates that Maisandari Ward faces a compound waste management crisis characterized by sachet plastic dominance, severe infrastructure deficits, reliance on hazardous burning, and critically low health risk awareness despite high environmental concern. Addressing this crisis requires moving beyond conventional environmental education toward integrated strategies that combine infrastructure provision, enforcement of sanitation regulations, community-based recycling, and targeted health communication that makes invisible risks visible. Without such integrated action, the environmental deterioration and preventable disease burden in Damaturu will intensify with continued urbanization and climate change.

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