



Article

Flooding and Waste Disposal Practices of Urban Residents in Nigeria

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Abstract: The rising incidence of flooding is a cause for global concern. Flooding is caused by both natural and human factors. In Nigeria, flooding has been attributed chiefly to human factors, such as poor waste disposal practices and management. Despite this known link, no empirical study is known to have engaged with urban residents to understand their actual waste disposal practices and ascertain their knowledge of the connection of their waste disposal practices to the flooding they are increasingly experiencing. This work fills this gap via an in-depth engagement with residents and experts on their waste disposal practices in the flood-prone city of Port Harcourt via a mixed-methods case study. Questionnaire surveys and qualitative interviews served as the primary data collection tools. The study confirms the poor waste practices of residents and provides empirical data on the prevalence of various forms of waste disposal practices. This provides key information that can guide the needed change in waste practices to eliminate this known flood driver in the pursuit of sustainable flood risk management. This is pertinent as waste management is one of the areas where citizens have agency to act. A behavioural shift is needed in this regard and must be encouraged via targeted public sensitization. Having local vanguards champion waste management behavioural turn is also recommended. The relevant authorities are encouraged to adopt a more sustainable approach to waste management by ensuring there are waste services and putting in place adequate disincentives to deter offenders.

Keywords: flooding disaster; climate change; sustainable development; environmental management; waste management; flood risk management



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1. Introduction

Flooding is a serious disaster responsible for the most fatalities due to environmental calamities globally. It is generally a product of hydrological and meteorological extremes but is also connected to human activity [1]. The frequency of flooding events has steadily increased over the years. In 2021, the Centre for Research on the Epidemiology of Disasters (CRED) recorded a sum of 432 catastrophic events globally. This was remarkably higher than the mean of 357 yearly disastrous events for the period of 2001–2020. Flooding disasters dominated these adverse occurrences, with 223 events, followed by 121 storm events recorded in EM-DAT for the same year. This was also higher than the mean of 163 yearly flood occurrences for the same period of 2001–2020 [2]. In 2022, flooding also dominated the list of costliest (costing USD 1.5 billion or higher) climate-related disaster events [3].

While flooding events are becoming more serious and frequent globally, the most vulnerable and impacted are the poorest and developing countries, such as Nigeria, which have a lower resilience and adaptive capacity. The development setbacks and ripple effects of flooding on all indices of sustainable development cannot be overemphasized. This means that flood risk management (FRM), which encompasses actions and measures geared towards mitigating the likelihood, threats, and effects of floods, needs to be holistic and consider the root drivers of flooding. These should then be paid urgent attention.

Africa is envisaged to become a flooding hotspot in the future due to climate change and socioeconomic factors [4]. The threat of flooding in the region is so unceasing that it may happen many times in a single month, typically from rain that does not reach the right channels or overflows from the available and often inadequate channels [5]. Notwithstanding the prevalence of floods, in the Global Flood Database, flood risk and exposure in developing countries are often underestimated [6]. This is the case in Nigeria, where data collection on flooding as well as reporting is poor despite the recurring nature and frequency of flood events [7].

Nigeria, Africa's most populous country and biggest economy, is prone to annual flooding that sets back sustainable development. This flooding is also more common in urban areas during the wet/rainy season, especially in cities such as Port Harcourt, Lagos, Ibadan, Warri, and Calabar [1]. Storm severity in Nigeria is not comparable in magnitude to events experienced in developed countries, such as hurricanes and tornadoes, but the impacts of flooding in Nigerian cities are more devastating overall and is thus a great source of worry to the people (ibid).

The frequency of flooding is expected to increase in coming years [8]. Global hydrological models predict more land areas will be affected by an increase in river floods, but this will vary according to the geographical region (IPCC, 2023). The number of people exposed to flooding is also expected to double in two generations, unless preventative and mitigating actions are put in place. A better understanding of these drivers of flooding is thus critical to understand and lay the foundation for urgent and critical action. Many interacting factors have been identified as the key drivers of flooding in Nigerian cities. These factors include rapid and unplanned urbanization, poor urban management, poor infrastructure, and climate change. Poor urban management leads to development in high-risk areas and floodplains [9]. The urban poor are most at risk as they are overrepresented in the number of those living in the most flood-prone locations [10,11].

High rainfalls, a climatological factor, drives flooding in Nigeria. Rainfall quantity, duration, and intensity are showing more variations in recent times [12,13]. Climate change impacts the frequency of storms, causing flooding especially in locations that lack stormwater management infrastructure. Waste disposal practices, which falls under the larger umbrella of urban management, is a known contributor to flooding in Nigeria. Waste disposal practices in the country are dismal and have been discussed in many studies [14–17]. The blockage of drains from indiscriminately disposed waste is common [9,18]. This means the drains can no longer channel water when it rains, which floods the surroundings. Poor waste disposal practices and management is a hallmark of many African cities, where about 80% of solid waste is disposed indiscriminately in open spaces, stormwater drains, streets, streams, and rivers [19]. This practice has been linked to institutional failures and poor awareness on the part of citizens [9,20].

Despite this known link of waste management to flooding in Nigeria, no empirical study is known to have engaged with urban residents to understand the actual waste disposal practices they practice, which can guide and inform better waste management solutions. This work fills this gap via an in-depth engagement with residents on their waste disposal practices in the flood-prone city of Port Harcourt. Experts employed in the public sector knowledgeable in the field of flood risk management were also engaged in this study. The overall goal is to understand and shed light on the actual waste disposal practices of urban residents since poor waste practices are a known contributor to flooding in Nigeria. This will provide empirical evidence and knowledge on real-life disposal practices that could potentially inform solutions and improvement of waste disposal practices. Better waste management practices will serve to eliminate a known flood risk factor and directly contribute to mitigating flooding while improving overall environmental quality. Given the poor state of waste management in Nigeria and the established link to flooding, paying attention to the challenge could positively contribute to flood risk management (FRM). Putting in place sustainable and long-term FRM measures entails integrating environmen-

tally and socially acceptable measures, of which better waste management needs to be an integral aspect.

2. Study Area

This work is a case study research that took place in Port Harcourt (PH). PH is the capital of the Rivers state, one of Nigeria's 36 states (see Figure 1). It is a coastal city in the Niger Delta region and Nigeria's fourth largest city [18]. It is a city of strategic economic importance in the Nigerian polity due to the oil operations that take place in the city. Crude oil remains Nigeria's main foreign revenue earner. Climate variability is already being witnessed in the city as the mean annual rainfall, as tracked over the years of 1950–2015, and the average temperature have risen [21].

While Nigeria has rainy and dry seasons, PH experiences a longer rainy season duration due to its location, with flooding being a yearly occurrence in most parts of the city [9,22]. Many residents are thus exposed to flood risks [23]. It is expected that Nigeria's urban population will increase in the coming years [24,25]. Cities, such as Port Harcourt, are likely to absorb the majority of this urban growth based on the current trajectories. Previous research has already identified and geo-spatially mapped the most flood-prone areas in the city of Port Harcourt. The present study thus focused on already known flood hotspots to ascertain their waste disposal practices. Understanding disaster risks and designing mitigation and prevention measures are critical, especially in highly populated urban areas where the impacts are more elevated due to the concentration of human activity. Port Harcourt city also has informal settlements that are home to over 500,000 residents built on marginal flood-prone land [18]. The informality of these settlements has led to many government evictions over the years, which has drawn international attention. However, the disproportionate flood risk they experience has received little attention in research, as no work is known to have studied flooding in these high-risk locations. Waste management practices are also known to be poor in these settlements. This work thus contributes to filling this gap by engaging with both residents of formal and informal settlements to provide a first-hand understanding of their waste disposal practices in a bid to set the stage for sustainable management measures to ameliorate flooding in the city. Including the disadvantaged informal settlements in this research was a conscious choice to promote inclusivity, considering their neglect in flooding research despite the high flood risk they are known for.

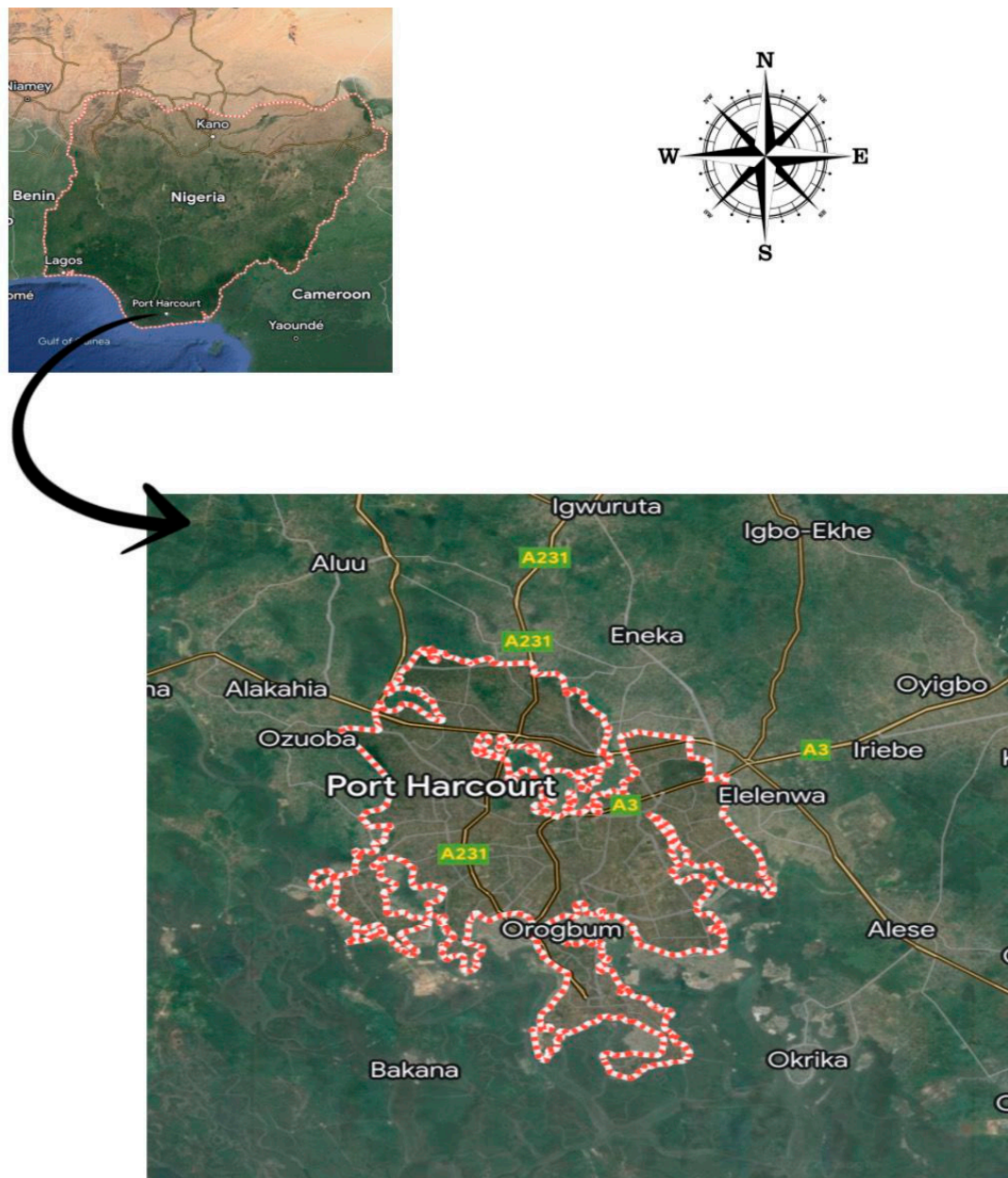


Figure 1. Map of Port Harcourt city [26].

3. Materials and Method

A mixed methods study was conducted. Primary data were collected using questionnaires, semi-structured interviews, and focus groups. Residents with lived experience of flooding and experts knowledgeable in flood risk management were interviewed. Survey data were collected from residents living in flood-prone areas in both formal and informal settlements of the city of Port Harcourt since the intention was to engage with people with experience of flooding. The survey was administered from March to May 2022. The questionnaires collected data on the demographic composition of respondents and other information relevant to the study. The questionnaires were administered in person by four research assistants with a local guide resident in each of the surveyed neighbourhoods accompanying them. This was to facilitate trust building and encourage respondents to partake in the study. The survey administration produced a fully completed and valid response number of 401. The number of samples needed to ensure representativeness in populations of an unknown sample size, such as in this study, is 385 [27]. The sample size

of 401 was thus sufficient to make generalizable conclusions for the case study. During the survey administration, the residents were asked to indicate if they would like to participate in another interview and the contact details of those who were willing were collected. They were then contacted during the qualitative stage of the interviews and interviewed. Thirty-one residents in total participated in the qualitative stage of the interviews. Four focus group discussions were conducted with twenty-one residents and ten semi-structured interviews were conducted with the rest of the participants.

Eighteen public sector experts versed in flood risk management in the city were also interviewed to understand the challenges of flooding and waste management in the city. The choice of public sector employees was made because they directly implement, and influence to some degree, environmental management decisions in the city. This group of participants were employed in various government ministries, universities, and a disaster research institute. The expert participants were recruited via snowballing. An acquaintance made the initial connection and subsequent referrals followed. Snowball sampling has been critiqued for its poor chances of establishing representativeness and sampling bias [28]. However, it was best suited in this work as a specific population was needed for this study. It also helped in building a cordial and trusting interview atmosphere as they were referred to the researcher by a person known to them. The interviews lasted an average of one hour and were recorded and transcribed verbatim using Microsoft Word. The analysis of the qualitative data followed an inductive approach, which involved condensing raw data into a brief format in order to establish links between the research objectives and the findings from the data [29].

Key categories and themes were derived via reading of the transcripts and an initial coding frame was developed. Coding is the sorting and organization of raw and often voluminous texts into clearer categories and themes [30], usually guided by research questions and responses. The transcripts were imported into QSR NVIVO (a qualitative data analysis software). The final thematic coding of the interviews was conducted using the software that simplified organizing of the data and conducting the final analysis. The participants in this work were assigned alphanumeric codes (RE1–RE31 for the residents and EP1–EP18 for the experts). Ethics approval was obtained from Queens University Kingston, Ontario, Canada, for this research.

3.1. Residents' Waste Disposal Practices in the City of Port Harcourt—Results from the Survey

The questionnaire survey elicited information on the demographic profile and waste disposal practices of residents of Port Harcourt. Table 1 is a representation of the demographic profile of the survey respondents.

The percentage of both male and female respondents in this research was uniformly distributed at 50%. A total of 21% of the respondents were aged 18–30 years, 41% were aged 31–40 years, 32% were aged 41–50 years, 5% were aged 51–60 years, and only 1% was aged 61 years and above. It is not an anomaly to have very few respondents in the upper age brackets because this research was conducted in an urban area. It is common for older people to retire and relocate to their ancestral family homes in the rural areas [31,32]. The highest level of education for 3% of the respondents was primary education, 15% completed junior secondary school, 51% completed senior secondary school, and 29% completed post-secondary education, while 2% of the respondents completed post-graduate studies. A total of 10% of the respondents were employed by the government, 71% were engaged in business or trade, and 14% worked in the private sector in a legally incorporated firm, while 4% worked in the private sector in a non-incorporated firm. A total of 24% of the respondents experienced flooding in their current neighbourhoods for 1–2 years and 34% experienced flooding for 3–4 years, while 42% experienced flooding for 5 years or more.

Table 1. Demographic profile of the survey respondents.

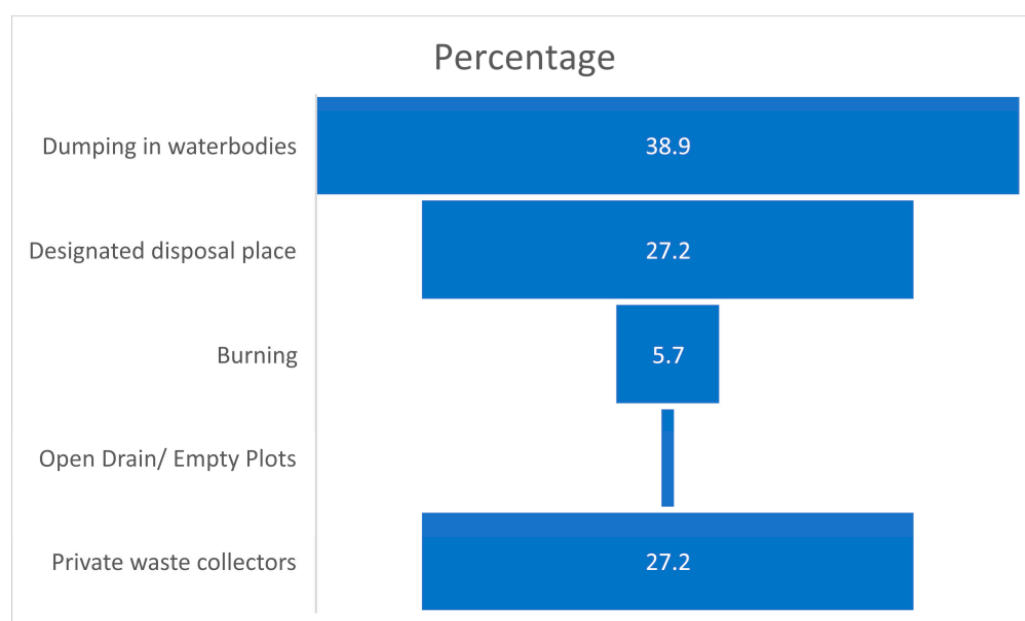
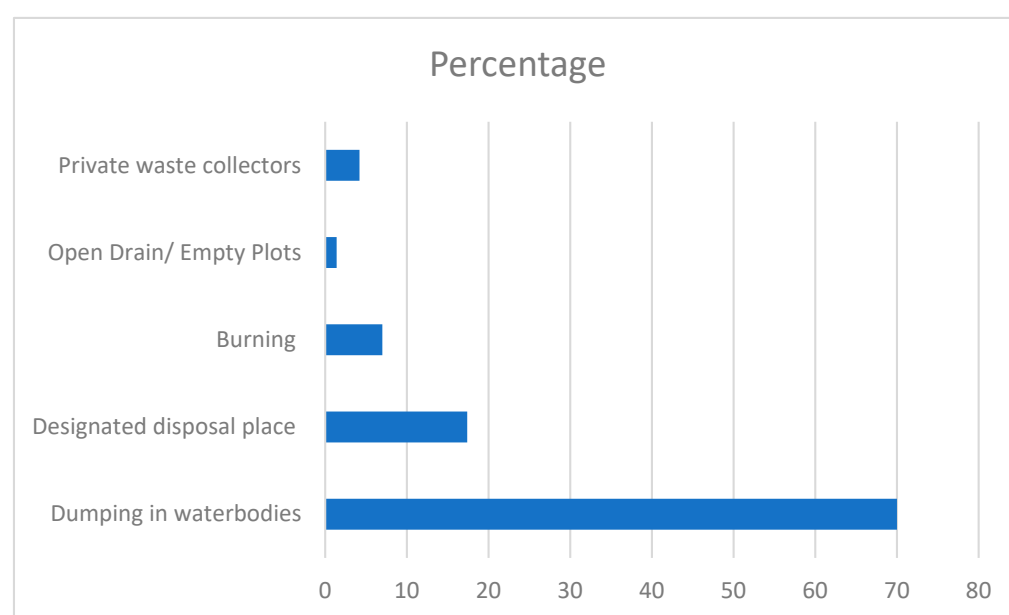
Flood Risk Vulnerability	n	Percentage
Sex		
Male	201	50.1
Female	200	49.9
Age		
18–30	85	21.2
31–40	164	40.9
41–50	128	31.9
51–60	21	5.2
61 and above	2	0.5
Missing	1	0.2
Highest Level of Education		
Completed Primary School	12	3
Completed Junior Secondary	58	14.5
Completed Senior Secondary	204	50.8
Completed Post-Secondary	118	29.4
Post-Graduate Education	9	2.2
Missing	3	0.7
Type of Employment		
Government Employment	40	10
Trade/Business	284	71.3
Private Sector (incorporated)	57	14.3
Private sector (non-incorporated)	17	4.3
Missing	3	0.7
Length of time of flood experience		
1–2 years	98	24.4
3–4 years	136	33.9
5 years or more	167	41.6

Information on the specific type of waste disposal practice undertaken by the respondents was also elicited. Evidence from the literature already provides insights on common waste disposal practices in Nigerian urban areas [1,9]. However, the actual prevalence and statistical evidence of these practices were not known, which is another gap this paper fills. In the informal settlements known as Waterside surveyed in this work, disposal in the surrounding water bodies is a common practice, and this was incorporated in the survey responses. There are also designated dumpsites in some parts of the cities where residents are expected to dispose of their refuse at set times, usually from evening to early morning, which is later evacuated by government trucks to perhaps final disposal places. The scope of this work and time limitations did not permit the elicitation of information on final disposal sites or practices by the government lorries that evacuate waste from designated disposal areas. This area is recommended for further research. Therefore, widely known waste disposal practices were included in the questionnaires for the respondents to fill in which specific practice they engaged in. Table 2 provides survey responses on waste disposal practices broken down according to settlement type (formal or informal) and also holistically, while Figure 2 is a graphical depiction of waste disposal patterns in the city as a whole.

Thirty nine percent of the respondents indicated that they dump their waste into the surrounding water bodies. A settlement-level analysis revealed that this is a widespread practice in the informal settlements (see Figure 3). Seventy percent of them indicated that they dump their waste in the waters near them.

Table 2. Waste disposal practices of residents according to settlement.

Number of Responses	Informal Settlements (213)	%	Formal Settlements (188)	%	Total (401)	%
Dumping in waterbodies	149	70	7	3.7	156	38.9
Designated disposal place	37	17.4	72	38.3	109	27.2
Burning	15	7	8	4.3	23	5.7
Open drain/Empty plots	3	1.4	0	0	3	0.7
Private waste collectors	9	4.2	100	53.2	109	27.2
Missing	-		1	0.5	1	0.2

**Figure 2.** Waste disposal practices in the city of Port Harcourt.**Figure 3.** Waste disposal practices in informal settlements.

The waterside settlements are built on reclaimed land from water. In another Nigerian city, Ibadan, most of the stream channels in low-income localities are also used as waste disposal sites by residents who cannot afford to use private waste collectors. As this act is illegal, residents venture out late at night or early in the morning to dispose of this refuse in river channels [1]. Only about four percent of the residents of the formal settlements indicated that they dump their waste in nearby waterbodies (see Figure 4). The lower numbers that reported dumping waste in nearby waterbodies in the formal settlements may be because there are no waterbodies around them in comparison to the informal settlements and not necessarily as a result of ingrained good habits.

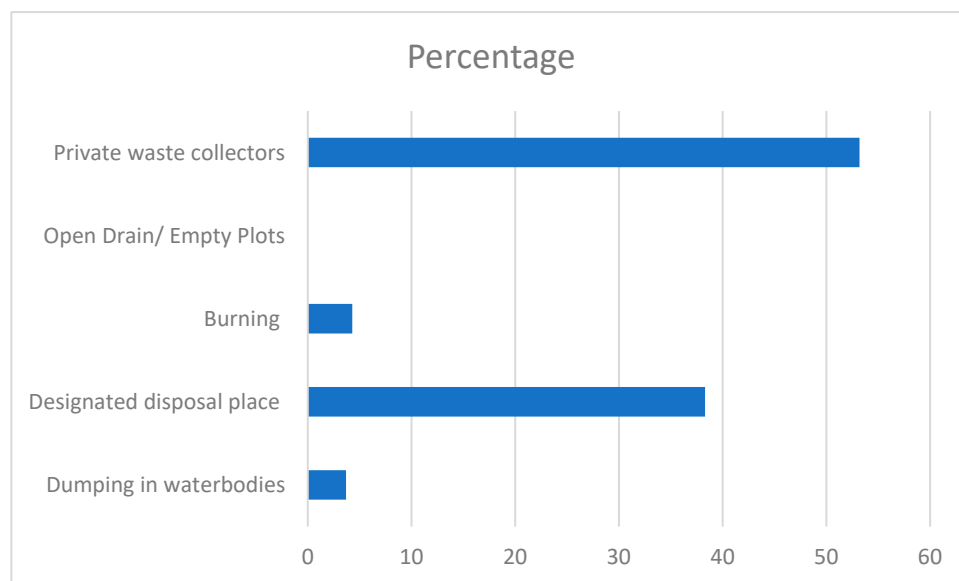


Figure 4. Waste disposal practices in formal settlements.

Overall, twenty seven percent of the total respondents reported that they dispose of their waste in designated disposal areas for later collection by government workers. Narrowing this down to a settlement level, 38% of the respondents in formal settlements conduct this, while 17% of residents of informal settlements reported conducting this. Burning is also a waste disposal practice, with 6% of the respondents reporting conducting it. In the informal settlements, this was 7% of the respondents, while in the formal settlements, it was 4% of the respondents. A small number of the residents (1%) of the informal settlements also reported that they dump their waste in open drains or empty plots of land, while no respondent from the formal settlement reported this as a waste disposal method they practiced. More than half (53%) of the residents of formal settlements use private waste collectors, while just 1.4% of the respondents in informal settlements reported the use of private waste collectors. There are private waste collectors in the city who charge a fee for their waste collection and disposal services. There is not much information on how they eventually dispose of the waste they collect. This also presents an opportunity for future research that is geared towards better waste management practices.

The results on waste disposal practices confirm the widespread poor waste disposal practices that has been widely reported in previous research [1,9]. Waste disposal practices are worse in the informal settlements, where the waste dumped into the waters end up washing in the settlements, making for an unpleasant sight (see Photos 1–3). For many residents in these areas, dumping waste into the waters is all they know and a practice they have conducted over the years, which means that they do not think that there are any problems with the behaviour. This waste disposal practice could have a direct impact on their livelihood, as some residents of the informal settlements fish for a living and pollution has been linked to depleting fish population [33]. This would mean a smaller catch for fishers who live in the area. The Waterside informal settlements were originally temporary

settlements for fishers, before they evolved into the communities they have become today. It would be interesting to engage more with fishers in the informal settlements to understand their perceptions on how waste disposal into the waters impacts marine life and their livelihood. This can create opportunities that help them to realize and possibly take charge in working towards a change in habit, which can help to control flooding while improving the overall living and sanitary conditions in the Waterside settlements. The high levels of waste disposal into natural waterbodies may be linked to the lack of access by vehicles to the waterside settlements due to their location. This makes it impossible for waste disposal lorries to access the communities for waste collection. As indicated earlier, the standard practice in the city is for waste to be dumped in designated collection points. For the waterside settlements, such points could be designated at the closest points accessible by waste collection trucks to discourage the prevalent dumping of waste into surrounding waterbodies. Additionally, the location of the waterside settlements makes them prone to both fluvial (river) and pluvial (rainfall induced) flooding, which is aggravated by dumping waste into open waters.

3.2. Findings from the Qualitative Interviews

While the quantitative part of this research yielded insightful statistical data on the waste disposal practices of residents, the qualitative aspect provided an opportunity to further discuss these findings in connection to the annual flooding that plagues the city. The participants remarked that the poor quality of water infrastructure, such as drains, of which the majority are open drains, do little to control the flooding in the city, especially as their open nature makes them easy dumping sites for undisciplined citizens.

Solid waste commonly causes the blockage of the available drainage infrastructure, which increases flood risk all over the country [26–35]. The disposal of household waste in drains, especially during rainfalls or in open spaces, is common [16,35]. The prevalent poor waste disposal attitude is reinforced by the lack of alternatives, even though there is some level of awareness among citizens on the link between indiscriminate waste disposal and flooding [7]. A poor choice in waste disposal has contributed to more widespread flooding in Port Harcourt, even in areas not originally prone to flooding. EP2 affirms this and connects the increasing flood incidence in the city to solid waste blocking the flow of rainwater. He stated:

‘The flood now is getting worse because before it doesn’t occur so often, but now it does happen regularly. Even this road [pointing to a road within view] you see is flooded when it rains. The cause is that the drainages are full of garbage’.

The poor drainage infrastructure in the city was highlighted by EP5, who lamented that the available drainage has been taken over by refuse. He stated:

‘The major problem is absence of comprehensive drainage plan for the city. Now, the few drainages that has been provided has actually been turned into waste dump sites by the citizens or people who live in PH. The idea of dumping waste you know, urban waste into streams, rivers and manmade drainage channels is actually another key factor [that cause flooding] and should be taken into consideration’.

EP15 also highlighted waste practices as a contributor to the flooding stating:

‘What I’ll say is that the flood situation right now is not as a result of torrential rainfall, but it is as a result of environmental changes. And then secondly, the residents or the inhabitants of a place not doing the right thing. They are dropping refuse in the drainage, blocking the drainages by building on it. Because of this, the drainages are blocked, and a little rain causes flooding and when there’s high tide in the riverine areas. . . most of the places have been built up. There’s no space for water to flow through. So definitely, there will be flood. . . because the drainages are blocked’.

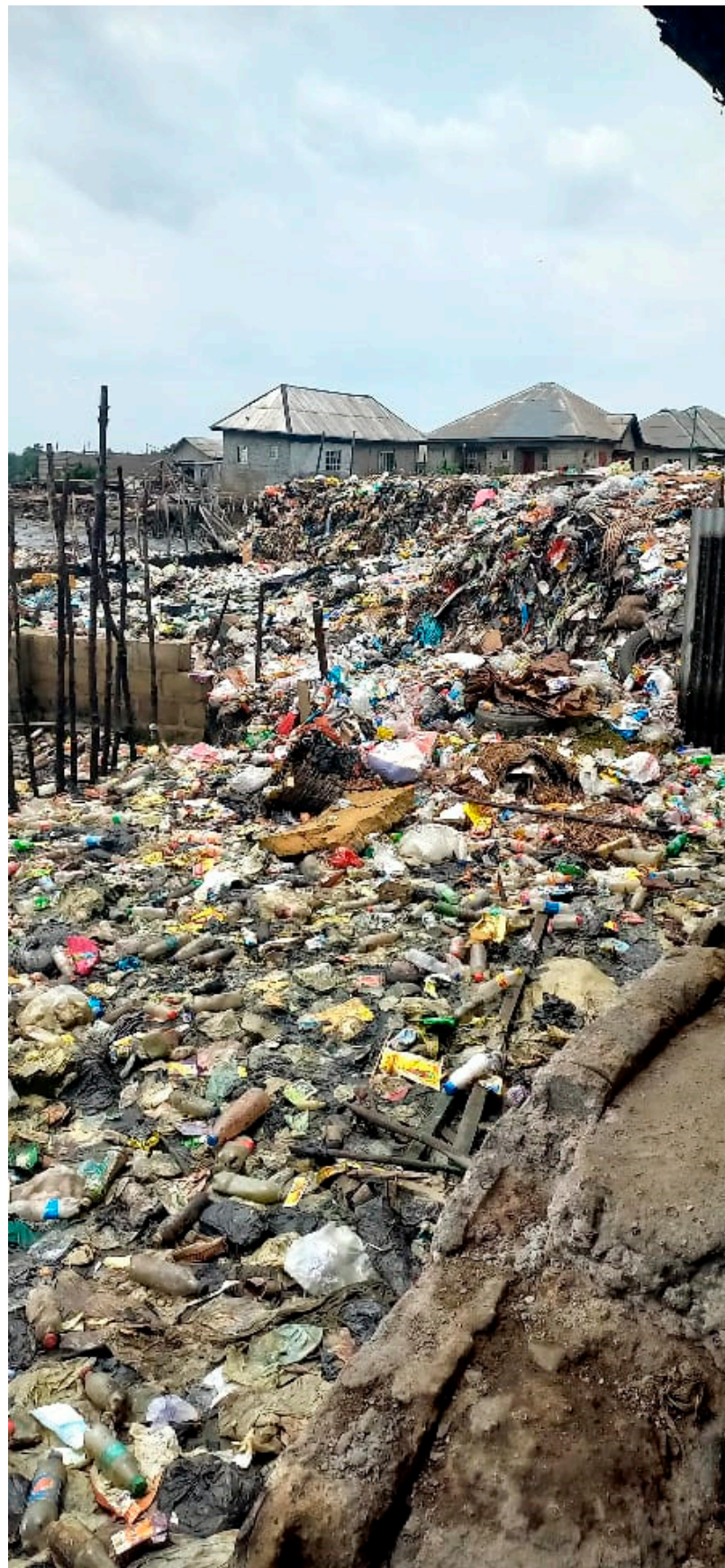


Photo 1. Waste surrounding homes at Waterside.



Photo 2. A Waterside settlement surrounded by waste.

Certainly, the city has witnessed considerable environmental transformations from its early days. The unplanned or poor nature of this urban growth has seen developments occur in flood plains and water channels, a situation that has aggravated the occurrence of flooding disasters in the city [18]. The impacts of climate change are also being experienced in terms of a higher mean annual rainfall over the years [21].



Photo 3. A major road in the formal settlements of Port Harcourt, with the road divider being used as a temporary waste dump for later collection by the relevant bodies.

RE1 affirmed that the blockage of drains causes flooding. We know at present that it is principally waste that blocks these drainages. She highlighted:

‘What is happening [flooding] is as a result of blocked drains as in over time the canal is beginning to narrow out so it cannot carry the amount of water that is coming in’.

RE17 also commented on the dominant practice of dumping refuse in drains as well as the lack of routine maintenance. She decried both the government’s lack of maintenance of drainage systems in the city and the citizens’ practice of dumping trash there.

EP11 attributed the prevalent indiscriminate disposal practice to lack of a feeling of ownership and responsibility on the part of residents and governance failure in waste management. He noted:

‘If you feel a sense of responsibility to make sure that where you live is in a good condition you don’t necessarily need to dump your waste in a water channel or drainage. That’s one part, the psychological part, and then the other part is we don’t have a well integrated urban waste management system. People must dump their waste somewhere and then finds a way to in the middle of the night. They go to the stream and dump their waste and walk away’.

RE25, another resident participant, emphasized the practice of residents believing that, during rains, it is a good time to dump refuse and the overall ineffectiveness of government-mandated environmental sanitation days, saying:

‘Our usual environmental day (environmental sanitation days are days of the month set aside by many state governments for citizens to clean up their environments. It is

usually for a few hours of the day in the mornings. Movements are not permitted except for those on essential duty) has become a jumboro (RE25 uses the term jumboro to explain it is meaningless or not taken seriously). Nobody cares about it, not even the government. So, the flood now has become a way of cleansing and cleaning of refuse so much so that when the flood comes, people say ehhhh, it's a free day, everybody empties their refuse into the flood'.

This practice was also confirmed by EP4, who highlighted:

'The way people behave, . . . when rain is falling you see them pouring refuse inside the gutter, where water is flowing, then where is that water going to? At times, it will go and block the channel. Once it blocks the channel or flow, the water will now recede back and then cause a disaster. So basically, that is the cause of flooding in Port Harcourt. Some persons people will throw plastic bottles into the drain. Purposely, when rain is falling you see people especially in this Diobu axis and Port Harcourt township, you see them pour refuse so that the running water will take it along, taking it along to where?'

When it rains, it is not uncommon for some residents to use the opportunity to dispose of their garbage during rain event. Researchers have also directly observed residents dumping waste in drains and canals whenever it starts raining [1]. This waste hinders the free flow of rainwater, which then overflows and causes flooding in the surrounding environment.

There are also routine community efforts to clear blocked drainage as evidenced by the mandatory clean-up days set aside by various state governments for environmental sanitation. However, these often prove ineffective because the excavated waste from drains ends up being mostly dumped next to the existing drainage or used to fill potholes on the road. This still ends up being returned to the drainage system when it rains [7,36]. Waste management is a core part of urban governance, but this remains a problem for many developing countries and contributes enormously to flood risk [37].

The participants in this research recognize the importance of changing waste disposal habits to alleviate flooding, given the prevalent indiscriminate methods of refuse disposal, including dumping waste in drains during rainfall. There are regulations guiding waste disposal, but the lack of enforcement of environmental laws is widespread [38].

The issue of poor waste management facilities cannot be overlooked and was pointed out by many of the participants, including RE1, who stated thus: 'there are no waste disposal facilities, and it is the government that will provide the waste disposal facilities'.

EP14 showed more nuance in the waste disposal problem, dividing the blame between the citizens and the government, stating:

'Arguments can be that there are not enough receptacles for waste, but it is more than just getting established waste receptacles as the case may be. We still see cases where people take a can of Coke or Yoghurt on-transit and then throw it out of the window. So, it's an issue of attitude not just about the absence of receptacles'.

Sights captured in the photographs shown in this work are commonly spread across settlements in the city. Harrison, an academic at the Rivers State University of Science and Technology, led research to understand the trend of dumping refuse on median road dividers, which is a fairly recent trend. These road dividers were only installed a few years ago, but they are at present waste disposal areas. He explained:

'Why are people dumping their waste there? I discovered that it was because of inefficiency in the location of waste collection points by the principal authority. As the settlements are growing, the approved dump sites are also not growing to meet the expanding situations. So, what we have is people will now dump it there. More so, the waste collecting agencies like the contractors too are encouraging it because they feel it's easier for them because their motor [waste collection vehicle] will just be rolling slowly and they will be taking it in or whatever but that's wrong. So, there are a lot of institutional challenges ranging from inefficiency in the provision of where waste should be gathered within the settlements and then encouragement like I said from waste contractors by allowing people to put their things along the middle so they can easily collect it. . . and a lot of other technological issues'.

According to Harrison, proper conduct is being sacrificed for the sake of convenience by the encouragement of waste disposal on the median separators on the roads. In some other Nigerian cities, news of arrests of defaulters, who indiscriminately dispose waste, have been reported [39,40]. However, news of similar arrests in Port Harcourt have not been reported or publicized in the media, although there are warnings against such actions on mass media, such as the radio. This suggests that stronger action is needed from the government with disincentives put in place against such actions as has been conducted in cities such as Lagos, where the apprehended offenders have been prosecuted. This can have the effect of discouraging others from partaking in poor waste disposal practices.

4. Discussion

The findings of this research reinforce and validate that poor waste management contributes to the flooding problem in the city. This work provided statistical data as well as qualitative evidence on the prevalence of various waste disposal practices. The need for urgent action cannot be overemphasized, and sustainable waste management deserves immediate attention in flood risk management. The poor waste disposal attitudes of residents, bordering on ignorance and lack of awareness of waste management, as well as the failings on the part of the governmental waste disposal authorities, contribute to flooding in Port Harcourt. The findings of the surveys administered in this research underscore the dismal waste disposal attitude, where the majority of the respondents admitted that they dispose of their refuse in waterbodies. The interviews with residents also reinforced the waste management conundrum. The experts in this research, who work and are knowledgeable in the field of flood risk management, also named poor waste disposal and management practices as culprits in the perennial flooding that plagues the city. This is a problem in both the formal and informal settlements of the city. The participants also proposed solutions that must be citizen-led for effectiveness. The statements of EP2 and EP7 aptly captured the suggestions proposed by the participants in this research.

EP7 State's: 'Citizen education is key. Community mobilization is needed. RIWAMA [Rivers State Waste Management Authority], the waste management agency can have for example, a Diobu community waste management committee that works with the people who live around there so that they see it as their own problem and then they work with RIWAMA at a higher level and then the Choba, Aluu (Choba and Aluu are also urban communities in the city) environment can have their own committees for that area. Then if you have that stage where you create citizen participation, I am sure that over time, this idea of urban waste management being a community thing will be ingrained in the thoughts and life patterns of the people. So, we have a psychological part and then we have a governance aspect which has got to do with lack of infrastructure, system failure and of course the government will always talk about finance. But I think that waste management if properly coordinated can be self-sustaining'.

EP2 emphasized the Need for Deeper Grassroots Engagement and Sensitization and States: 'We need awareness campaigns to sensitize our people, especially those of them at the grassroots to know the impact of flooding to them and because they do not know. Most of them will keep their refuse until rain comes and they pour into the drainage. Then the drainages take the refuse to maybe a culvert and because of the cans and plastics the drains outlet gets blocked and the water level around there rises causing flooding.'

The need for change in the waste disposal practices is evident from the findings of this research. Individual measures can contribute to mitigating flood risk capacity [41]. In this research, there was a widely held conviction that flood protection lies within the purview of the government rather than private responsibility, leading to a reduced perception of individual agency. Yet, waste management is an area where individuals have agency and can contribute the most with regards to FRM. This agency does not negate the fact that there are limitations to what individual actions can achieve in flood risk management in the absence of basic infrastructure, such as drainage, and also the role of the government in providing good waste management services. Behaviour-related changes in FRM flood-

prone areas have been labelled a '*behavioural turn*', with individuals being the key target group for necessary behavioural modifications [41]. This is most needed in Port Harcourt and even other parts of Nigeria and must be intensively advocated for. Local leaders living in the communities can lead this. The dominant waste disposal practices are very poor. A behavioural shift is needed in this regard and must be encouraged via targeted public sensitization. The demographic information garnered from this research provides an idea into who the residents are and could help to guide the direction of communication. For example, among the youth, social media could be leveraged as a viable tool for engaging with this demographic, while newspaper and radio sensitization could be used to reach the older demographic. Religious institutions also have a role to play in the sensitization considering the high reverence that a significant proportion of the locals have for religious leaders. A new consciousness regarding sustainable waste management practices is critical and when this becomes ingrained in individuals, the result is better waste disposal practices on a larger societal level. Educating and having local vanguards, for example, fishermen, in the informal settlements who are directly impacted by these practices can help to control the indiscriminate dumping of waste in the waterbodies of the informal settlements. The local community and neighbourhood associations/taskforce that are known work on committees such as electricity provision and road maintenance can also be convened to work in the area of better waste disposal. Upstream solutions to the problem of plastic waste (being the chief waste product) also deserve critical attention in both research and policies.

5. Conclusions

Waste management is a significant contributor to flooding that has been established by research. However, no empirical study is known to have studied the preferred or actual waste disposal patterns of citizens in flood-prone urban areas in Nigeria, a gap this study fills. The limitations of this study include the number of neighbourhoods surveyed in the city. The most common waste disposal method by the residents in this research was dumping in water bodies, with 39.2% of the participants adopting this method. A settlement-level analysis revealed this is very common in informal settlements located on marginal lands, where 70% of the respondents dispose of their waste in the surrounding waterbodies. A total of 27.2% of the participants dispose their waste in designated disposal locations for later collection by municipal authorities. The same percentage of residents use private waste disposal, with no information on where these private collectors eventually dispose of the waste. A total of 5.7% of the participants burn their waste, while a small percentage dump their waste in open drains and spaces. The qualitative interviews established that the connection between poor waste management and flooding is well acknowledged by the residents. This indicates the engagement in poor waste practices is not due to lack of knowledge on the impact of poor waste disposal practices. This means state authorities need to ascertain the missing link responsible for poor citizen behaviour regarding waste management. Previous research has named a lack of adequate services or alternatives as a factor that falls under the purview of the government. With the knowledge provided by this study, there is a clearer picture of real-life waste disposal practices that can inform sensitization programs and also guide waste services' improvement. Adequate disincentives must also be put in place to deter offenders. A behavioural turn is needed on the part of the citizens, while municipal authorities must urgently improve waste management to eliminate a known factor in the flood risk to which the city is exposed, while improving the overall environmental quality and sustainability at the same time. In addition to the recommendations proposed in this study, other ways to achieve this behavioural turn and practical ways of improving waste management locally are areas suitable for further research. It is critical that integrated waste management becomes a key part in the management of urban flooding in the city, especially considering the fact that waste management is a flood-causative factor in the city.

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