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# Solid Waste Management and Vulnerability to Floods in Gombe Metropolis, Nigeria

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**Abstract:** ***Several empirical works in developing countries have shown a relationship between solid waste management and vulnerability of cities to floods. Gombe Metropolis being one of the cities in the developing countries is not an exception. Thus, this research aimed at studying the relationship between solid waste management and vulnerability to floods in Gombe Metropolis. Specifically, it examined the population dynamics and its impact on the amount of solid waste it generates. The research also studied the current solid waste management system with efforts to establish an association between the solid waste management and the recent floods in the metropolis. To achieve these objectives, questionnaire was developed and administered to one hundred and seven sampled households in all the wards of the metropolis. The data collected from the questionnaire survey was analysed using Statistical Parkage for Social Sciences. The result shows that the number of individual in each household have been doubled within the last ten years on average and nearly all these households have no access to refuse bins. In addition, sixty two percent of the households have no designated refuse collection points, as a result close to half of the households disposes refuse into drains, streams and gullies within the metropolis. Thus, poor management of solid waste is probably responsible for the increasing flood vulnerability in urban Gombe. Though, in general terms the research discovered a very weak positive association between solid waste management and floods in Gombe Metropolis.***

**Keywords:** Solid waste Management, Gombe Metropolis, Vulnerability and Floods

## 1. Introduction

Solid waste may refers to rubbish, refuse, garbage, and trash or any unwanted materials from industrialized processes or household activities (Sulemanu et. al 2018). Solid waste management on the other hand involves the generation, collection, transportation, and disposal of the waste. Collection process may include the gathering and moving of solid wastes from the original sources to destination where the contents of the collection are finally disposed (Tchobanoglous, Theisen, and Vigil, 1993).

However, poor waste management is a recurrent crisis that is set to get worse with the increasing urban expansion especially in the developing nations and the incapability of municipalities to resource the necessary waste management system (Sulemanu et. al 2018). And this can leads to the mixture of poorly built and maintained drainage facilities with insufficient waste management.

Poor solid waste management contributes to the occurence of urban flood risk though blocking drains, and accumulations of debris (Idris and Lal, 2016). Hence, solid waste management is an emerging issue in flood risk management practices around the globe. The management of waste is a recurring problem in developed and developing countries and it is an emerging environmental issue in respect to flood risk management (UN Habitat, 2010). This is because, poor disposal of solid waste regularly leads to blockages in drainages and waterways, thereby reducing their carrying capacity for storage and conveyance and most likely leads to urban floods. Therefore, poor solid waste management has an important influence on the incidence of local urban floods especially developig countries. Because, insufficient solid-waste management and poor drains maintenance swiftly clog waterways systems and causes flooding in cities, hence it is very important to study the trend so as to mitigate its impact on the urban residents.

This is a true incidence, where poor solid waste management aggravated floods in some cities of developing nations like Bamako, Accra, Cotonour, Lagos, Jakarta, Mexico City and Guyana (Balica, Douben and Wright, 2009). For instance, Guyana experienced 29 local floods from 1990 to 1996 as a result of mismanagement of solid waste and inhabitants of Tanzania as well recognised that poor solid waste management through streams blockage has worsen their flood risk disaster in recent years (Balica, Douben and Wright, 2009). Solid waste management in Gombe Metropolis is restricted to a timely collection of refuse by the Gombe State Environmental Agency (GOSEPA). Idris and Lal (2016) have established a positive relationship between poor solid waste managent and Flood Risk in Gombe Metropolis. This is because the current refuse disposal methods basically rely on discarding refuse into natural drainage channels and drainage facilities.

Therefore, Poor solid waste management played an important role as a factor for global urban floods and as urban population increase, there is likelyhood urban areas will be vulnerable to floods. For that reason, sustainable management of solid waste within cities at risk of frequent floods has the potential to mitigate the flood vulnerability via a systematic solid waste management. Thus the management of solid waste can be considered as one of the most important efforts required for urban resilient to the emerging floods vulnerabilities around the globe.

Based on the above points this paper aimed at studying solid waste vulnerability to floods in Gombe Metropolis and specifically tried to find out whether any relationship actually exist statistically between the current solid waste management and the frequent annual floods occurences in Gombe metropolis.

## 2. Methodology

The scope of the research is the whole Gombe Metropolis. Multystage sampling was conducted, where the whole city was clustered into eleven residential wards consisting of; Government Residential Areas (GRA), Pantami, Barunde, Checheniya, Federal Low-cost quarters, Arawa, Kagarawal/UnguwaUku, Dawaki, Madaki, Jekadafari, Herwagana, Jankai and Tudun Wada. The target residents consist of a total of 1,913 individual households in the Metropolis. Subsequently, a total of one hundred and seven households were at randomly selected from theses groups. Furthermore, set of questionnaires were administered to eight households in each residential wards to obtain the dispensable information appropriate to the research. Likertscales rating scale of four points were constructed to determine the variables. And lastly, Peasons Correlation coefficient was calculated using a computer and Statistical Package for Social Science (SPSS) to correlate floods variable (dependent) from a set of solid waste management variables (independent) including; number of persons per household, solid waste disposal methods, daily amount of solid waste produces by household, availability of refuse collection point, number of times households disposes refuse daily and number of times GOSEPA collect refuse in a week. The independent variables were transformed into a single varible using recode into different variables in SPSS.

## 3. Result and Discussion

The research aimed at studying solid waste vulnerability to floods in Gombe Metropolis and specifically tried to find out whether any relationship exist between the current solid waste management method and the frequent annual floods in Gombe Town. Therefore, the data collected were basically field survey data through the use of questionnaure survey.

The data collected were analysed using Statistical Parkage for Social Science (SPSS) and presented the result in tables and graphs in a form of percentages and averages. Additionally, Pearson's corraltion analysis was coducted to discover assocations between solid waste management and floods. The result of the anaysis is presented here according to the following themes: Population of Gombe and its tendency to generate high amount of solid waste, availability of solid wates disposal facilities, types of solid waste, solid waste management methods and the relationship between solid waste management method and the frequent annual floods inGombe Town. The results are presented in detail below.

### 3.1 Gombe Town Population and Its Tendency to Generates High Amount of Solid Waste

Increasing population growth has a common tendency to increase the amount of solid waste that can be generated by a given population. This is because; rapid increase in city population may likely amplify the needs for a viable waste disposal method for environmental sustainability and resilience. The population of Gombe as in 2008 was a total number of seven persons per household. However, in 2018 the total number of persons per household was doubled as shown in **table 3.1** below.

**Table 1:** Average Number of Persons Per Household in 2008 and 2018

| Year | Minimum Number of Persons in an Household | Maximum Number of Persons in an Household | Avearge Number of Persons in an Household |
|---|---|---|---|
| 2008 | 2 | 5 | 7 |
| 2018 | 5 | 20 | 13 |

**Source:** Fieldwork, 2018

This sharp demographic increase will definitely have a positive increase in the amount of waste that will be generating by individual household. Figure 1 below shows that more than half of the individual household generates 1 to 2 kilogram (kg) of solid waste daily.

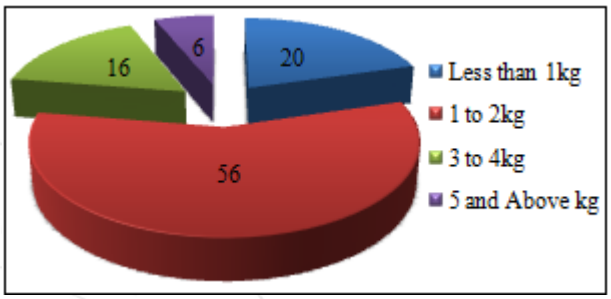


**Figure 1:** Daily Amount of Solid Waste Generates by Households
Source: Fieldwork, 2018

Hence, each individual household can generate 15 to 30 kg of solid waste per month or 180 to 360 kg per annum. Consequently, the need for adequate and systematic waste disposal management system for sustainable solid waste management became necessary.

### 3.2 Availability of Solid Wates Disposal Facilities

Gombe State Environmental Protection Agency (GOSEPA) is responsible for solid waste management in the state. Households were interviewed whether refuse disposal facilities is adequately distributed for waste collection in all wards of the metropolis. Almost all the households (92%) claimed to have no facility whatsoever distributed by the environmental agency for solid waste management. Furthermore, a significant number of the household (62%) do not have a designated solid waste disposal points where they can disposes their waste, while few number of the households (38%) have refuse collection points in their areas.

### 3.3 Solid Waste Types, Management Methods and Efficiency

Solid Waste management consists of three most important steps: collection, transportation and disposal (Lamond, Namrata and Bloch, 2012). Poor provision of refuse bins and inadequate designated refuse disposal points have forced almost half (46%) of the households to dispose their refuse into waterways (contsructed drains, streams, and gullies) as seen in figure 2, thereby blocking the waterways and become susceptible to urban floods. Nonetheless, some household use refuse pits, bins and burning methods for solid waste management.

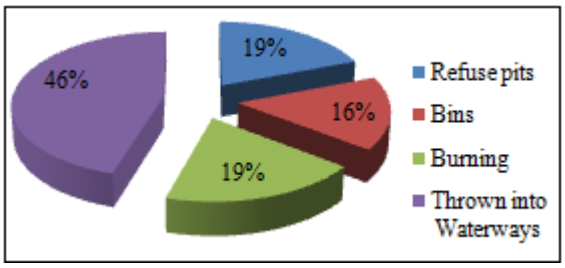


**Figure 2:** Solid Waste Disposal Methods
Source: *Fieldwork, 2018*

The household's types of solid wastes are basically, papers, plastics, rags, animal dungs, ash/dust, polythene bags and cooking leftovers (see figure 3). Though, the highest amount of solid waste commonly generated in Gombe Metropolis comes from ash/dust and polythene bags (more than 70%) as indicate in figure 3 below.

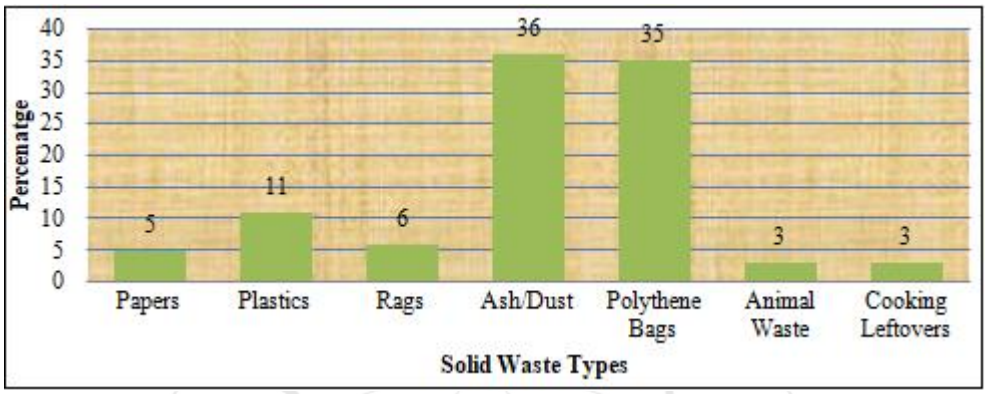


**Figure 3:** Common Types of Solid Wastes in Percentage
**Source:** *Fieldwork, 2018*

The number of times hosseholds disposes waste is very crucial in waste management system. Table 2 also shows that half of the households dispose refuse once in a day or once in two days, while the remaining half disposes waste two times or once in a week.

**Table 2:** Number of Times Households Disposes Solid Waste in a Week

| Number of Times | Percentage |
|---|---|
| Once in a Week | 25 |
| Two Times a Week | 25 |
| Once in Two Days | 20 |
| Once in a Day | 30 |
| Total | 100 |

**Source:** *Fieldwork, 2018*

A good solid waste management system will require a systematic management approach such as adequate designated points, suffcient supply of bins, and public enlightement and consistant collections of waste after household's waste disposal.

Figure 4 below indicate that close to half (47%) of the households claimed that refuse is only collected once in a month or none at all. This confirmed why almost half of the households (46%) of the hoseholds disposes waste into the waterways.

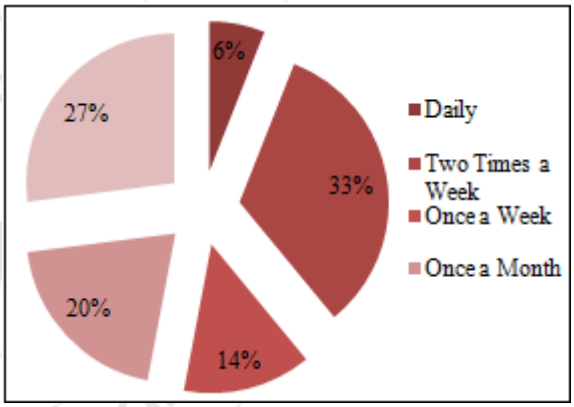


**Figure 4:** Number of Times GOSEPA Collect Refuse in a Month
**Source:** *Fieldwork, 2018*

The reseach further make an enquiry from the households to rate the performance of GOSEPA interms of solid waste management according to their individual perceptions. Sixty percent of the households feel the performance was poor to very poor, while more than quarter has a neutral perceptions reagrding the issue (See table 3). Although an insignificant number of the households rated the performance as good to very good.

**Table 3:** Rating of Solid Waste Management by GOSEPA

| Rating | Percentage |
|---|---|
| Very Poor | 27 |
| Poor | 33 |
| Neutral | 28 |
| Good | 7 |
| Very Good | 7 |
| Total | 100 |

**Source:** Fieldwork, 2018

### 3.4 Solid Waste Management and Frequent Flooding inGombe Town

The research discovered that morethan half (52%) of the households experienced flood occrences in their wards, while less half have no experience of flood occurrences. In addtion, the households that have flood experienced, 74% of them experienced frequent annual floods.

**Table 4:** Households Floods Experiences

| Floods Occurences | Percentage |
|---|---|
| Once in a Year | 74 |
| Twice in a Year | 11 |
| MorethanTwoe Times a Year | 15 |
| Total | 100 |

**Source:** *Fieldwork, 2018*

In order to establish a relation between solid waste management and the frequent floods in Gombe Town, a statiscal analysis (Pearson Correlation coefficient) was calculated using SPSS and the result obtained is presented in table 5 below. The correlation model conveyed Floods (Dependent variable) as a function of poor solid waste management (Independent variable). The result established a very week positive relationship with r (correlation) as .005 between floods and solid waste management. In essence, the result means increase in the current solid waste management system increases floods by .005. Nonetheless, the result is statistcally not significant, because the level of significant was 0.96 (at 2 tailed) as indicated in table below.

**Table 5:** Correlations Matrix for Solid Waste Management and Floods in Gombe

| Variables | Mean | Standard Deviation | Solid Waste Management | Floods |
|---|---|---|---|---|
| Solid Waste Mangement | 24.7 | 5.3 | 1 | .005 |
| Floods | .52 | .50 | .005 | 1 |

Source: Field Work, 2018
Note: Significant Level = .96 (2 Tailed)

## 4. Conclusion and Policy Implicationsss

The research in general has discovered a very week posistiveassociation between solid waste management and floods, but statistically insignificant. Furthermore, a sharp demographic change was found, where an average number of individuals in a household was doubled from seven persons in 2008 to 13 persons in 2018. This population dynamics has led household to generate 15 to 30 kg of solid waste on daily basis.

Virtually 92% of the households do not have refuse collection bins and 62% have no any designated refuse collection points for waste disposes. Hence, poor provision of solid waste facilities forced half of the households to thrown solid into waterways (streams and gullies) as an alternative. The most common types of solid waste in Gombe metropolis are basically papers, plastics, rags, animal dungs, ash/dust, polythene bags, ash/dust, polythene bags and cooking leftovers. Nevertheless, more than 70% of the solid wastes are essentially ash/dust and polythene bags. It was also discovered that household dispose solid waste daily or once in two days. However, Environmental Protection Agency collects refuse once in a month or none at all in virtually half of metropolis.

**Policy Implication**

Based on the findings of the research, the following are applicable to policy makers in the state for a sustainable solid waste management method for floods mitigation in the metropolis: The current municipal solid waste management system is not efficient to handlethe the level of daily solid waste generates by households in the metropolis. Therefore, the results of the research indicate that there is a general lack of commitment in providing adequate management facilities (such refuse bins), poor collection of refuse (only once in a month) and lack of designated refuse collection points for all the wards of the metroplis. Hence, there is a need adequate commitment and engagement in solid waste management in order to mitigate the menace of floods in Gombe Metropolis.

Futhermore, the Gombe State Environmental Protection Agency should develop an enlightment campaign and enforcement of rules and regulations to ensure strict sanctions to any household found dumping solid waste into the drains, streams and gullies.

And finally, since, ash/dust and polythene bags have formed the bulk part of the solid waste generates by households in the metropolis; the agency should come up with an environmentaly friendly parkaging system so as to reduse the amount of polythene bags usage by households. Special treatment should be given to ash/dust, through steady collections of refuse daily.

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