Waste Management and Disaster Risk Reduction: Community Practices, Stakeholder Perceptions, and Environmental Risk Governance in Rivers State, Nigeria

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ABSTRACT

Poor waste management is increasingly recognized as an environmental governance and disaster-risk challenge in rapidly urbanizing cities, particularly where inadequate infrastructure, weak enforcement, and unsafe disposal practices interact. This study assessed waste-management practices, stakeholder perceptions, and environmental disaster-risk hotspots associated with poor waste management in Port Harcourt Metropolis, Rivers State, Nigeria. A descriptive cross-sectional survey was integrated with Geographic Information System (GIS)-based spatial analysis. Using the Taro Yamane formula, 400 questionnaires were administered, of which 377 were valid, representing a 94.25% response rate. Data were analysed using weighted mean, grand mean, one-way analysis of variance (ANOVA), Pearson Product Moment Correlation, Pearson Chi-Square, and GIS-based buffer and overlay techniques. Results indicated generally inadequate waste-management practices, reflected in an overall grand mean of 2.22. Institutional waste-management practices were comparatively better than those reported for households and commercial centres. Respondents demonstrated strong awareness of waste-related disaster risks, with an overall perception mean of 3.55. Disease transmission, inadequate waste infrastructure, drainage blockage and flooding were among the most strongly perceived risks. GIS analysis showed that high- and medium-risk hotspots were concentrated mainly within densely populated areas and locations proximal to rivers, creeks and drainage networks. Inferential analysis revealed significant differences in waste-management practices among households, commercial centres and institutions ($F = 84.62$, $p < 0.001$), a significant positive relationship between stakeholder perceptions and waste-related disaster-risk assessments ($r = 0.768$, $p < 0.001$), and a significant association between poor waste-management practices and flooding, pollution and fire hazards ($\chi^2 = 185.37$, $df = 18$, $p < 0.001$). The study concludes that waste management should be integrated into urban disaster-risk reduction and environmental governance through improved collection infrastructure, source segregation, regulatory enforcement, community participation, drainage protection and GIS-informed planning.

Keywords: Waste management; disaster risk reduction; stakeholder perceptions; environmental governance; GIS; Port Harcourt; environmental risk

INTRODUCTION

Waste management has become an important environmental and disaster-risk concern in rapidly urbanizing regions, particularly where population growth, inadequate infrastructure, weak collection systems and uncontrolled disposal interact. In Rivers State, Nigeria, the problem extends beyond sanitation because poorly managed waste can obstruct drainage systems, contribute to flooding, degrade air and water quality, create conditions favourable to disease vectors and increase fire hazards. Ferronato and Torretta (2019) noted that waste mismanagement in developing countries is associated with environmental degradation, public-health concerns and institutional weaknesses, while Abarca Guerrero et al. (2013) emphasized the importance of technical capacity, governance, financing and stakeholder participation in effective solid waste management.

Community practices are central to the performance of waste-management systems. Household, commercial and institutional activities influence waste generation, storage, segregation, collection, reuse and disposal. Poor segregation, indiscriminate dumping, open burning and disposal into drainage channels can increase environmental exposure and disaster vulnerability. Fadhullah et al. (2022) identified knowledge, attitudes, infrastructure and service availability as important determinants of household waste-management practices, while Moeini et al. (2023) demonstrated that targeted interventions can improve waste-segregation behaviour. In Port Harcourt, Ogboeli et al. (2025) similarly identified waste segregation as an important strategy for improving urban waste management.

The relationship between waste and disaster risk is particularly important in flood-prone urban environments. Waste deposited in drainage channels can obstruct stormwater flow and contribute to localized flooding. Echendu (2023) identified waste-disposal practices as an important dimension of flood vulnerability in Nigerian cities, while Ojolowo and Wahab (2017) demonstrated the relationship between municipal solid waste and flooding in Lagos. In Port Harcourt, Weli and Efe (2020) identified urban flooding as a significant environmental sustainability challenge, while Akukwe and Ogbodo (2015) documented spatial variations in flood vulnerability across the metropolis.

Stakeholder perceptions are also important because environmental risk-reduction interventions depend partly on public awareness, behavioural responses and participation. Risk perceptions can influence household preparedness, compliance with environmental regulations and willingness to adopt safer waste-disposal practices. Yin et al. (2021) showed that risk perception influences disaster preparedness, while Wantim et al. (2023) demonstrated the relevance of community perceptions to flood control and waste-management strategies. Environmental communication can therefore support behavioural change and strengthen public participation. Obuah and Okon (2017) emphasized the importance of environmental communication in sustainable waste management.

Environmental risk governance provides the institutional framework through which waste management and disaster-risk reduction can be coordinated. Effective governance requires appropriate regulations, monitoring, enforcement, infrastructure, geospatial planning and collaboration among government agencies, communities, private operators and other stakeholders. The Sendai Framework for Disaster Risk Reduction emphasizes understanding disaster risk, strengthening risk governance, investing in resilience and improving preparedness (United Nations Office for Disaster Risk Reduction, 2015). GIS-based approaches can complement these measures by identifying environmentally sensitive areas, vulnerable settlements and locations where waste-disposal practices overlap with other hazards.

Although previous studies have examined waste management, flooding and environmental vulnerability in Port Harcourt and other Nigerian cities, there remains a need for integrated assessments that connect community waste-management practices, stakeholder perceptions and the spatial distribution of environmental risk. This study therefore combines survey evidence with GIS-based hotspot analysis to examine the contribution of waste-management practices to environmental and disaster risks in Port Harcourt Metropolis.

Aim of the Study

The study aimed to assess waste-management practices, stakeholder perceptions and the spatial distribution of environmental and disaster-risk hotspots associated with poor waste management in Port Harcourt Metropolis, Rivers State, Nigeria.

Objectives of the Study

The study specifically sought to:

1. assess waste-management practices among households, commercial centres and institutions in Port Harcourt Metropolis;

2. examine community and stakeholder perceptions of waste-related disaster risks;

3. identify environmental and disaster-risk hotspots associated with poor waste management, flooding, pollution and fire hazards; and

4. examine the relationships between waste-management practices, stakeholder perceptions and waste-related disaster risks.

MATERIALS AND METHODS

Research Design and Study Area

The study adopted a descriptive cross-sectional survey design integrated with GIS-based spatial analysis. The survey component assessed waste-management practices and stakeholder perceptions, while the spatial component examined the geographical relationship between waste-disposal locations, settlements, drainage networks and water bodies.

The study was conducted in Port Harcourt Metropolis, Rivers State, Nigeria. The metropolis is a major urban, commercial and industrial centre within the Niger Delta and contains densely populated residential areas, commercial districts, institutions, transportation corridors, drainage networks, rivers and creeks. Rapid urban development and increasing waste generation have created challenges including indiscriminate dumping, open burning, inadequate segregation, irregular collection and disposal into drainage channels.

Study Population and Sample Size

The study population comprised residents and relevant stakeholders associated with households, commercial centres and institutions in Port Harcourt Metropolis. Waste-disposal locations constituted the principal spatial units for the GIS-based environmental-risk assessment.

The Taro Yamane formula was used to determine the questionnaire sample size at a 5% level of precision. A sample of 400 respondents was targeted, and 400 questionnaires were administered. Of these, 377 were properly completed and returned, giving a valid response rate of 94.25%. The 377 valid questionnaires constituted the dataset used for statistical analysis.

Sampling Procedure

A multistage sampling procedure was adopted to achieve spatial and sectoral representation. Selected communities and urban sections were identified across the metropolis, after which respondents were recruited from households, commercial centres and institutions. Waste-disposal locations were identified through field observation and spatial referencing, with particular attention to their proximity to settlements, drainage channels, rivers and creeks.

Data Collection

Primary data were obtained using a structured questionnaire, field observations and GIS spatial data. The questionnaire consisted of sections addressing respondents' socio-demographic characteristics, waste-management practices and perceptions of waste-related disaster risks.

A four-point Likert scale was used for attitudinal and perception items: Strongly Agree (4), Agree (3), Disagree (2) and Strongly Disagree (1). A criterion mean of 2.50 was adopted. Mean scores ≥2.50 were interpreted as accepted/agreed, whereas scores <2.50 were interpreted as rejected/disagreed.

GIS and Spatial Analysis

GIS techniques were used to map waste-disposal locations and examine their spatial relationships with settlements, drainage networks, rivers, creeks and other environmentally sensitive features. A 500-m buffer was applied around relevant environmental and settlement features to assess the proximity of waste-disposal locations to potential receptors.

Spatial overlay analysis was subsequently used to classify locations into high-, medium- and low-risk categories. High-risk locations were those occurring within or in close proximity to densely populated settlements and water bodies; medium-risk locations occurred within or near settlements but had comparatively less proximity to major water bodies; and low-risk locations were relatively distant from densely populated settlements and major water bodies.

Data Analysis

Questionnaire responses were coded and analysed using weighted means, grand means and ranking. One-way ANOVA was used to examine differences in waste-management practices among households, commercial centres and institutions. Pearson Product Moment Correlation was used to assess the relationship between stakeholder perceptions and waste-related disaster-risk assessments. Pearson Chi-Square was used to examine associations between poor waste-management practices and reported flooding, pollution and fire hazards.

All inferential tests were evaluated at the 0.05 significance level. The null hypothesis was rejected when $p < 0.05$.

RESULTS

Socio-demographic Characteristics of Respondents

Table 1. Socio-demographic characteristics of respondents

Variable	Category	Frequency	Percentage (%)
Gender	Male	180	47.7
	Female	197	52.3
	Total	**377**	**100**
Age	Below 18 years	9	2.4
	18–25 years	47	12.5
	26–35 years	59	15.6
	36–45 years	125	33.2
	46–55 years	110	29.2
	56 years and above	27	7.1
	Total	**377**	**100**
Marital status	Single	109	28.9
	Married	181	48
	Divorced	31	8.2
	Widowed	56	14.9
	Total	**377**	**100**
Education	No formal education	41	10.9
	Primary	93	24.7
	Secondary	72	19.1
	NCE/OND	70	18.6
	HND/Bachelor's	73	19.4

	Postgraduate	28	7.3
	Total	**377**	**100**
Employment	Unemployed	70	18.6
	Self-employed	92	24.4
	Employed	110	29.2
	Student	62	16.4
	Retired	43	11.4
	Total	**377**	**100**

Source: Field Survey, 2026.

Table 1 shows that females constituted 52.3% of respondents, compared with 47.7% males. Respondents aged 36–45 years constituted the largest age group (33.2%), followed by those aged 46–55 years (29.2%). Married respondents constituted 48.0% of the sample. In terms of education, primary education was the most frequently reported category (24.7%), followed by HND/Bachelor's degree (19.4%) and secondary education (19.1%). Employed respondents constituted 29.2%, followed by self-employed respondents (24.4%). Overall, the sample represented a range of demographic and socio-economic backgrounds.

Waste-Management Practices

Table 2. Waste-management practices among households, commercial centres and institutions

No.	Waste-management practice	Mean	Decision	Rank
1	Household waste is properly separated before disposal	1.66	Rejected	10th
2	Household waste is stored in covered bins	2.06	Rejected	6th
3	Burning of household waste is commonly practised	3.15	Accepted	4th
4	Households participate in regular waste collection	1.43	Rejected	13th
5	Households pay for waste collection when required	1.01	Rejected	14th
6	Shops and markets provide waste bins	1.51	Rejected	12th
7	Traders properly dispose of business-generated waste	2	Rejected	7th
8	Waste is sorted before disposal in commercial areas	1.53	Rejected	11th
9	Waste-collection facilities are adequate in commercial centres	1.01	Rejected	15th
10	Open dumping is common in commercial centres	3.45	Accepted	3rd
11	Institutions have designated waste-disposal facilities	3.06	Accepted	5th
12	Institutional authorities enforce waste-management rules	1.91	Rejected	8th
13	Waste bins are provided at strategic institutional locations	3.72	Accepted	2nd
14	Institutional waste is regularly collected by authorised collectors	3.85	Accepted	1st
15	Environmental sanitation exercises are conducted regularly	1.87	Rejected	9th
	Grand mean	**2.22**	**Rejected**	

Source: Field Survey, 2026.

Table 2 indicates generally inadequate waste-management practices, with a grand mean of 2.22, below the criterion mean of 2.50. Institutional practices were comparatively stronger, particularly regular collection by

authorised collectors (M = 3.85), provision of waste bins at strategic locations (M = 3.72) and designated disposal facilities (M = 3.06). However, institutional enforcement of waste-management rules (M = 1.91) and regular environmental sanitation (M = 1.87) remained below the criterion mean.

Household practices were generally inadequate. Waste segregation (M = 1.66), covered storage (M = 2.06), participation in regular collection (M = 1.43) and payment for collection services (M = 1.01) were below the criterion mean, while waste burning was reported as common (M = 3.15).

Commercial centres also showed weak waste-management conditions. Provision of waste bins (M = 1.51), waste sorting (M = 1.53), proper disposal of business waste (M = 2.00) and adequacy of collection facilities (M = 1.01) were below the criterion mean. Open dumping, however, recorded a mean of 3.45, indicating that it was commonly reported in commercial areas.

Overall, the results indicate substantial weaknesses in waste segregation, formal collection, waste storage, disposal infrastructure and enforcement despite relatively stronger institutional collection arrangements.

Community and Stakeholder Perceptions of Waste-related Disaster Risks

Table 3. Community and stakeholder perceptions of waste-related disaster risks

No.	Perception item	Mean	Decision	Rank
1	Poor waste management contributes significantly to flooding	3.47	Accepted	6th
2	Indiscriminate disposal poses serious public-health and environmental risks	3.67	Accepted	4th
3	Open burning contributes to air pollution and respiratory health problems	3.45	Accepted	7th
4	Waste blocking drainage channels increases rainy-season flooding	3.73	Accepted	3rd
5	Poor waste management contributes to disease spread	3.91	Accepted	1st
6	Public awareness of waste-related disaster risks is inadequate	3.26	Accepted	9th
7	Weak enforcement of sanitation laws contributes to disaster risks	3.25	Accepted	10th
8	Existing waste collection/disposal infrastructure is inadequate	3.76	Accepted	2nd
9	Greater community/stakeholder participation is necessary	3.43	Accepted	8th
10	Improved waste management can reduce disaster risks and enhance sustainability	3.55	Accepted	5th
	Grand mean	**3.55**	**Accepted**	

Source: Field Survey, 2026.

Table 3 shows a generally high level of awareness of waste-related disaster risks, with a grand mean of 3.55. The highest-rated item was the perceived contribution of poor waste management to disease transmission (M = 3.91). This was followed by perceived inadequacy of waste-collection and disposal infrastructure (M = 3.76), drainage blockage and flooding (M = 3.73), and the public-health and environmental consequences of indiscriminate disposal (M = 3.67).

Respondents also agreed that improved waste management could reduce disaster risks and improve environmental sustainability (M = 3.55). Open burning and air pollution (M = 3.45), stakeholder participation (M = 3.43), inadequate public awareness (M = 3.26), and weak enforcement (M = 3.25) were also identified as relevant concerns.

Environmental and Disaster-Risk Hotspots

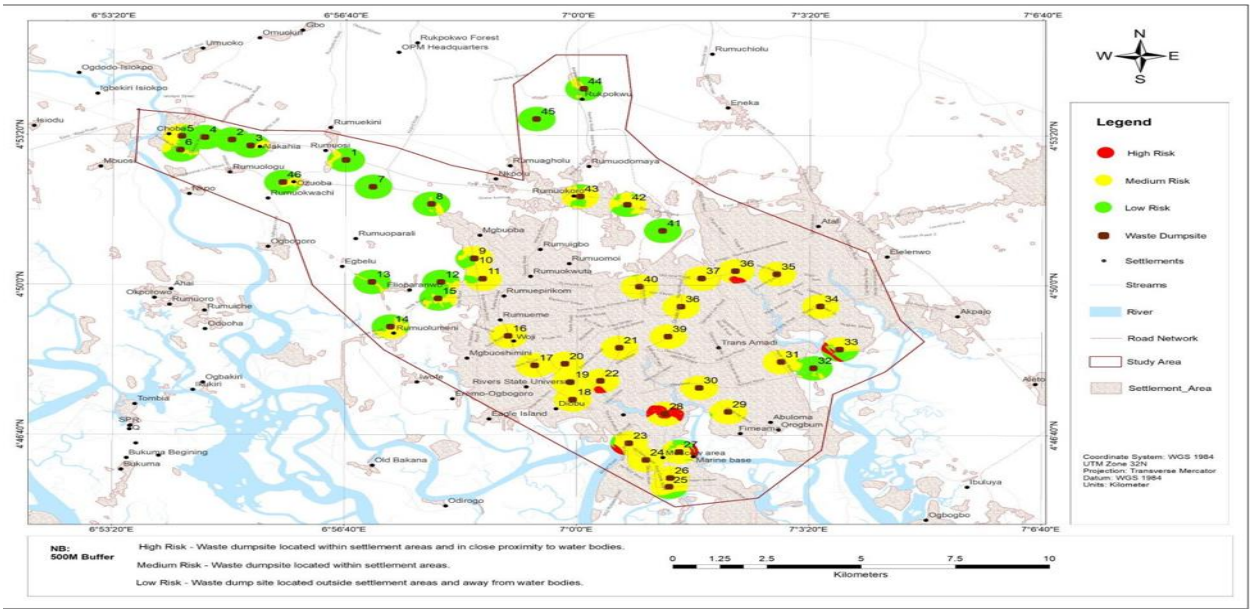


Figure 1. Environmental and disaster-risk hotspots associated with poor waste management, flooding, pollution and fire hazards in Port Harcourt Metropolis

Figure 1 presents the spatial distribution of waste-disposal locations classified according to their proximity to settlements and water bodies using a 500-m buffer and spatial overlay analysis. The resulting pattern indicates that environmental risk was spatially heterogeneous across the metropolis.

The northern areas, including Rukpokwu, Rumuokoro, Rumuodomaya, Eligbolu, Eleozu and Harmony Estate, were predominantly characterized by low-risk locations. The western sector, including Choba, Owhipa, Alakahia, Rumualogu, Rumukwachi, Ozuoba, Rumuosi and Egbelu, contained mainly low- and medium-risk locations.

The central sector, including Mgbuoba, Rumuigbo, Rumuola, Rumueme, Eliparanwo, Ogbogoro, Mgbuosumini, Rumuepirikom and Rumuolumeni, contained a relatively high concentration of medium-risk locations. The eastern sector, including Elelenwo, Trans-Amadi, Oginigba, Rumuobiakani, Woji, Odili Road and D-Line, contained medium- and isolated high-risk locations.

The southern sector showed the greatest concentration of high- and medium-risk locations, particularly around Oroworukwo, Mile 1/Mile 2–Diobu, Abuloma, Marine Base, Creek Road and Azikiwe Road. The spatial pattern indicates that locations close to densely populated settlements and surface-water/drainage networks constitute priority areas for waste-management and disaster-risk interventions.

HYPOTHESIS TESTING

Difference in Waste-Management Practices among Sectors

H_{01}: There is no significant difference in waste-management practices among households, commercial centres and institutions in Port Harcourt Metropolis.

Table 4. One-way ANOVA of waste-management practices

Source	Sum of Squares	df	Mean Square	F	p-value
Between groups	122.74	2	61.37	84.62	<0.001
Within groups	817.34	1,128	0.72		
Total	**940.08**	**1,130**			

Source: Field Survey, 2026.

The one-way ANOVA revealed a statistically significant difference in waste-management practices among households, commercial centres and institutions ($F = 84.62$, $p < 0.001$). The null hypothesis was therefore rejected. The result indicates that waste-management practices varied significantly across the three sectors.

Relationship between Stakeholder Perceptions and Waste-related Disaster Risks

H_{02}: There is no significant relationship between community/stakeholder perceptions and the level of waste-related disaster risks.

Table 5. Pearson Product Moment Correlation

Variables	r	p-value
Stakeholder perception and waste-related disaster risk	0.768	<0.001

Source: Field Survey, 2026.

A strong positive and statistically significant relationship was observed between stakeholder perceptions and waste-related disaster-risk assessments ($r = 0.768$, $p < 0.001$). The null hypothesis was rejected. The result indicates that higher recognition of waste-related environmental problems was associated with higher reported recognition of related disaster risks.

Association between Poor Waste Management and Environmental Hazards

H_{03}: Poor waste-management practices are not significantly associated with the occurrence of flooding, pollution and fire hazards in identified hotspots.

Table 6. Pearson Chi-Square test

Test	Value	df	p-value
Pearson Chi-Square	185.37	18	<0.001

Source: Field Survey, 2026.

The Pearson Chi-Square test revealed a statistically significant association between poor waste-management practices and the occurrence of flooding, pollution and fire hazards ($\chi^2 = 185.37$, $df = 18$, $p < 0.001$). The null hypothesis was rejected. The result indicates that poor waste-management practices were significantly associated with the reported environmental hazards assessed in the study.

DISCUSSION

The findings demonstrate that waste management remains a significant environmental governance challenge in Port Harcourt Metropolis. The overall grand mean of 2.22 indicates that reported waste-management practices were generally below the study's adequacy threshold. The strongest deficiencies occurred in source segregation, regular formal collection, commercial waste infrastructure and enforcement.

Institutional respondents reported comparatively stronger waste-management arrangements, particularly regular collection by authorised operators and provision of designated bins and disposal facilities. However, weaknesses in enforcement and sanitation exercises indicate that the presence of infrastructure does not necessarily guarantee consistent compliance. This is consistent with the observation of Serge and Simatele (2020) that institutional capacity and policy implementation remain important determinants of sustainable waste management.

Households showed limited participation in formal collection and waste segregation, while open burning was commonly reported. Such practices can increase local exposure to smoke, particulate emissions and other combustion products. Fadhullah et al. (2022) similarly identified household behaviour and service availability as important determinants of waste-management outcomes. The findings also support Ogboeli et al. (2025), who identified source segregation as an important component of improved waste management in Port Harcourt.

Commercial centres recorded substantial weaknesses in waste infrastructure and disposal practices, particularly the provision of waste bins, sorting and collection facilities. The high mean for open dumping indicates that commercial waste disposal remains a significant concern. Commercial areas generate substantial quantities of waste and often experience intense human activity, meaning that inadequate collection can result in rapid accumulation and secondary environmental effects.

The perception results show that respondents were highly aware of the relationship between waste management and environmental risk. Disease transmission was the most strongly perceived consequence, followed by inadequate infrastructure, drainage blockage and flooding. This finding supports the broader literature linking poor waste management with environmental degradation and public-health concerns (Abarca Guerrero et al., 2013; Ferronato & Torretta, 2019).

The strong perception of drainage blockage as a contributor to flooding is particularly important for Port Harcourt because of the city's drainage characteristics and exposure to intense rainfall. Waste deposited in drains can reduce hydraulic conveyance and increase localized flood exposure. This finding is consistent with Echendu (2023) and Weli and Efe (2020), who identified waste disposal and drainage conditions as relevant dimensions of urban flooding in Nigeria.

The GIS results further demonstrate that environmental risk is spatially uneven. High- and medium-risk locations were concentrated mainly in densely populated areas and near rivers, creeks and drainage networks.

Such spatial concentration increases the potential for interaction between waste-related hazards and human or environmental receptors. The findings reinforce the value of GIS for environmental risk assessment and waste-facility planning, consistent with studies by Eze et al. (2023) and Sibe and Gobo (2022).

The statistically significant ANOVA result confirms that waste-management practices differ across households, commercial centres and institutions. This difference indicates that interventions should not rely on a uniform strategy. Household interventions may require stronger collection access and behavioural programmes, commercial areas may require improved collection infrastructure and enforcement, while institutions may require stronger compliance monitoring and sanitation management.

The significant positive correlation between stakeholder perceptions and waste-related disaster risks suggests that risk awareness is associated with recognition of environmental consequences. However, perception alone cannot substitute for infrastructure and institutional capacity. Effective risk reduction requires the combination of public awareness, reliable services, regulatory enforcement and spatially targeted interventions.

The significant Chi-Square result further demonstrates an association between poor waste-management practices and the assessed environmental hazards. This finding should be interpreted as an **association rather than proof of direct causation**, particularly because the study employed a cross-sectional design. Nevertheless, the statistical result, field observations and GIS patterns collectively indicate that poor waste management constitutes an important component of environmental vulnerability in the study area.

CONCLUSION

The study demonstrates that waste management in Port Harcourt Metropolis is characterized by substantial weaknesses in source segregation, regular collection, disposal infrastructure and regulatory enforcement. Although institutions reported comparatively stronger waste-management practices, households and

commercial centres exhibited greater deficiencies, including household waste burning and commercial open dumping.

Stakeholders demonstrated a high level of awareness of the relationship between poor waste management and environmental risks, particularly disease transmission, drainage blockage, flooding, pollution and inadequate waste infrastructure. GIS analysis showed that environmental risk is spatially heterogeneous, with high- and medium-risk locations concentrated mainly around densely populated settlements and areas close to rivers, creeks and drainage networks.

The inferential results further established significant differences among sectoral waste-management practices, a significant relationship between stakeholder perceptions and waste-related disaster-risk assessments, and a significant association between poor waste management and the assessed environmental hazards. The findings therefore support an integrated approach to waste management and disaster-risk reduction in which community practices, infrastructure, institutional enforcement and spatial planning are addressed simultaneously.

RECOMMENDATIONS

1. Strengthen waste collection infrastructure and service delivery: Waste-management authorities should improve the coverage, frequency and reliability of formal waste collection, particularly in underserved residential and commercial areas. Adequate waste bins and collection facilities should be provided in markets, shops and other commercial centres, while institutions should maintain designated disposal facilities and regular authorized collection arrangements.

2. Promote source segregation and control indiscriminate disposal: Households, commercial operators and institutions should be encouraged to separate recyclable, organic and residual wastes at source. Regulatory agencies should strengthen monitoring and enforcement against open dumping and uncontrolled burning while providing accessible and affordable alternatives for proper waste disposal.

3. Integrate waste management with flood and environmental risk reduction: Waste should be prevented from entering drains, culverts and stormwater channels, with regular desilting and removal of accumulated waste incorporated into flood-risk management. Waste-management planning should form part of broader urban resilience and disaster-risk-reduction programmes, particularly in areas identified as environmentally vulnerable.

4. Strengthen environmental education and community participation: Sustained environmental-awareness programmes should educate residents, market groups, institutions and private operators on the links between improper waste management, flooding, pollution, disease risks and fire hazards. Community associations and other stakeholders should also be actively involved in waste-management planning, monitoring and environmental sanitation.

5. Adopt GIS-based risk planning and targeted intervention: Waste-management authorities should incorporate GIS into routine planning to identify and monitor high-risk disposal locations, prioritize interventions and guide the siting of waste facilities away from densely populated and environmentally sensitive areas. Spatial risk information should be regularly updated to support evidence-based allocation of waste-management and disaster-risk-reduction resources.

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