Household waste disposal attitude and perception of flood risk in Somolu, Lagos State, Nigeria

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ABSTRACT

Urban flooding is a perennial problem in Lagos state, Nigeria, given its location by the coastline, improper drainage and waste management, and a rapid rate of urbanization. Practices of open waste dumping into drainages in higher elevation areas increase flood risk downslope. The study thus analyzed residents' perception of flood risk and household waste disposal in Somolu Local Government Area, Lagos State, to further understand the situation of waste in the area as well as the relationship between flooding and waste disposal practices along varying degrees of elevation. Spatial and non-spatial data sources were utilized via field measurements using GPS and a social survey, where the questionnaire was administered to 200 respondents. The findings reveal that the elevation of the area varied from 2m to 20m above sea level. Generally, waste is collected mainly in waste baskets. It is disposed of in waste trucks and public bins, with a few respondents alluding to disposing of it in drainage and on roadsides. Public bins were used mainly in high-elevation areas, facilitating a higher rate of disposal than those in the mid and low elevations, which rely mainly on the waste vans. Only about 35% of the respondents experienced frequent flooding in their streets, the majority blaming it on the dumping of refuse in unsanctioned places. Increased efficiency by waste van operators, proper maintenance of public bins, and adoption of more flood-resilient management strategies, especially in the lowlands, were recommended.

Keywords: *Flood risk, Waste Disposal, Elevation, Drainage, Attitude, Perception, Lagos*

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1. INTRODUCTION

A large portion of the global population currently lives in cities, and this is expected to continue in future decades, particularly in developing countries. Indeed, concentrating large groups of people in one place increases the volume of activities that consume resources and create waste for the environment to deal with (Oyelola, Babatunde, and Abiodun, 2008). Solid waste (SW) mismanagement is of global importance. It requires integrated evaluations and all-inclusive approaches, given its significance for social inclusion, economic stability, and environmental preservation (Ferronato and Torretta, 2019). The goal for local authorities is thus to manage waste sustainably. The number of resources consumed and waste generated per capita increases proportionately with the population's per capita income (Adeyemi, Olorunfemi, and Adewoye, 2001; Oyelola *et al.,* 2008). Since 1990, per capita waste creation in developed countries has increased about threefold, a rate roughly six times higher than in developing countries. However, as the world's population and living standards continue to rise in emerging countries, waste creation is increasing rapidly. If current trends continue, the world's waste generation might multiply more than fivefold by 2025 (Euiyoung and Sunghan, 2002).

The apparent increase in the volume of waste being generated globally is at a rate faster than the ability of the authorities to expand on the financial and technical resources needed to match this growth (Aderogba, 2012). Indeed, Suocheng, Tong, and Yuping (2001) estimated that the global generation of municipal solid waste in 1997 was 0.49 billion tons, and an expected annual growth rate of 3.2 to 4.5% in developed nations and 2 to 3% in developing nations over the years. Chandak (2010) also noted that about 2.5 to 4 billion tons of waste was generated globally in 2006, out of which municipal solid waste was 1.84 billion tons. As a result, proper management of municipal solid waste (MSW) is necessary (Chifamba, 2007). However, such management must adhere to established legal, social, and environmental rules that protect people's health as well as the environment (Salvato, Nemerow, and Agardy, 2003). Most city administrators throughout the world have adopted and put the concept of sustainable municipal solid waste management into practice. In contrast, because different countries' social and economic situations are reflected in their consumption patterns, technological development levels, and other factors, municipalities in different countries have chosen different approaches to solid waste management.

Rapid urbanization in cities in Nigeria has put a strain on the country's urban infrastructure. This has become apparent in waste management, where the current system appears unable to deal with the daily deluge of generated waste (Adepoju, Salimonu, Onabanji, and Agedeyi, 2017). Waste collection from different sources, including households, factories, etc., to dump sites is a challenge in developing countries where waste management is said to account for about 30 to 50% of municipal operational budget (Ojolowo and Wahab, 2017). Fakinle *et al.* (2020) estimated that about 10,000 tons of solid waste are generated each day in Lagos, with a generation per capita (GPC) of 0.65kg/person/day. On their part, Ojolowo and Wahab (2017) stated that the collection rate is about 43%, estimating a total of 2,468,707.57 m3 of MSW deposited at landfill sites in Lagos State from January to September 2014.

The challenge of waste management is perennial, mainly in various countries and more so in the developing ones, seeing that

there is a correlation between urbanization, population explosion, and an increase in volume of waste generation (Narayana, 2008). Over the years, waste disposal has become a significant problem in Lagos State, Nigeria, despite various efforts made toward effective and appropriate management. Indeed, urban centers such as this are experiencing an increased rate of environmental deterioration, as refuse is being daily dumped along drainage channels (Adepoju *et al.,* 2017). Poor waste disposal practice and inadequate waste collection points have resulted in the indiscriminate dumping of waste refuse in drainages, both natural and artificial, roadsides, and available spaces in the Somolu Local Government Area, Lagos State. This is worse during the rainy season, posing a significant problem as a result of the drainage being blocked.

Improper disposal of waste poses a threat to the environment and, indeed, public health. However, residents' perceptions of the consequences of the adopted waste disposal method go a long way in determining their attitude towards it. The public's perception of and desire to participate in optimum waste management methods is influenced by several factors (Adekunle *et al.,* 2012). Indeed, such factors as distance to disposal site, transport cost, and convenience come into play. With several drainages blocked almost all year round in Somolu LGA, the study assessed residents' perception and attitude to open dumping and the predominant waste disposal methods in the area. This was, however, done by evaluating the variation along elevation areas, seeing that waste-generated upland will ideally flow through the drainages down to the canal, posing a long-term danger of environmental pollution due to flooding in lowland locations.

Flooding is a common natural disaster in Sub-Saharan African cities, owing to poor infrastructure, particularly that which mitigates extreme weather events. Poor urban planning, in combination with other urban governance challenges, contributes to putting African urban slum dwellers at risk, leading to new development in flood-prone areas and those that should instead be left undeveloped (for example, wetlands) due to their significance as buffers against flooding (Adelekan, 2010). The insufficiency of the drainage network, which is sometimes inadequate to evacuate stormwater after heavy rains, exacerbates floods in lowland places like Lagos, which are inherently prone to flooding. The problem is further compounded by the culture of dumping solid waste on roadsides and in drainage systems without regard for the environment.

Uncontrolled urban growth, weak institutional capacity and coordination, inadequate and poorly maintained drainage systems, inappropriate solid waste management practices, as well as inadequacies or non-existent early warning systems and public awareness are all major contributors to flood risk in the state (Lucas, 2021). Indeed, Correa et al. (2011) stated that with the world having a population approaching seven billion, and the combined effect of rapid urbanization and frequent natural disasters, there is a significant increase in the risks to which millions of people are exposed, especially in developing countries. One such disaster common in Lagos is floods facilitated by waste practices such as open dumping. Zambarno *et al. (2018)* claimed that the rising frequency of floods in Lagos is due to the indiscriminate dumping of waste into drainage systems, which clogs the system and prevents water flow and runoff. Furthermore, urbanization and high population density are compromising the design of drainage systems, which are mainly built to cope with lesser volumes of runoff and their ability to

handle flood water, according to Atufu and Holt (2018).

The consequences of flooding are rarely documented, even though the rate of floods in different parts of the Lagos metropolis has been a source of concern and hardship for residents and government officials in recent years (Aderogba, 2012). Floods in Lagos have caused building collapses, submerged markets, destroyed property, and displaced over 300,000 people since the early 1970s (Ojolowo and Wahab, 2017). Flood-related economic losses in the state are estimated to be USD 4 billion per year, or 4.1 percent of the state's GDP, or 1.0 percent of national GDP (Croitoru *et al.,* 2020). Recent road and channel infrastructure renovations for flood management in Somolu have resulted in the replacement of the majority of the open drainage systems with covered ones, even though those in a number of streets are still uncovered and constantly full of solid waste. Ge *et al.* (2021) noted that an understanding and improvement in public perception of flood risk is essential for its management.

Earlier studies identified drivers of flooding in several parts of Lagos and the nature of waste management, but this study focused on investigating these two phenomena along lines of elevation. The study thus assessed predominant waste disposal methods and the nature of flooding in the area. It further established the implications of these phenomena for sustainable waste and flood management in Lagos State.

2. STUDY AREA

Somolu Local Government Area (LGA) is a residential area located within the Lagos Metropolis between Latitude 6°31’12’’N, 6°33’36’’N, and Longitude 3°22’22’’E, 3°24’36’’E (Figure 1).

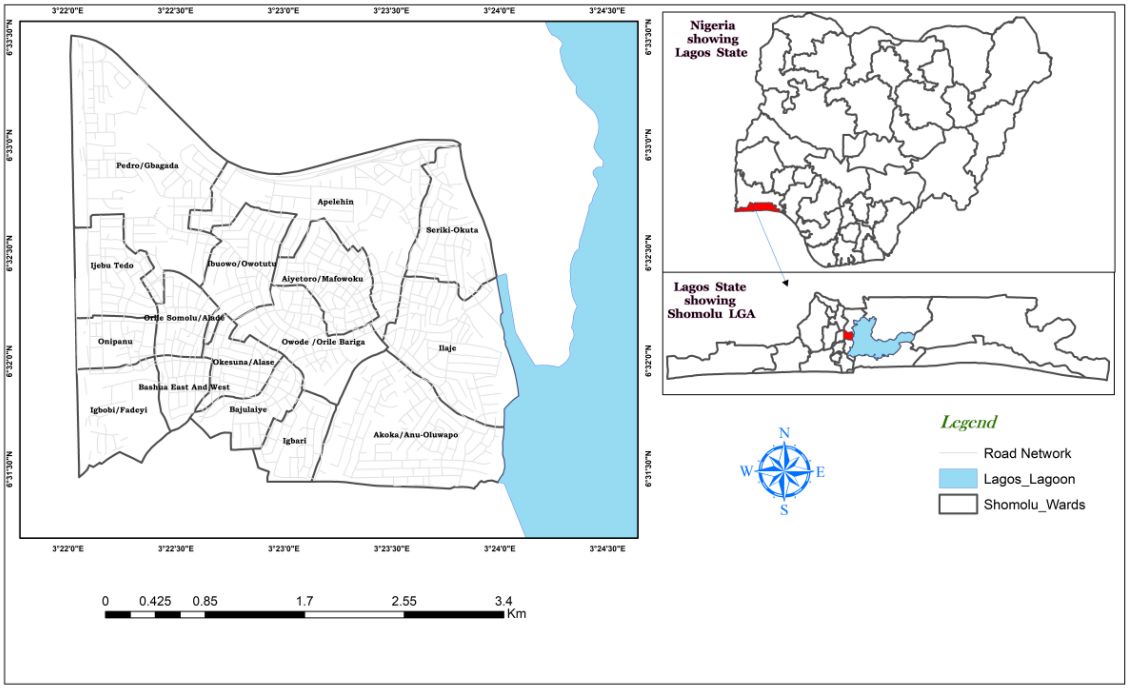

Fig. 1: The Study Area (Somolu Local Government Area: Source: Author, 2022)

Significant wards in the LGA include Onipanu, Akoka, and Pedro, among others. Somolu had a population of 402,673 persons as of the 2006 census, with an area of 14.6 km2. The topography and relief of Somolu Local Government is low and covered by nearly uniform terrain, made up of mainly sandy soil. As a result of its natural layout, settlement was possible on this slightly elevated upland area of Lagos, where dry land exists away from the coastal plain. The rock type is a sedimentary basement complex of Precambrian origin. The types of soil mostly encountered here are sands and clays, which are predominant in Lagos. The soils are frequently saturated by water that appears grey because the minerals that give them red/yellow colours have been eroded.

The region has a tropical wet and dry climate that borders a tropical monsoon climate. It experiences two rainy seasons, with the heaviest rains falling from April to July and a weaker rainy season in September to November. There is a brief, relatively dry spell in August and a longer dry season from December to March, which is termed the harmattan period. This period is characterized by hot and dry weather with very low relative humidity. Monthly rainfall between May and July averages over 400mm, while in August and September, it is down to 200mm, and in December, as low as 25mm.

3. MATERIALS AND METHODS

A pilot survey was conducted primarily to become acquainted with the study area and the characteristics of potential respondents. Before arriving at a final format, the questionnaire to be administered was tested and changed. The nature of the water flow downstream to the canal was noted. Field measurements were taken using a GPS to determine the latitudinal and longitudinal positions as well as the average elevation of each street. This was done to validate reconnaissance data acquired from Google Earth. An elevation map of the study area was produced using the kriging surface interpolation method in ArcGIS 10.5. This enabled the division of the study area into three elevation zones: high, moderate, and low elevation regions. The study used a stratified sample technique, in which sample streets were selected from each of the elevation zones, and then respondents were chosen at random on those streets. A total of 200 copies of the questionnaire were distributed around the area, as seen in Table 1.

Table 1: The sampling frame for Questionnaire Administration

S/n	Street names	Elevation	Number
	High Elevation		
1.	Fasanya Street	20m	20
2.	Adenekan Street	18m	20
3.	Mafowokwu Street	16m	20
	Mid Elevation		
4.	Isaac John Street	14m	20
5.	Bashua Street	12m	20
6.	Obiwunmi Street	10m	20
	Low Elevation		
7.	Bailey Street	8m	20
8.	Vincent Street	6m	20
9.	Kayode Street	4m	20

10.	Fola Agoro Street	2m	20

Source: Authors' Analysis

The questionnaire covered topics such as waste disposal techniques, income, perceptions of open dumping, and frequency of flooding, amongst others. The monthly rainfall (mm) from 2012 to 2022 was sourced from the National Aeronautics and Space Administration's POWER database (NASA, https://power.larc.nasa.gov/). The POWER database data was preferred for the study over the widely used ground-based sources since time series of metrological variables may exhibit false increases or decreases due to measurement procedures, instrument error, exposure, station relocation, and several other factors (Usman *et al.,* 2018; Akinyemi *et al.,* 2019; Ogbu *et al.,* 2020).

The types of waste generated, the container used, and the frequency of disposal were identified. The differences in garbage disposal methods among respondents from each region were then investigated using measures of central tendency. The purpose was to see if there was any link between elevation and waste disposal practices.

After determining the most common waste disposal methods, the nature of flooding in the area was assessed at various elevation levels. The study went on to see if there was any link between the two occurrences. The impact of waste disposal on flooding and residents' opinions of the causes of flooding were also explored.

4. RESULTS AND DISCUSSION

Identification of predominant waste disposal methods in Somolu LGA

The elevation map of the study area shows a decrease in height from the northwestern region (about 20 meters above sea level) down towards the southeastern region (2 meters), which is where the canal is (Figure 2). Hence, the waste practices across the three elevation areas and propensity for open dumping into drainages were further investigated.

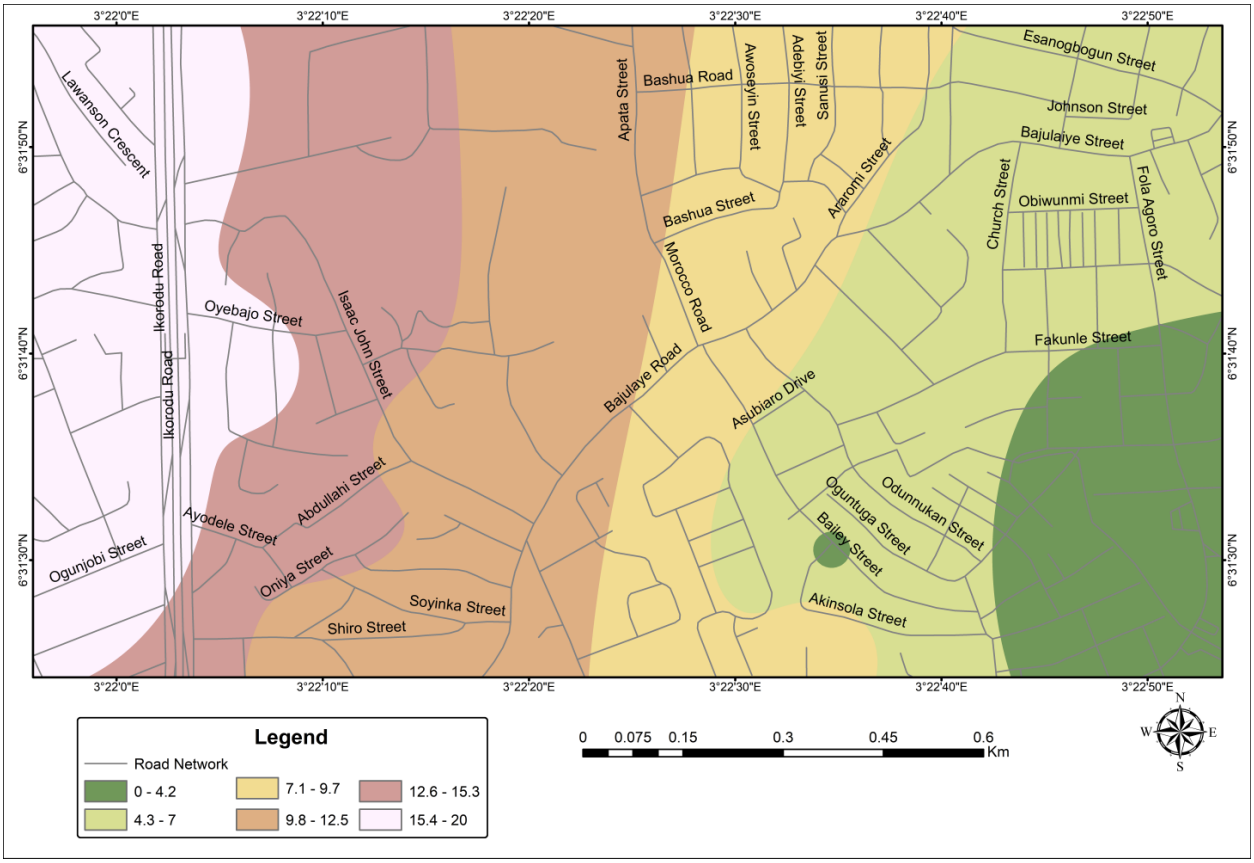

Fig. 2: Elevation Map of Somolu LGA (Source: Author, 2022)

Areas such as Fakunle, Bailey, and Vincent streets, which lie within the low elevation region, are close to the canal, which is the primary collector system in the local government. The general trend in the area was the use of waste baskets and old buckets to collect waste before being disposed of outside. The use of cartons and polythene bags was, however, noted in the low elevation areas. Whereas in the high elevation areas, the majority of collected waste was disposed of at least once every two days, those in the mid and low elevation areas had the majority doing so once a week. The collected wastes were disposed of mainly in public bins in high elevation areas, while waste vans were relied on more by those in the mid and low elevation areas (Figure 3).

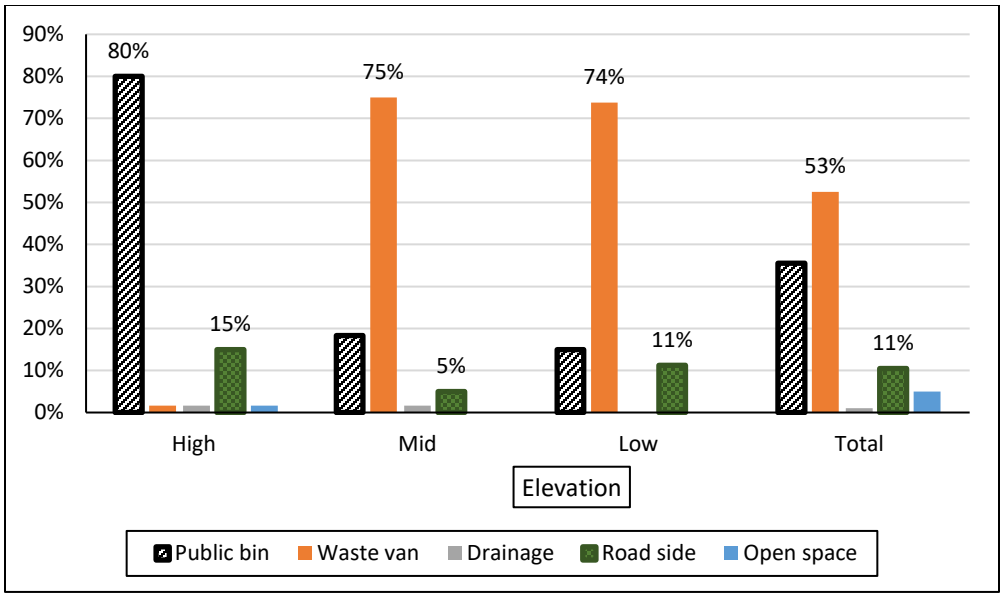

Fig. 3: Waste disposal points across elevation areas (Source: Authors' fieldwork, 2022)

It is worth noting that about 14% of high-elevation residents dispose of their waste on roadsides. These were mainly left for the waste vans to pick up when they came around. Unfortunately, some of these find their way into nearby drainages. It is also significant that those in the low elevation areas rarely disposed of their waste into the drainages. Such practices were only found with the high and mid-elevation residents. The implication of this is that those in the low elevation areas have found this to be problematic, especially during the rainy season, contributing to flooding; hence, the change in attitude. This is in alignment with the thought expressed by Fuchs *et al.* (2017) that risk perception influences the individual's adaptation strategy after learning from past incidents.

The almost unanimous claim of available public bins in the high elevation areas accounts for the high proportion of use in the area. This also explains the frequency of disposal, seeing that the high elevation residents could easily access the public bins at any time, while others have to wait for the routine drive-by of the waste vans (Table 2). Unfortunately, in any case of delay, they might adopt other unsustainable options. In the mid-elevation area, it was noted that public bins were available at Bashua Street but rarely at other streets in the region.

Table 2: Waste practices among residents of Somolu LGA

		Elevation		
		High	**Mid**	**Low**
Waste Container Used	Wastebasket	73.33%	50.00%	56.25%
	Carton	0.00%	1.67%	3.75%
	Old bucket	16.67%	33.33%	21.25%
	Others	10.00%	15.00%	18.75%
Waste Container Emptying Frequency	Once a day	36.67%	18.33%	6.25%
	Once every 2 days	33.33%	13.33%	18.75%
	Once a week	21.67%	63.33%	61.25%
	Others	8.33%	5.00%	13.75%
Availability of Public Bins	Yes	96.67%	38.33%	21.57%
	No	3.33%	61.67%	78.43%
Frequency of emptying public bins	Once a week	79.90%	84.55%	84.53%
	Twice a week	15.10%	9.20%	23.80%
	Thrice a week	3.33%	6.25%	0.00%
	Others	1.67%	0.00%	3.57%
Perception of waste disposal as a problem	Yes	45.00%	46.67%	51.25%
	No	55.00%	53.33%	48.75%

(Source: Authors, 2022)

Public bins fill up quickly, hence the need to empty them as soon as possible. Failure to do this usually results in overflowing bins, leaving waste strewn all over the roadsides. Where these are available, respondents noted that it was usually cleared on Thursdays, except when it fills up faster, then it is evacuated twice or thrice a week. While the majority in high and mid-elevation areas didn't see waste disposal as a challenge in their neighbourhood, a higher proportion of residents in the low-elevation areas thought otherwise. The position of respondents in the low elevation region thus suggests a consciousness of the problem and perhaps better personal attitudes towards waste management.

Assessment of the nature of flooding in the area and its link with waste disposal methods

The total annual rainfall in Somolu LGA from 2012 to 2022 has been over 1000mm, with years such as 2012, 2014, 2019, and 2021 recording well above the average (Figure 4).

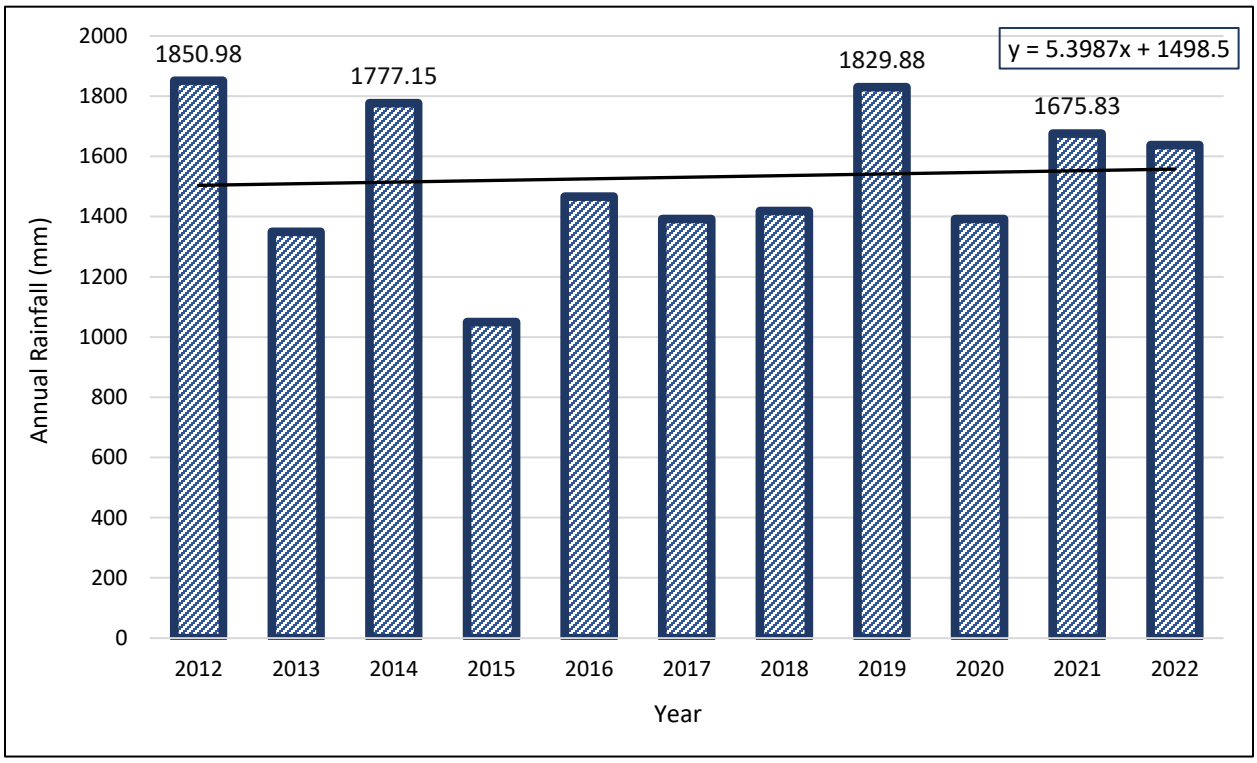

Fig. 4: Total annual rainfall in Somolu LGA from 2012 to 2022 (Source: Adapted from NASA database)

The most significant years, 2012 and 2019, which recorded excess rainfall of about 1850mm and 1830mm, respectively, were further investigated. Data from these years were disaggregated into months (Figures 5 and 6)

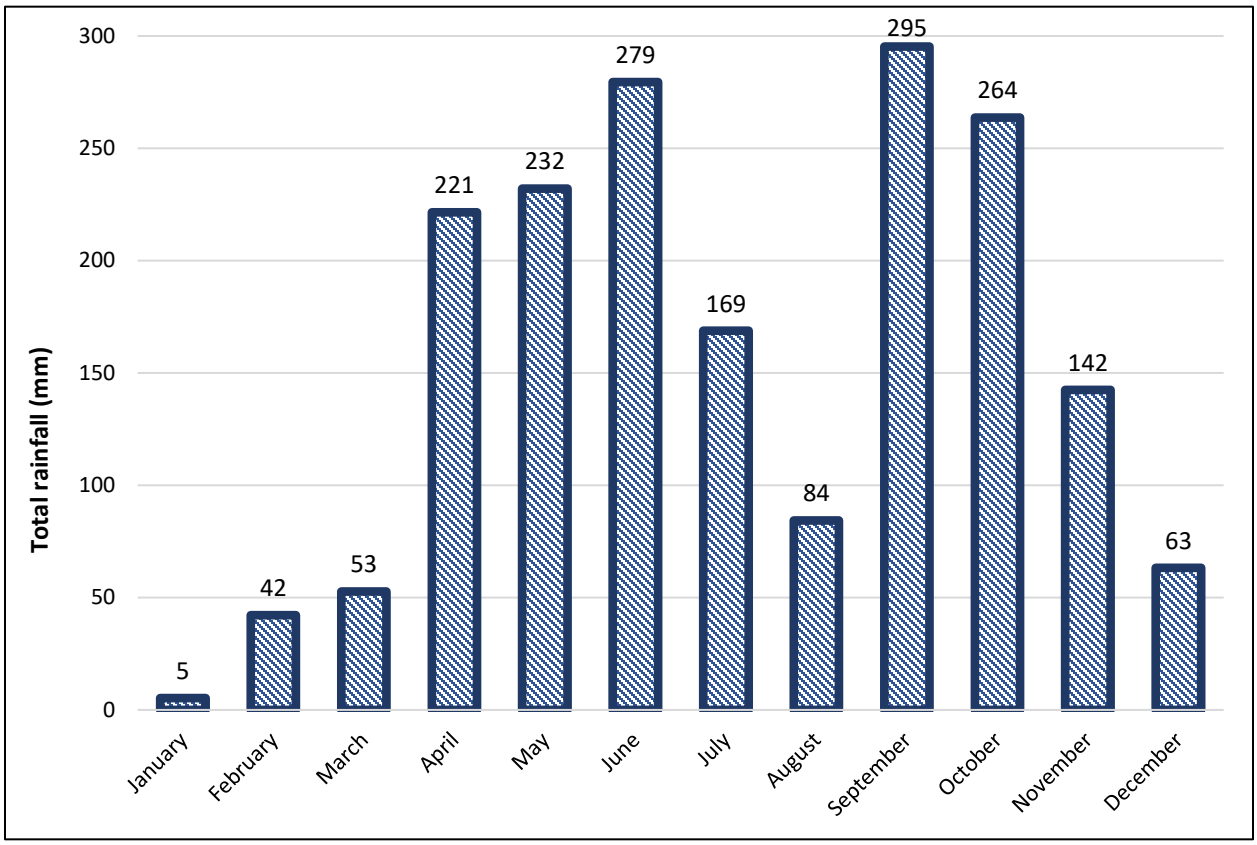

Fig. 5: Total monthly rainfall in Somolu LGA for 2012 (Source: Adapted from NASA database)

As expected, the rainy season peaked in June with about 280mm before the *"August break," which saw the volume drop to 84mm. Then, it peaks again in September (295mm) and then drops* into the dry season.

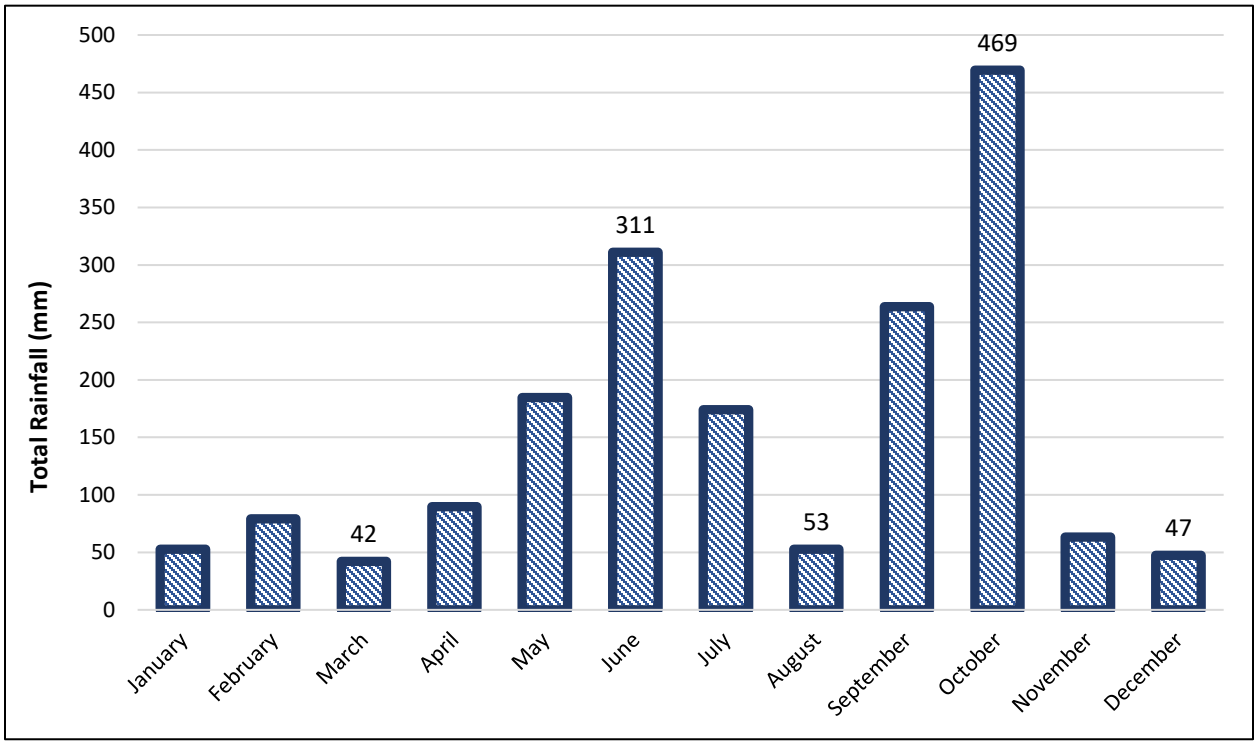

Fig. 6: Total monthly rainfall in Somolu LGA for 2019 (Source: Adapted from NASA database)

In 2019, the situation followed the same trend with the first peak in June (311mm) and the second peak after the August break, in October (469mm). In Somolu, a large percentage of inhabitants (65%) have not encountered frequent flooding in their streets. In contrast, Atufu and Holt [12] identified flooding as a serious issue in Lagos state, claiming that 80% of inhabitants have experienced flooding and 60% own a house that has recently been flooded, making Lagos the most flood-prone state in Nigeria. The other 34% of respondents who experience flooding in their location say it happens once or twice a month during the rainy season, which runs from July to September (Table 3).

Table 3: Nature of Flooding in Somolu LGA (Source: Authors' fieldwork, 2022)

Categories	Frequency	Percentage
Flooding in the Neighborhood		
Yes	69	34.5
No	129	64.5
Non-responsive	2	1.0
Total	200	100.0
Period of flooding		
January-March	1	0.5
April-June	9	4.5
July-September	59	29.5
October-December	1	0.5
Total	70	35.0
Non-responsive	130	65.0
Total	200	100.0
Nature of flooding in the last five years		
Increasing	30	15.0
Decreasing	15	7.5
No change	10	5.0
Oscillates	9	4.5
Not sure	6	3.0
Total	70	35.0
Non-responsive	130	65.0
Total	200	100.0
The contribution of refuse dumping in the drainage to flooding		
Low	5	2.5
Normal	13	6.5
High	29	14.5
Very high	23	11.5
Total	70	35.0
Non-responsive	130	65.0
Total	200	100.0
Impact of flooding on the neighborhood		
Loss of property	5	2.5
Restriction of movement	55	27.5
Displacement of people	2	1.0
Others	8	4.0

(Source: Authors' fieldwork, 2022)

In the last five years, 43% of respondents who experienced flooding believed its frequency had increased, with about 74% blaming this significantly on illegal dumping of waste in drainage systems. Flooding has hampered movement chiefly in Somolu, but Atufu and Holt (2018) believe that flooding has caused damage and loss of property, disruption of activities, and displacement of residents generally in Lagos.

Flooding is less common in lowland areas than in surrounding higher elevation areas, a situation that must have arisen from significant adjustments over time to improve adaptation. However, flooding appears to be a big issue in the mid-elevation zones, with respondents reporting events up to 10 times per month (Figure 7).

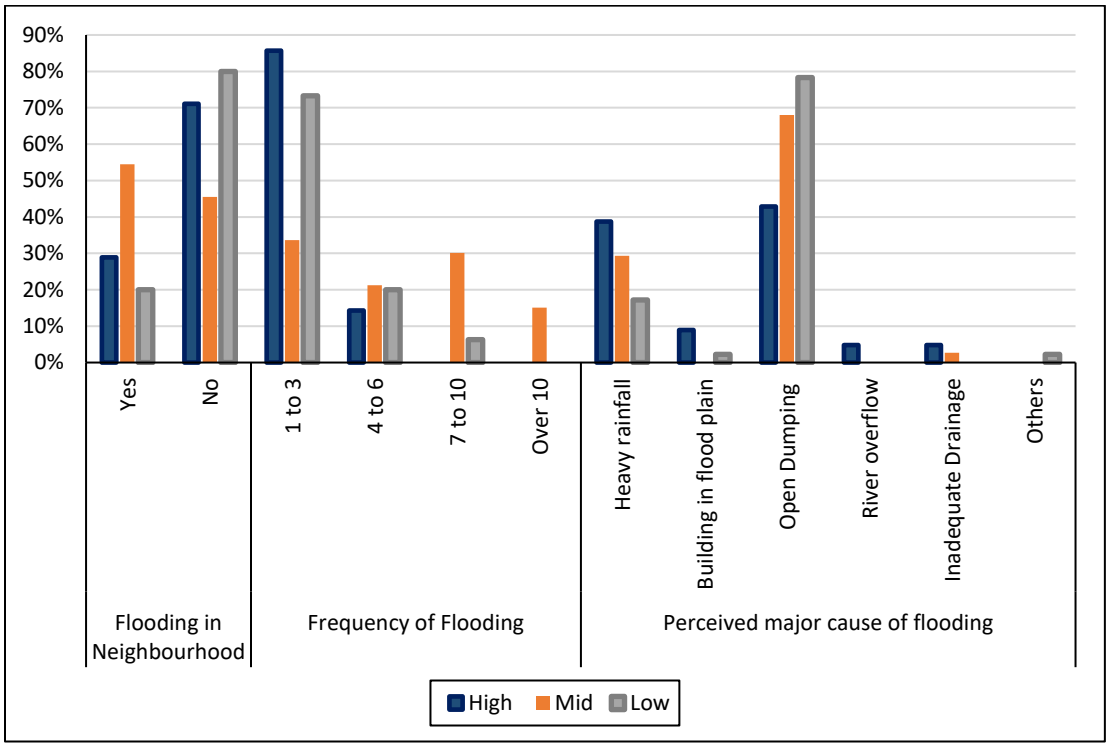

Fig. 7: Respondents' perception of flooding variables (Source: Author's fieldwork, 2022)

Indiscriminate disposal of waste, particularly in drainages, is the most significant cause of flooding in Lagos state, according to Zabrano *et al.* (2018). In the study area, flooding in high-elevation areas was blamed on heavy rainfall and illegal solid waste dumping, according to residents. The main contributing factor in the mid and low-elevation areas was also judged to be indiscriminate waste disposal. In high-elevation places, the impact of construction near floodplains was also underlined. As a result, it may be argued that the flood effect of open dumping is not limited to the areas of low elevations.

5. CONCLUSION

Issues surrounding infrastructural deficits concerning waste and flood management persist in Shomolu LGA. Rainfall variability has also increased the susceptibility of sections of the area to flooding. Contrary to the assumption of incessant flooding in the low-elevation sections, a significant attitudinal change was observed. This has led to more personal and community responsibility in waste collection and disposal to reduce its contribution to flooding. Nonetheless, there are still issues of waste disposal from markets and commercial sections, which were not considered in this study. The occurrence of flooding in the high elevation areas brings to the fore the notion that a proper urban management system is required even at such heights, with a focus on ensuring the appropriate flow of water downstream.

6. RECOMMENDATIONS

The following recommendations were thus highlighted:

1. Waste vans, which are relied on by most residents for waste disposal, should increase their turnaround time to at least twice a week.
2. Sanitary facilities should also be mandated for all buildings, especially the single-room apartment buildings.
3. Appropriate maintenance of public bins and distribution to all sections of the local government must be ensured.
4. Residents should be better enlightened on appropriate waste disposal, and drainages along the streets should be covered to reduce access for waste dumping.
5. Residents should also adopt more resilient structures to flooding, especially in preparation for the peak of the rainy season.
6. Further studies should incorporate waste disposal practices at the markets and commercial centres of the LGA.

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