LAUTECH Journal of Civil and Environmental Studies
Volume 9, Issue 1; September, 2022
DOI: 10.36108/laujoces/2202.90.0130

Assessing the Effects of Solid Wastes on Urban Flooding: A case study of Isale Koko

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Submitted on: 02/06/2022 Accepted on: 25/09/2022

Abstract

The management of solid waste continues to be a major challenge in urban areas throughout the world particularly in the rapidly growing cities of the developing world such as Ilorin. This study aimed at identifying the contribution of Solid Wastes to the incessant flooding and its primary cause in Isale koko in Ilorin East Local Government Area of Kwara state. A reconnaissance survey was conducted for the purpose of observing the condition of the engineering structures, the residents, and the magnitude of loss caused after it experienced another episode of flood. Focal point interviews were carried out with use of 100 structured questionnaires, 94 returned for data collection. Solid wastes in drains were quantified and characterized to identify the classes of wastes present in the existing drainages. Descriptive statistical analysis was used on the data. Results showed 86 (91.7%) of the respondents have suffered loss or destruction of properties due to flood, while 8 (8.3%) had their houses destroyed. Of the respondents, 33 (35.2%) dispose their waste once a day, 19 (20.5%) dispose it once in 2 days, and 42 (44.3%) dispose once in a week. Also, 19 (20%) dispose their waste in the public bin, 12 (13%) inside the valley, 9 (9%) by the roadside and 40 (43%) on an open space, 14 (15%) dispose by burning, all ending up in drains during floods. Solid wastes in drains consist mainly plastics (80%), paper (10%), wood (10%), and occupied 20% of drainage volume. It is therefore concluded that uneven channeling and solid wastes in drains contributed to flood in Isale koko.

Keywords: Solid waste, Urban flooding, Drainage, Solid waste disposal, Isale Koko.

Introduction

In this period of increasing urbanization, more than half of the global population lives in cities, and if current trends continue unabated, approximately 66 percent of this will be living in cities by 2050 (Barragán and de Andrés, 2015). As many city governments strive to provide a safe and secure living environment for their citizens, this population inflow has raised demands on cities across the world. Solid waste management and urban flood risk management are two of its many issues, and the intersection of these two sectors is becoming more of a focus in recent studies (Mercado *et al.*, 2020; Yoshioka *et al.*, 2021). Without excluding Sub-Saharan Africa, basic public services are frequently missing in the developing countries (Ziraba *et. al.*, 2016).

Many of today's cities are growing at a significantly rate compared to the rates at which flood risk management strategies and infrastructure are being created. In addition, existing systems are ill-equipped to handle changing and growing runoff patterns as a result of climate change and increased impermeable surfaces. These stresses are felt most keenly in growing cities' informal settlements, where impromptu houses frequently extend into flood-prone, low-lying regions or existing drainage systems (Kim and Newmann, 2019). Meanwhile, industrialization increases and diversifies waste produced per capita, resulting in a waste output rate that is higher than true urbanization (Yoshioka *et al.*, 2021). Municipal and domestic wastes are likely the most abundant of the numerous categories of these urban waste (Jha *et al.*, 2012). Despite this, fewer than 30% of urban waste in developing nations gets collected. Residents resort to dumping these wastes into surrounding drains, streams, and open areas due to lack of waste collection services and understanding of health and sanitation implications. Open dumpsites inside drains

or rivers increase pressure on an already overburdened drainage system, causing urban floods to become more frequent and severe (Ziraba *et al.,* 2016).

Multiple issues arise as a result of poor drainage and pollution of urban runoff. Stagnant water created by discarded plastics or clogged drainage lines serves as a breeding or feeding ground for vectors, raising the risk of communicable disease transmission in a highly populated area. Flooding causes access to clean water and sanitation to be disrupted, which can subsequently lead to public health crises such as cholera and E. coli epidemics (Neckel *et al.*, 2021). Polluted waterways also affect surface and groundwater supplies, limiting post-disaster and long-term access to healthy drinking water. These constraints are amplified in poorer urban areas, where the poor have the least access to public services and the least capacity to plan for and recover from catastrophes, thereby trapping them in a poverty cycle (Adelekan and Asiyanbi, 2016). Lack of solid waste management and urban flood risk management has a significant and long-term influence on a city's economic growth, inhabitants' and families' health, and community worth. In addition, poorly managed waste dumps, such as open landfills, are sources of greenhouse gas emissions. While Green House Gas emissions have no direct influence on the local community, climate change's cumulative effects do. Extreme weather events and natural hazards, such as heavy rain, increase the likelihood of urban floods, compounding the problems already confronting cities (World Bank Group, 2017).

Previous studies have looked at how solid waste management affects urban flood risk in different parts of the world (Ziraba *et al.,* 2016; Abass, 2020; Yoshioka *et al.,* 2021). The findings of these studies revealed that local administrations are frequently overburdened with other issues, have competing priorities, and/or lack appropriate resources. Both in government and among citizens, there is a pervasive lack of awareness of health and sanitation concerns. Waste management is sometimes regarded as a low-status job with poor pay, which contributes to absenteeism. Community and private firms are the only active waste management entities in certain places, creating employment and cash from recycling and garbage sorting, but their influence is typically minimal and insufficient since waste from adjacent regions soon floods the streams. Non-governmental organizations (NGO)/nonprofit organizations (NPO) and government action were effective in other areas in the short term but had little long-term influence. Based on these findings, it is essential to find the specific effects of solid wastes on urban flooding with particular attention to developing urban communities in developing countries. Hence the objectives of this study are to assess the impact of flooding and the condition of the existing drainage system in Isale koko, identify the level of awareness and practice of solid waste management by the residents of Isale koko and conduct a reconnaissance survey on the study area, waste characterization, through the administration of questionnaires and conduction of oral interviews on the residents of the area hence proffer appropriate solutions to the flood problems prevalent in the area.

Materials and Methods

Study Area

The study area, Isale koko is in Ilorin East Local Government Area of Kwara state (fig.1) on longitude 8^{O}30’14’’N and latitude 4^{O}33’48’’E. It has an area of about 0.82km². It is a residential area of Ilorin city. Ilorin city has a tropical climate comprising of the dry and wet seasons with the wet season starting around May and lasting for about four to five months however, there is variability both temporally and spatially in the rainfall of Ilorin (Ajadi, 1996). Olaniran, 2002 reported the total annual rainfall of the area to be about 1200mm. The relative humidity of the city is 65% in the dry season and between 75 to 80% in the wet season (Tinuoye, 1990). The mean monthly temperature of the area varies from 25^{0}C to 28.9^{0}C (Ajadi *et al.* 2011; Mokuolu *et al.,*2020).

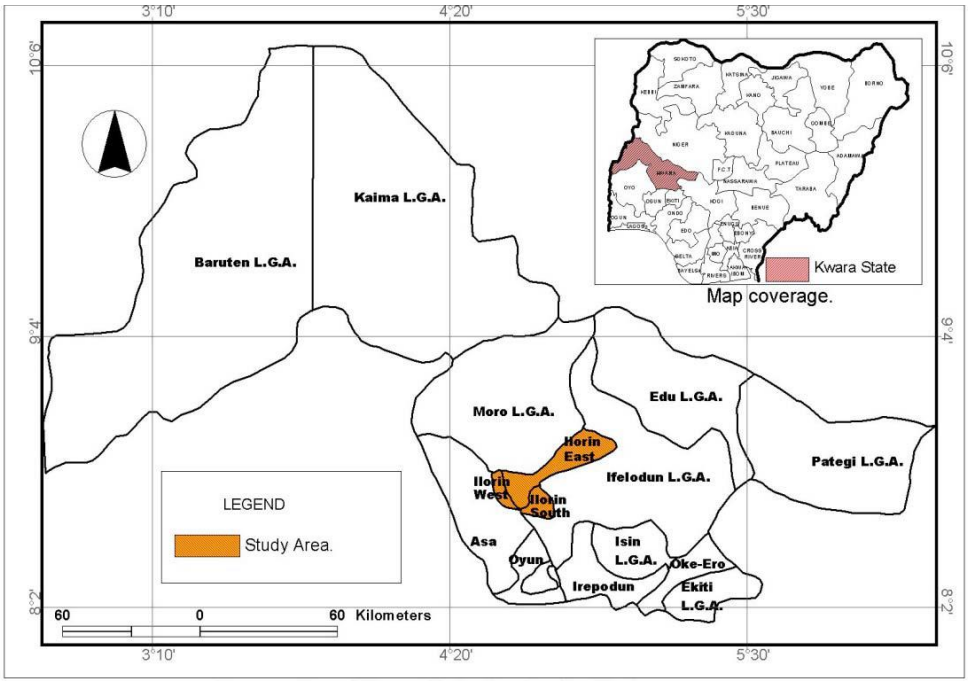

Figure 1. Map of Kwara state showing the study area insert is map of Nigeria (Adapted from Mokuolu *et al*, 2014)

Data Collection

Data for the study was collected through reconnaissance survey, oral interviews, waste quantification, waste characterization, and administering of questionnaires.

Reconnaissance Survey: The study area was visited multiple times to observe the condition of the engineering structures, the residents, the magnitude of loss caused after it experienced another episode of flood. Pictures of submerged drainages, road and buildings were taken.

Oral Interview: Interviews were conducted among the residents during the period of visitation, and it was done on focal persons which according to them, have been residing in the study area long before flooding began.

Waste Quantification and Characterization: The drainage randomly chosen was divided into 8 sections of 1meter per section and the solid wastes in the respective sections were weighed and the average weight of solid wastes existing in the drainage was calculated. The cross-sectional area and effective volume of the drainage was also measured. The wastes were categorized into different waste components such as plastic, paper, nylon, metals, ceramics, and non-combustible material.

Table 1: Characterization of solid waste sample

S/N	Waste Component	Contents
1	Plastics	Plastic plate, pet bottles, buckets
2	Papers	Cardboard, newspaper, magazine
3	Metals	Cans, iron metals, and aluminium material
4	Nylon	Polythene
5	Ceramics	Glass, tiles, jars
6	Wood	Wooden material
7	Non-combustible material	Rubber

Questionnaire administration:
A well-structured questionnaire was developed to consider all the important factors necessary to achieve the aim and objectives of this research.

Data processing and analysis**:**
Information collected from the questionnaire was examined to check completeness, accuracy, and consistency of responses. The data were analyzed using descriptive analysis with the use of SPSS and Statistical tables and charts were constructed for easier interpretation and discussion.

Results and Discussion

Assessing the impact of flood in isale koko

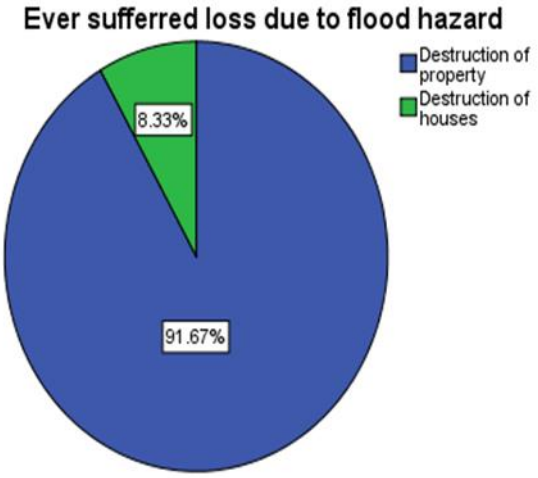

Figure 2: Ever suffered loss due to flood? **Plate 1:** Aftermath of flood in Isale koko

According to the chart (Figure 2), the study shows that 91.7% have previously suffered loss of destruction of properties due to flood, while 8.3% had their houses partly or wholly destroyed.

Assessing the Condition of the Drainage System

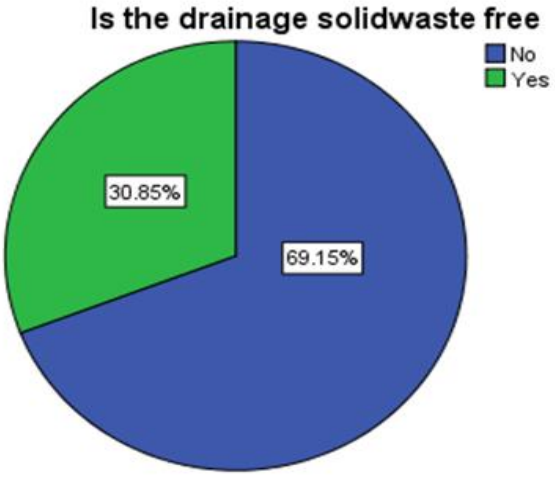

Figure 3: Drainage condition around the house **Plate 2:** Condition of drainage in the study area

Of the respondents, 69.1% revealed that the drainage was not free from solid waste, while 30.9% responded their drainage to be free from solid wastes. The conclusions of Shwetmala *et al.*, 2011 on the drainage network in Bangalore city was that a large load of solid wastes disposed into the drain upstream aggravates the situation by partially choking the water course under these roads and bridges to cause a temporary flooding.

The Level of Awareness and Practice of Solid Waste Management (SWM)

Figure 4: Awareness level about SWM

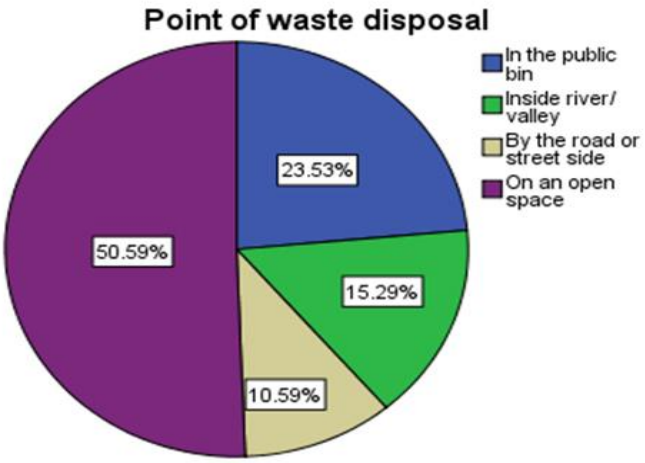

Figure 5: Point of waste disposal

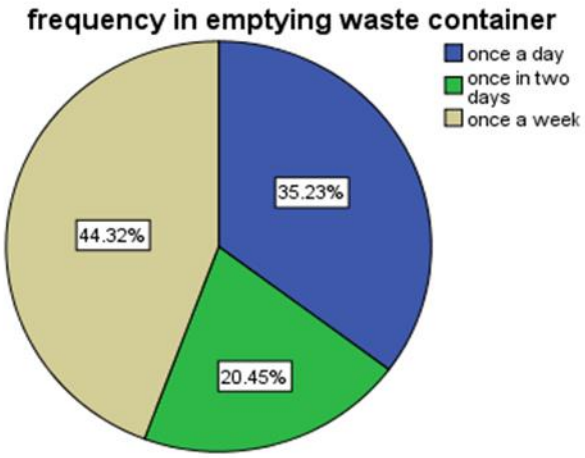

Figure 6: Frequency in emptying waste container

According to the results obtained from the descriptive analysis of the data acquired from the field survey in this research, 63.9% of the respondents have heard of Solid Waste Management (SWM) while 36.1% have not heard of it. Furthermore, 86.4% have their source from the radio, 3.4% over the TV, 8.5% in school, and 1.7% on posters. Some other ways are public sensitization from Government officials. From the response of the respondents, it is deduced that 35.2% dispose the waste container once a day, 20.5% dispose it once in 2 days, and 44.3% dispose once in a week. For 20% of the respondents, they dispose their waste in the public bin, 13% dispose it inside the valley, 9% by the roadside and 43% on an open space, 15% dispose by burning. Similarly, Babayemi and Dauda 2009, reported that the level of awareness of waste collection services and waste management regulations were relatively high in Abeokuta, contradictorily, the percentage of those who used other indiscriminate solid waste disposal methods like open dumping, open burning, and dumping in drainages were high.

Oral Interview

The record of the highly disastrous flood started in 2014 when a certain construction was carried out on the Asa River by the Government. The river was however not properly and completely channelled over the location of Isale Koko which now became a nightmare to the residents when it overflows during the rainy season. To further solidify the fact the uneven channelling of the Asa River is a time bomb that is always expected to blow off in the raining season is that most of the streams in Kwara State are not gauged, and even the ones gauged are on ad hoc bases as it doesn't give avenue for proper assessing of the level of impact it can have on a community. From the ad hoc gauging, it was observed that the rate of discharge for Asa River was 105.95m³/s compared to River Oyun at Ijagbo which was just 7.97m³/s (Kwara State Ministry of Water Resources).

Waste Quantification and Characterization

The drainage was divided into 8 sections with the same cross section area and volume (Mokuolu *et al.*, 2020). The dimensions were: Length=1m, Breadth = 0.6m, Depth = 0.6m. The area was 0.6m×1m = 0.6m², while the volume was 1×0.6×0.6 = 0.36m³.

$$Averagemass = \sum ofMass\,ofsolidwaste \div numberofsections$$

- Average mass = 1.05 Kg was present for every 0.36m³ of the drainage
- The volume occupied by 1.05 Kg of waste in the cubic section of 0.36m³ was 1m×0.6m×0.12m = 0.072m³.
- For every 1m³ of the drainage, 0.2m³ of the drainage was filled with solid waste. Which is 20% of the entire drainage.

  For the characterization, the section with the highest weight of the solid waste was used.

The wastes were sorted and characterized as follows

Table 3: Categories of waste

S/N	Waste Component	Content
1	Nylon	Polythene, water sachet,
2	Plastic	Plastic plate, pet bottles, buckets
3	Paper	Cardboard, newspaper, magazine
4	Wood	Wooden material

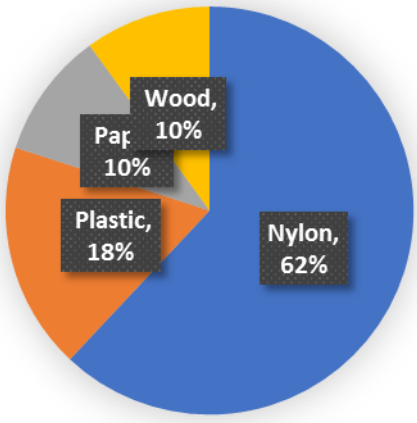

Figure 7: Percentage of characterized solid waste

Waste composition in Ghana according to Kodwo *et al.,* 2015 was 61% organics, 14% plastics, 6% inert, 5% paper, 5% miscellaneous, 3% metals, 3% glass, 1% leather and rubber, and 1% textiles while in Chihuahua Mexico, main fraction of MSW were Organics 48%, paper 16%, and plastics 12% (Guadalupe *et al.,* 2008). In a university community as reported by Ugwu *et al.,* 2020, the percentage of waste composition by weight of the Municipal Solid Waste generated in the University of Nigeria, Nsukka, Organic waste formed the biggest component of the MSW generated in the campus which was about 34.29%. This was closely followed by polythene at 32.36%, with paper and plastics at 14.05% and 8.53%, respectively.

Conclusion

Based on the results deduced from this study, it is evident that:

i) Residents of Isale koko have suffered huge loss due to the incessant flooding of which would have accumulated to millions of naira in monetary value over the years as the study also shows that 91.7% have suffered loss of destruction of properties due to flood, while just 8.3% had their houses destroyed. This loss has brought about families becoming homeless, loss of jobs due to businesses destroyed. This has affected the economic life of the area, increasing the level of poverty and also increasing crime rate. This has brought little or no development to the area as it makes business owners and investors relocate away from the vicinity.

ii) Condition of the drainage system is not encouraging. The condition of the existing drainage system revealed as 78.6% opines that the drainage is inadequate, while 21.4% said it is adequate. Table 2 also shows that 65% of the respondents do not accept the drainage to be free from solid waste while 29% responded their drainage to be free from solid wastes. According to Mokuolu *et al*.,2020 the current drainage infrastructure of the study area is inadequate in effectively collecting and disposing the generated storm water as it is of a rectangular section with a dimension of B=0.6m, H=0.6m. Including the fact that the drainage is inadequate even when empty. This study showed that 20% of the already established inadequate drainage contains solid waste. This makes it grossly inadequate.

iii) According to the analysis of the data obtained during the field survey, the awareness of the residents was quiet encouraging as 63.9% of the respondents are aware of solid waste management, there was however no provision made for it. This is seen from the results showing that 20% of the respondents dispose their waste in the public bin, 13% dispose it inside the valley, 9% by the roadside and 43% on an open space, 15% dispose by burning. This showed indiscriminate disposal of waste and in turn has an effect and greatly contributes to the flooding disaster and also affects the sustainability of having a flood free neighborhood.

iv) From the oral interview conducted, it was discovered that the study area was not a flood prone area before, though they claimed it occurs when the rain is extremely heavy, yet it is not as disastrous as they have it now. The record of the highly disastrous flood started in 2014 when a certain construction was carried out on the Asa River by the Government. This is also in sync with the dates gathered from the respondents as the number of flood occurrence had a quantum leap from the year 2014. Therefore, it is safe to conclude that the uneven and incomplete channeling of the Asa River is the Primary and major cause of Flooding as the occurrence tally with the period the construction was abandoned by the Government. According to Oyebande, 1990 water will always find its way if not well channelized. Its choice route often poses problems to man by tampering with his physical environment, health and products of agriculture, urbanization and industrialization.

v) The drainage was not adequate as the study area is a low land with a gentle slope, having high flow rate of surface runoff during rainfall. With all these established, the poor practice of Solid Waste Management will still bring about the same disaster to Isale koko as indiscriminately disposed solid waste will still find its way to the drainage and ultimately reducing its serviceability. This is similar to Olajoke *et al,* 2013 that concluded in his findings that one of

the major causes of flood is indiscriminate dumping of waste in drainage which culminates to blocked drainages.

The following are the recommendations for a sustainable flood free Isale Koko.

I. Adequate and stringent Urban planning and policies should be made which cuts across proper channeling of stream, adequate construction of drainage networks and sewers be made.

II. Integrated SWM system should be established, as Government should not only make awareness of the consequences of indiscriminate disposal of solid waste nor punish defaulters, but provide the facilities needed for proper waste management from waste generation to disposal.

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