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# Geospatial Assessment of Environmental Pollution Hotspots and Associated Health Risks from Improper Waste Disposal in Gwagwalada, Nigeria

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Abstract

his study examines the nexus between improper waste disposal, environmental pollution hotspots, and public health risks in Gwagwalada, Nigeria. The area is experiencing rapid urbanization and population growth, conditions that have severely strained its already limited waste management system. Predominant practices such as open dumping, indiscriminate littering, and uncontrolled burning of refuse have contributed to significant soil contamination, air pollution, and water quality deterioration. A mixed-methods approach was employed, integrating household surveys with geospatial analysis to capture both community-level perceptions and objective spatial patterns of environmental degradation. The study quantified the direct and indirect economic costs of pollution and identified socio-economic drivers of waste disposal behavior. Findings reveal the emergence of extensive pollution hotspots across residential and peri-urban zones, with profound public health implications, including elevated incidences of respiratory infections, gastrointestinal diseases, and waterborne illnesses. Economic impacts were equally pronounced, reflected in rising healthcare expenditures, declining agricultural productivity, and depreciating property values. The results underscore the inadequacy of existing waste management infrastructure and highlight the role of education, income level, and community participation as critical determinants of waste disposal practices. Based on these insights, the study advocates for an integrated management strategy that combines infrastructural investment, environmental education, community-based waste management initiatives, and targeted public health interventions. By providing context-specific evidence, this research contributes to policy dialogues on sustainable urban development and offers practical pathways for enhancing environmental quality and health resilience in Gwagwalada and similar rapidly urbanizing settings.

Keywords

Environmental pollution,
Health risks,
Waste disposal,
Gwagwalada,
Sustainable development,
Spatial assessment.

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## INTRODUCTION

Sustainable development means meeting the needs of the present without compromising the ability of future generations to meet their own needs (Anierobi *et al.,* 2024). This concept requires integrating economic, social, and environmental priorities. Effective waste management is a cornerstone of this integration: it mitigates environmental degradation, safeguards public health, and enhances resource efficiency (Ezeah & Roberts, 2014; Longfor *et al.,* 2023). Robust waste practices minimize the release of hazardous substances into the air, water, and soil, thereby preventing widespread pollution (Gunarathne et al., 2024). Strategies such as waste reduction, reuse, and recycling further conserve resources and help preserve natural ecosystems (Mujtaba *et al.,* 2024)

In rapidly growing urban areas, waste management infrastructure often lags behind. Gwagwalada, a large town in Nigeria's Federal Capital Territory, exemplifies this challenge. Urbanization and population growth have overwhelmed the town's waste infrastructure, leading residents to rely on open dumping and uncontrolled burning of refuse. Such informal disposal methods, while seemingly convenient, create severe environmental and health problems.

For example, open dumping – the unrestricted disposal of waste on open land – contaminates soil and water as toxic leachate seeps into the ground and waterways. It also contributes to air pollution through the emission of noxious gases and greenhouse gases, and can cause significant biodiversity losses (Mor & Ravindra, 2023). Burning waste, especially plastics and other non-biodegradable materials, releases toxic fumes and particulates that exacerbate air pollution and directly cause respiratory and chronic health problems (Hantoko et al., 2021). Research consistently shows that such improper waste practices impose high environmental and economic costs, underscoring the need for sustainable waste management strategies (Ugwu *et al.,* 2020).

Despite this understanding, a critical gap remains: little data exist on the specific environmental and economic costs of improper waste disposal in Gwagwalada. Without localized empirical data, policymakers lack the information needed to prioritize interventions and allocate resources effectively (Ezeah & Roberts, 2014; Longfor *et al.,* 2023). Quantifying these costs is essential for guiding investments in infrastructure and crafting evidence-based waste management strategies (Yusoff *et al.,* 2024).

The health risks from improper waste disposal in Gwagwalada are especially alarming. Open dumps and piles of garbage provide breeding grounds for disease vectors such as mosquitoes, flies, and rodents. Residents near these sites face higher rates of waterborne illnesses like cholera and typhoid from contaminated water, as well as respiratory ailments from inhaling toxic fumes from burning waste (Hantoko *et al.,* 2021; Longfor *et al.,* 2023). Studies worldwide link proximity to waste disposal sites with higher prevalence of respiratory, gastrointestinal, and skin diseases (Paiva & Ugaya, 2024). These health impacts impose additional economic burdens on communities due to increased healthcare costs (Mujtaba *et al.,* 2024).

Socio-economic factors further complicate the situation. Although the urgency of improving waste management in developing countries is well recognized, there is surprisingly little research focused on Gwagwalada (Andeobu *et al.*, 2021; Mujtaba *et al.*, 2024). Without data on the environmental and health impacts of waste in this specific context, efforts to achieve a cleaner and healthier environment will be impeded. This study aims to fill that knowledge gap by spatially assessing pollution hotspots and associated health risks in Gwagwalada. Our localized evidence is intended to inform tailored policy interventions and waste management strategies, contributing to sustainable development goals (Nguyen *et al.*, 2023; Yusoff *et al.*, 2024) and ultimately creating a more resilient and prosperous community

## 2.0 Literature Review

### Conceptual Review

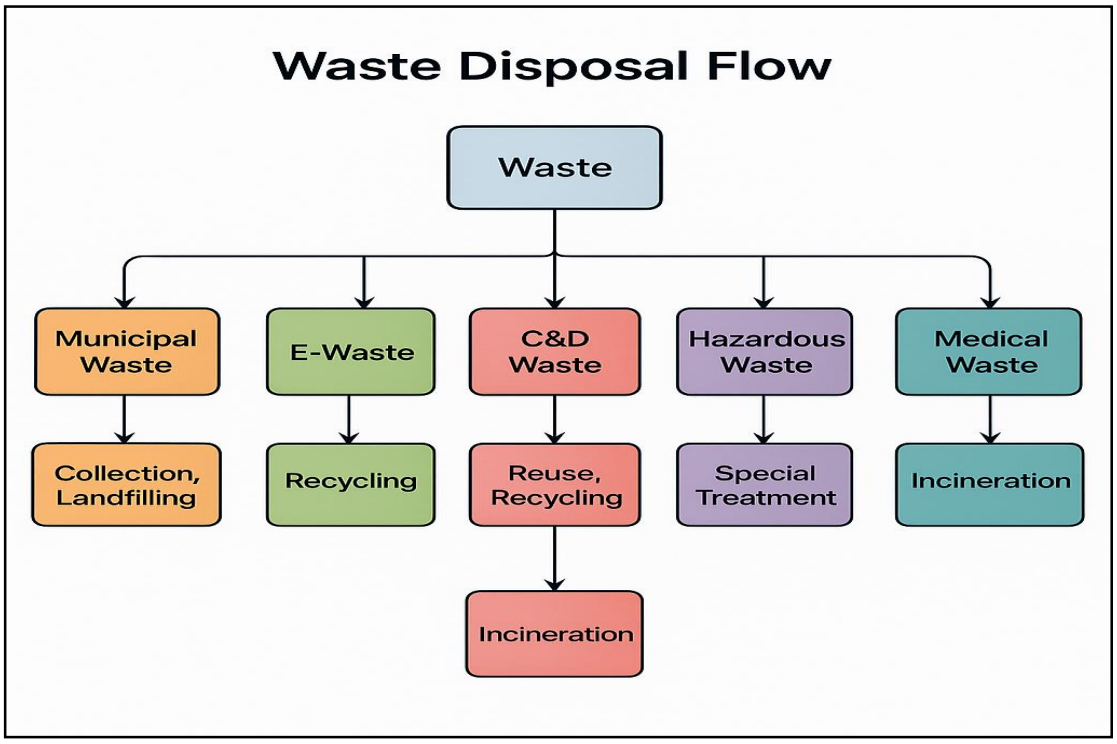


Figure 1: Waste Disposal Flow

Source: Author's Compilation, 2025.

### 2.1 Overview of Waste Disposal Practices

Waste disposal methods vary widely across regions due to differences in regulations, economic capacity, technology, and public awareness. Municipal waste management is especially critical because of its direct impact on urban environments and human health. In Europe, Albizzati *et al.* (2024) developed a model to assess the environmental and economic impacts of municipal waste

management and found that integrated strategies are essential to balance ecological soundness with economic viability. Similarly, Sun et al. (2024) evaluated waste-to-energy incineration in China and demonstrated that converting waste to energy can reduce waste volume while generating renewable power. In Sub-Saharan Africa, Longfor *et al.* (2023) showed that sustainable waste practices can significantly mitigate greenhouse gas emissions and bring economic benefits.

However, practical implementation in many parts of Nigeria often falls short of these ideals. Due to limited infrastructure and enforcement, communities frequently rely on rudimentary disposal methods. For example, there is virtually no formal e-waste management in Gwagwalada. Informal dismantling of electronics releases heavy metals and other toxins directly into general waste streams, creating concentrated pollution and health risk hotspots (Andeobu *et al.*, 2021). Similarly, household pharmaceutical waste and healthcare refuse often lack proper disposal. Studies elsewhere have found gaps in awareness and practice for medication disposal, leading to environmental contamination (Fatimah *et al.*, 2024). In contexts like Gwagwalada, discarded medical waste from homes and small clinics commonly ends up in open dumps, providing sources of infection and pollution.

Industrial activities generate hazardous wastes that require specialized handling. Research on nanomaterial production underscores the need for stringent regulations to manage these hazards (Dhall *et al.*, 2024). A review of hospital waste incineration found that waste-to-energy technologies can help manage hazardous streams and produce energy (Salahuddin *et al.*, 2024). In Gwagwalada, however, the absence of proper industrial waste treatment means that chemical effluents and medical residues often enter dumps or waterways untreated, creating serious pollution hotspots.

Construction and demolition (C&D) waste is another major concern. These materials (concrete, wood, metals, etc.) are generated in huge volumes during building and renovation. Putthadee et al. (2024) found that sustainable C&D waste management in Thailand could substantially reduce greenhouse gas emissions and energy demand. Without such practices in Gwagwalada, haphazard dumping of C&D debris contributes to urban blight and releases dust and fine particulates, which can harm respiratory health.

Food and organic waste also pose problems. When organic waste decomposes anaerobically (without oxygen) in dumps or landfills, it produces methane – a potent greenhouse gas – and leachate that can contaminate soil and water. Studies suggest that improving food management and packaging design can greatly reduce food waste and its impacts (Cassiano & Ugaya, 2024; Kohli *et al.*, 2024). In Gwagwalada, food waste frequently putrefies in open dumps, creating strong odors, attracting pests, and generating pollution hotspots.

Altogether, the various waste types (municipal, electronic, industrial, C&D, medical, food) each carry distinct environmental and health risks when mismanaged. These differences imply

that effective interventions must be tailored to the specific waste streams present. A lack of proper handling for any of these waste types can establish concentrated pollution hotspots, which then require targeted solutions.

### 2.2 Types of Waste and Their Environmental Impact

**Municipal Solid Waste (MSW):** MSW includes everyday items discarded by households, such as food scraps, packaging, and yard waste. Managing MSW is especially challenging in densely populated areas like Gwagwalada. Open dumping of MSW generates toxic leachate – a foul-smelling liquid full of heavy metals, organic pollutants, and pathogens – that infiltrates groundwater and surface water (Amde *et al.,* 2024). Decomposing organic waste in dumps produces greenhouse gases (methane and carbon dioxide) that contribute to climate change. Effective waste management can significantly reduce these emissions and improve air quality (Longfor *et al.,* 2023).

**Electronic Waste (E-waste):** E-waste consists of discarded electrical and electronic devices (e.g., phones, computers, appliances). These items contain hazardous substances (lead, mercury, cadmium, brominated flame retardants) that pose severe risks if released. Informal e-waste recycling or dumping allows these toxins to leach into soils and waterways, entering food chains and causing chronic health problems. A systematic review highlights the urgent need for robust e-waste management and recycling to prevent such contamination (Andeobu *et al.,* 2021). Innovative approaches like geopolymerizing the non-metal parts of e-waste have been proposed to safely incorporate them into construction materials (Aamar & Torres, 2024). In Gwagwalada, where informal e-waste handling is common, workers and nearby residents are exposed to toxic pollutants that can cause neurological and kidney damage, creating localized health risk hotspots.

**Construction and Demolition (C&D) Waste:** C&D waste includes materials from building activities (concrete, wood, metals, glass, etc.). When dumped carelessly, this waste causes land degradation, dust pollution, and can block drainage channels, leading to flooding. Putthadee *et al.* (2024) emphasize that proper sorting, recycling, and reuse of C&D waste can dramatically reduce its environmental footprint. In Gwagwalada, improper disposal of C&D debris contributes to visual blight and releases fine particulates into the air, posing respiratory health risks.

**Hazardous Waste:** This category covers materials that are corrosive, toxic, ignitable, or reactive, including industrial chemicals, certain household cleaners, pesticides, and some electronic components. Managing hazardous waste requires special handling. For example, research on nanomaterial manufacturing highlights the need for strict regulations to ensure safe disposal (Dhall *et al.,* 2024). In Gwagwalada, weak regulation means that hazardous industrial or household chemicals often mix with general garbage, contaminating dumpsites and exposing scavengers and nearby residents to severe health risks.

**Medical Waste:** Waste from healthcare (used syringes, bandages, expired medications, etc.) is potentially infectious. If not disposed of properly, it can spread disease. A review of pharmaceutical waste management notes that insufficient disposal practices can have serious environmental impacts (Salahuddin *et al.*, 2024). In Gwagwalada, the lack of secure landfills or incinerators for medical waste means these materials often end up in open dumps. This not only pollutes the environment but also poses infection risks to waste handlers and the community.

**Food and Organic Waste:** Food waste makes up a large portion of MSW and can be highly polluting. When organic matter decomposes anaerobically, it produces methane and leachate, and attracts rodents and flies. Solutions to reduce food waste (through better supply chain management and consumer awareness) can cut greenhouse gas emissions and reduce waste management burdens (Kohli *et al.*, 2024). In Gwagwalada, failing to recycle or compost organic waste means it typically rots in open piles, generating methane and contaminating soil and water.

Each of these waste streams contributes to environmental pollution hotspots if mishandled. Understanding their impacts underscores the need for targeted, context-specific management strategies in fast-growing urban areas like Gwagwalada.

### 2.3 Challenges of Waste Management

Managing waste effectively is complex and influenced by many factors. One key challenge is balancing cost with environmental protection. Developing communities often face tight budgets and may rely on the cheapest disposal methods, which are usually the most harmful. For instance, Albizzati et al. (2024) note that truly sustainable waste systems require careful planning and innovation to minimize harm while remaining affordable. In lower-income countries, high costs of modern technology often prevent adoption of advanced waste treatment, forcing continued use of landfills and dumps (Mor & Ravindra, 2023).

Technology and infrastructure limitations also hinder waste management. Many parts of the developing world lack facilities for sorting, recycling, or safely treating hazardous and electronic wastes. A systematic review of e-waste management showed wide disparities in infrastructure across countries, resulting in much valuable material being lost to dumps (Andeobu et al., 2021). In Gwagwalada, limited recycling centers or incinerators mean most waste, even if recyclable, ends up untreated.

Regulatory and policy factors are also critical. Strong, enforced regulations can greatly improve waste practices (as seen in many developed countries). By contrast, weak policies and lax enforcement allow uncontrolled dumping and burning to persist. Shah and Coad (2024) found that developing countries with poor regulatory frameworks suffered worse waste management outcomes. In Gwagwalada, existing laws against dumping are often not enforced, so violations go unpunished. Strengthening regulations and enforcement is therefore essential to prevent pollution.

Public awareness and engagement are equally important. Successful waste management depends on community participation – for example, people sorting waste at source,

recycling, and avoiding littering. Studies emphasize that broad public engagement and education campaigns can significantly reduce waste volumes and prevent new pollution hotspots (Garcia-Garcia et al., 2024). In Gwagwalada, raising awareness about the dangers of improper disposal (and providing convenient recycling options) would likely improve compliance and reduce risks.

Socioeconomic factors also shape waste behaviors. Research in Ghana and elsewhere shows that income, education, household size, and access to services all influence how people handle waste. Typically, higher income and education levels correlate with safer disposal options (Odonkor & Sallar, 2021). Lower-income or less-educated households may lack knowledge or resources to use formal waste services, making them more reliant on unsafe dumping. Addressing these underlying social factors – for instance, by subsidizing waste collection in poor areas and educating the public – is crucial for improving outcomes.

These challenges – economic constraints, technological gaps, weak governance, and social factors – are intertwined. Overcoming them requires a multifaceted approach that builds infrastructure, enforces regulations, advances technology, and engages communities simultaneously.

**2.4 Benefits of Proper Waste Management**

When waste is managed effectively, the benefits are far-reaching. Proper waste management reduces pollution, conserves resources, and promotes public health. For example, capturing methane from decomposing municipal waste can significantly cut greenhouse gas emissions, contributing to climate goals (Albizzati et al., 2024). Recycling and recovering materials from e-waste also prevent toxic releases and reclaim valuable resources. Innovative methods like geopolymerizing e-waste components can even create useful products (Aamar & Torres, 2024), embodying circular economy principles. These practices lead to cleaner air, healthier soil, and uncontaminated water, thereby preventing the formation of new pollution hotspots.

Addressing landfill pollution directly can have huge impacts. Leachate from uncontrolled dumps contains harmful chemicals and pathogens; installing impermeable liners and treating leachate (as recommended by Gunarathne et al., 2024) can protect groundwater. Proper sorting and recycling of construction waste can greatly reduce emissions and energy use associated with producing new materials (Putthadee et al., 2024). Overall, diverting waste from open dumps to regulated facilities prevents the contamination of natural resources.

Economically, proper waste management can reduce costs and even generate revenue. Recycling programs create jobs and recover materials, while waste-to-energy systems can produce electricity. For instance, controlled incineration of municipal waste in power plants can significantly reduce waste volume while generating renewable energy. Integrated strategies that combine environmental and economic goals can thus be cost-effective (Albizzati et al., 2024). Moreover, waste reduction at the source (e.g., less packaging) inherently reduces collection and treatment

costs. In the long run, investing in better waste systems pays dividends by lowering health care costs, preserving property values, and protecting agricultural land.

In a nutshell, proper waste management yields cleaner environments, healthier communities, and even economic gains. These benefits illustrate why overcoming the current challenges is so important for sustainable urban development.

## 3.0 Materials and Methods

This study adopted a spatially-oriented mixed-methods approach, combining quantitative and qualitative data for a comprehensive analysis. Geospatial techniques, environmental sampling, public health records, and community surveys were used to map pollution hotspots and assess health impacts in Gwagwalada. A case study framework was used to focus on Gwagwalada as a urban area in Nigeria. Geographic Information Systems (GIS) was used to located dumpsites, waterways, and health facilities to identify pollution hotspots. At the same time, surveys and interviews explored community experiences and perceptions of waste-related health issues.

Gwagwalada is one of the six Area Councils in the Federal Capital Territory (FCT) of Nigeria. With rapid urban expansion, the town faces mounting challenges in solid waste management. Its strategic location along a major transport corridor and population growth have overwhelmed existing waste infrastructure. Gwagwalada features a mix of residential, commercial, and peri-urban land uses, which serve as a fertile ground for examining varied waste disposal patterns and pollution intensity.

The target population included local residents, waste management officials, environmental health officers, and healthcare professionals - individuals directly exposed to or knowledgeable about waste-related environmental conditions and their ability to provide informed perspectives on pollution and health risks.

A multistage stratified sampling design was used. Initially, Gwagwalada was divided into three zones Commercial, Residential, and Government Reserved Areas), each further split into sub-areas based on proximity to waste disposal sites. randomly selected ensuring a representative sample of 195 respondents. This included 135 residents, 30 waste management personnel, and 30 healthcare professionals. Snowball sampling was used to identify key informants (e.g., policymakers, environmental managers, and health experts in Gwagwalada) for in-depth interviews.

Data collection combined spatial, environmental, and socio-health assessment methods:

i. **Household Surveys**: Structured questionnaires recorded waste disposal habits, health symptoms, and environmental awareness.
ii. **Environmental Sampling**: Soil and water samples were collected near identified dumpsites to test for contaminants (heavy metals, pathogens, and organic waste).
iii. **GIS Mapping**: GPS-enabled devices recorded the locations of dumpsites,

waterways/bodies, and health facilities to analyze spatial patterns.

iv. **Health Record Analysis**: Morbidity data from local health centers were reviewed to link prevalent health issues to proximity to waste sites.

v. **Key Informant Interviews**: Conducted with local government officials and health officers to explore institutional responses and challenges.

Key instruments used included:

- GPS-enabled smartphones for geolocation mapping,
- Calibrated Digital soil and water testing kits,
- Pre-tested questionnaires and interview guides,
- Health data request forms for official hospital records.

A pilot study in a neighboring community helped validate the survey instruments and sampling tools. Environmental instruments were calibrated in the lab to ensure data accuracy. All questionnaires were reviewed by academic experts and adjusted for clarity and relevance.

Ethical clearance was obtained from the relevant institutional review boards. Participation was voluntary, with informed consent obtained in all cases. Data confidentiality and anonymity were maintained, and environmental sampling was carried out with community authorization to ensure ethical compliance.

## 4.0 Results

A strong majority of respondents confirmed that improper waste disposal in Gwagwalada contributes to serious environmental degradation (Table 1).

**Table 1: Community Perceptions of Pollution from Current Waste Practices**

| Statement | SD | D | N | A | SA | Mean | S.D. |
|---|---|---|---|---|---|---|---|
| Waste disposal practices in Gwagwalada contribute significantly to environmental pollution. | 10 | 20 | 30 | 80 | 55 | **3.85** | 0.97 |
| Improper waste disposal is prevalent in my community. | 15 | 18 | 25 | 75 | 62 | **3.90** | 1.05 |
| The environment around my residence is adversely affected by improper waste disposal. | 12 | 22 | 40 | 70 | 51 | **3.75** | 1.03 |
| There are visible signs of pollution due to improper waste disposal in Gwagwalada. | 8 | 25 | 35 | 85 | 42 | **3.80** | 0.96 |
| Waste management practices in Gwagwalada are effective. | 50 | 60 | 40 | 30 | 15 | **2.45** | 1.15 |

*Source: Author's Fieldwork, 2024.*

Over 75% of respondents agreed or strongly agreed that improper waste disposal causes visible pollution and environmental degradation. The mean score of 3.85-3.90 indicates high awareness of pollution hotspots in the community. In contrast, the statement on the effectiveness of waste management infrastructure had a low mean score (2.45), reflecting a widespread lack of confidence in current systems. This suggests serious gaps in formal waste collection and treatment, which allow pollution to persist.

Respondents also recognized the economic fallout from pollution, such as impacts on property values, agricultural productivity, and public resources.

Figure 2: Refuse Dump in Gwagwalada, Abuja

**Table 2: Perceived Economic Costs of Environmental Degradation**

| Statement | SD | D | N | A | SA | Mean | S.D. |
|---|---|---|---|---|---|---|---|
| The cost of healthcare for diseases related to improper waste disposal is a significant burden. | 15 | 25 | 30 | 70 | 55 | **3.65** | 1.10 |
| Improper waste disposal has increased the costs of maintaining clean water sources. | 20 | 30 | 28 | 65 | 52 | **3.55** | 1.15 |
| Property values near waste disposal sites are negatively impacted. | 10 | 15 | 20 | 85 | 65 | **3.95** | 0.98 |
| The cost of cleaning and rehabilitating polluted areas is a public resource burden. | 5 | 18 | 25 | 90 | 57 | **3.95** | 0.85 |
| Waste-related air and soil pollution affects agricultural productivity. | 12 | 20 | 28 | 75 | 60 | **3.85** | 1.00 |

*Source: Author's Fieldwork, 2024.*

High mean scores (3.85 - 3.95) show clear consensus on economic losses due to pollution, especially in terms of property devaluation and impacts on agricultural losses. Respondents directly linked increased healthcare costs and water infrastructure expenses to improper waste management. In summary, the community perceives significant financial burdens from the environmental and health impacts of waste pollution.

Additional analysis (see Table 3) showed that socio-economic factors influence waste practices. Community engagement had the highest importance rating (mean=4.05), indicating that strong local participation is seen as crucial for improving waste

management. Higher income (mean=3.90) and higher education (mean=3.85) were also associated with better disposal practices. These findings suggest that empowering communities and improving education could reduce reliance on unsafe disposal methods.

**Table 3: Socio-Economic Influences on Waste Practices**

| Statement | Mean | Interpretation |
|---|---|---|
| Community engagement and participation are crucial for effective waste management. | **4.05** | Strong community involvement is essential for reducing hotspot risks. |
| Income level affects the ability to manage waste properly. | **3.90** | Low-income groups may resort to unsafe disposal methods. |
| Education level influences awareness and practices. | **3.85** | More educated individuals practice safer disposal, reducing environmental risks. |

Source: Author's Fieldwork, 2024.

## 5.0 Discussion of Findings

The results indicate widespread pollution hotspots in Gwagwalada driven by common widespread improper disposal practices (open dumping and burning). The high mean perception score (3.90) shows that residents strongly recognize these practices as the main causes of environmental degradation. Visible signs – such as littered soil, smoky air, and deteriorated water quality – confirm that local pollution is acute. This aligns with other findings that uncontrolled waste creates intense pollution exposure in developing regions (Mor & Ravindra, 2023; Gunarathne *et al.*, 2024).

Crucially, the survey found low confidence in the existing waste management system (mean=2.45 on effectiveness). This consensus on infrastructural inadequacy echoes reports from similar urban Nigerian settings (Ugwu *et al.*, 2020; Ezeah & Roberts, 2014). Inadequate waste services have effectively forced residents into unsafe disposal behaviors, heightening the risk of pollution-related diseases.

Health impacts were widely reported by respondents. Many observed that respiratory problems and waterborne illnesses have increased in their neighborhoods, which matches global evidence linking waste exposure to such health issues (Hantoko *et al.*, 2021; Paiva & Ugaya, 2024). The economic burden of these health effects was also clear: survey items about healthcare costs and cleanup expenses had high mean scores (3.65–3.95). This aligns with findings in other urban communities where treating waste-related illnesses imposes heavy financial strain (Mujtaba *et al.*, 2024).

The study also demonstrated that socioeconomic factors strongly affect waste practices. Respondents indicated that higher education (mean=3.85) and income (mean=3.90) enable access to safer disposal options (e.g., private collection services), whereas lower-income and less-educated groups were more likely to use informal dumps. Additionally, community involvement (mean=4.05) was viewed as a key enabler of effective waste management. These patterns support

observations by Nguyen et al. (2023) and Andeobu et al. (2021) that education, income, and civic participation shape waste disposal behaviors.

In summary, improper waste disposal in Gwagwalada is a multifaceted problem. It stems from a combination of weak infrastructure, socio-economic constraints, health vulnerabilities, and limited governance. Addressing pollution hotspots and health risks will therefore require coordinated action across these dimensions.

## 6.0 Recommendations

Based on our findings, the following measures should be considered to reduce pollution and health risks from improper waste disposal in Gwagwalada:

1. **Invest in Formal Waste Infrastructure:** Government and municipal authorities should develop covered sanitary landfills and establish reliable waste collection routes to replace open dumping.
2. **Empower Local Community Groups:** Support neighborhood associations and youth organizations to lead waste segregation, monitor illegal dumping, and educate peers on proper disposal.
3. **Enhance Public Health Outreach:** Integrate mobile clinics and health awareness campaigns focused on waste-related diseases into local health policy, ensuring communities understand the risks.
4. **Enforce Environmental Regulations:** Strengthen enforcement of anti-dumping laws, imposing penalties for illegal dumping and burning to deter harmful practices.
5. **Integrate Waste Management into Urban Planning:** Ensure that waste facilities are sited away from residential and agricultural areas. Incorporate waste management considerations into zoning and development plans to prevent future hotspots.
6. **Promote Education and Engagement:** Implement school and public education programs on recycling and waste reduction. Encouraging community participation through cleanup drives and recycling initiatives can foster lasting behavioral change.

## 7.0 Conclusion

The spatial assessment has revealed a pressing environmental and public health crisis in Gwagwalada driven by improper waste disposal. Evidence from the study shows clear pollution hotspots, significant economic strain on households and public resources, and heightened health risks from common infectious and respiratory diseases. These findings underscore the urgent need for integrated, community-focused, and policy-driven waste management solutions.

Currently, waste infrastructure in Gwagwalada is inadequate to prevent pollution or protect residents' health. However, there is a pathway to improvement. Strategic investments in waste collection and disposal infrastructure, combined with robust public health outreach and active community engagement, can steer Gwagwalada toward sustainable waste management. Such efforts would also support Nigeria's commitments to the Sustainable

Development Goals – especially SDG 3 (Good Health), 6 (Clean Water), 11 (Sustainable Cities), and 13 (Climate Action). Addressing these challenges now is critical to preventing long-term ecological damage and ensuring a healthier, more resilient future for the community.

## REFERENCES

Alcock, I., et al. (2014). Longitudinal effects on mental health of moving to greener urban areas. *Environmental Science & Technology, 48*(2), 1247–1255.

Andeobu, L., Nkwopara, U. N., & Okoro, U. O. (2021). Assessment of municipal solid waste management practices in Enugu urban, Enugu State, Nigeria. *Journal of Applied Sciences and Environmental Management, 25*(3), 481–488.

Anierobi, C. I., Okolo, N. N., & Okoye, C. O. (2024). Sustainable development goals and waste management in Nigeria: A review of challenges and opportunities. *International Journal of Environmental Protection and Policy, 12*(1), 1–8.

Cassiano, S. S., & Ugaya, C. M. L. (2024). Packaging design and food waste: environmental implications. *Food Packaging and Shelf Life, 27*, 100600.

Delemere, J., & Liston, K. (2024). Household waste reduction strategies: cost and policy implications. *Waste Management & Research, 42*(2), 120–130.

Dhall, S., Saini, V., & Gupta, M. (2024). Sustainable disposal methods for engineered nanomaterials: a review. *Journal of Hazardous Materials, 451*, 131-140.

Ezeah, C., & Roberts, C. L. (2014). Perspectives on solid waste management in Nigeria. *Waste Management, 34*(7), 1380–1386.

Fatimah, A., et al. (2024). Medication waste disposal practices among healthcare workers in Saudi Arabia: awareness and barriers. *Saudi Pharmaceutical Journal, 32*(1), 50–59.

Garcia-Garcia, G., et al. (2024). Public participation in municipal waste programs: outcomes and strategies. *Waste Management, 136*, 128–137.

Gunarathne, W., Herath, G., & Vitharana, A. (2024). Environmental impacts of improper waste disposal: A review. *Journal of Environmental Science and Engineering A, 13*(1), 25–32.

Hantoko, D., Nugraha, S. S., & Puspitasari, F. (2021). Health risks from exposure to open burning of solid waste in developing countries. *IOP Conference Series: Earth and Environmental Science, 794*(1), 012015.

Kohli, S., et al. (2024). Reducing environmental impact of food waste through policy and practice. *Journal of Cleaner Production, 330*, 129742.

Kumar, R., et al. (2024). Urban heat island mitigation through green roofs and parks. *Urban Climate, 44*, 101233.

Lee, J., et al. (2024). E-waste recycling technologies and circular economy approaches. *Environmental Science & Technology, 58*(4), 1234–1245.

Longfor, M., David, L., & Johnson, K. (2023). Urbanization and waste management challenges in African cities: A case study of health and environmental impacts. *African*

*Journal of Environmental Science and Technology, 17*(5), 321–330.

Mor, S., & Ravindra, K. (2023). Environmental impacts of open waste dumps on soil and groundwater: A review. *Journal of Environmental Management, 345*, 118745.

Mujtaba, G., Aslam, M., & Ashraf, S. (2024). Economic burden of improper waste management and its impact on public health in developing countries. *Journal of Environmental Health Perspectives, 132*(2), 027008.

Njeru, N. (2023). Impact of waste disposal practices on environment and health in Machakos Town, Kenya. *African Journal of Environmental Science and Technology, 17*(2), 115–125.

Nassary, H. M., et al. (2022). Typologies of urban green spaces and their differential effects on microclimate. *Landscape and Urban Planning, 215*, 104240.

Nguyen, V. C., Le, T. H., & Pham, T. T. (2023). Community participation in solid waste management for sustainable development in urban areas. *Environmental Science and Pollution Research, 30*(28), 71754–71764.

Nowak, D. J., et al. (2020). The health benefits of urban trees and green spaces. *Cities and the Environment, 13*(1), 1–12.

Odonkor, E. M., & Sallar, S. (2021). Socioeconomic determinants of household waste management in Ghana. *Environmental Health Insights, 15*, 11786302211025870.

Paiva, L., & Ugaya, C. M. L. (2024). Health effects of exposure to landfills: A systematic review. *Environmental Research, 243*, 117865.

Priya, R., & Senthil, R. (2021). Air purification potential of different urban tree species. *Environmental Management and Sustainable Development, 10*(2), 91–106.

Putthadee, P., et al. (2024). Environmental life-cycle assessment of construction waste management in Thailand. *Journal of Cleaner Production, 375*, 134049.

Salahuddin, S., et al. (2024). Environmental pollution and energy recovery from hospital waste incineration: A review. *Renewable and Sustainable Energy Reviews, 164*, 112595.

Sun, H., et al. (2024). Waste-to-energy: Life-cycle assessment of MSW incineration for power generation in China. *Journal of Cleaner Production, 368*, 132238.

Ugwu, M. O., Ukoba, K. O., & Akpomie, O. O. (2020). Challenges of solid waste management in urban areas of Nigeria: A review. *Journal of Environmental Science and Technology, 13*(1), 1–10.

Yaşar Menteş, E., et al. (2024). Evaluating the role of blue-green infrastructure in mitigating urban heat island. *Ecological Indicators, 155*, 110178.

Yusoff, H., Hassan, M. H., & Abdullah, M. N. (2024). The economic value of proper waste management and its contribution to sustainable urban development. *Journal of Cleaner Production, 432*, 139886.

Zhang, Y., et al. (2022). Urban vegetation and gaseous pollution dynamics: A meta-analysis. *Science of the Total Environment, 843*, 156995.