

An Assessment of the Extent and Impact of Annual Flooding in Kano Metropolis, Kano State - Nigeria

Liman Yakubu Bashir, Akilu Suleiman and Idris Rakiya Kabir

Department of Geography, Federal College of Education, Zaria-Nigeria.

Corresponding author: liman-albashir@hotmail.com

Abstract

Floods are natural phenomena and it can also be induced by human interaction with the environment. Flood disasters can be avoided through increase awareness and compliance to town and country planning regulations and due regards to environmental sanitation and safer hygienic practices among the citizens. This paper reports the result of the extent and impact of annual flooding undertaken in two local government areas within Kano metropolis through the collection of secondary data using check list from the government agency (National Emergency Management Agency, NEMA) responsible for the management of any kind of disaster like flooding, interviews with stakeholders and field surveys specifically to bridge the prevailing gap on awareness creation to ensure disaster risk reduction and build well informed and resilient societies across the state. Field surveys using purposive non-probability sampling techniques were carried out in thirteen residential zones that are affected with the disaster in order to understand the factors and identify the impact. The result showed that 86% of the respondents were male and they are within the age bracket of 35 – 44 years old, majority of them do not have formal education but few from them had primary and secondary as their school leaving certificate as the rest were ND, NCE, HND & B.Sc. holders with business as the major type of occupation. It also revealed that there are several factors responsible for flooding which characterized by building houses in areas liable to flood, lack of proper drainage channels, dumping of refuse inside the drainage systems as well as heavy rainfall as represented by 42%, 22%, 21% and 15% respectively. The result also confirmed that the disaster (flood) affects so many things drastically as houses destroyed in nearly all the areas, houses destroyed, mosque and clinics affected, transportation routes and educational settings (destruction of bridges and schools). It was recommended that all illegal structures blocking the free-flow of water are being removed no matter who own them, government of Kano state should also construct more water channels and streams across the state to provide the much needed drainage to mitigate the impact of flooding, the government should also construct permanent rehabilitation camps to accommodate people displaced by future disaster and to avoid the use of schools as temporary shelters which can be a detriment to education.

Keywords: Assessment, Impact, Extent, Annual, Flooding.

Introduction

Humans are clustering together in towns and cities leading to increasing urbanization. One of the consequences of urbanization is increasing rate of flooding (UNEP, 2018). Flood, like droughts are usually described as natural hazards which have impacted negatively on human lives, properties and environment (Omid *et al.* 2016). However, it may be induced by human's misuses and significant alteration in the environment, which can be defined as

a body of water, which moves over and above an area of land, which is not normally submerged. Since the 1960s human activities have led to a high increase in flood deaths and damages. Today, flood contributes to about 55% of all fatalities with close to 2.5 billion people affected and about 30% of global economic loss from natural disasters (EMDAT, 2015). Floods are natural phenomena, but they become a cause for serious concern when they exceed the coping capacities of affected communities, destroying lives and damaging properties. They affect settlement of all types, from small villages and mid-sized market towns and service centers to major cities and metropolitan. In many regions of the world, people moving from rural areas to cities, or within cities, often settle in areas that are highly exposed to flooding thereby making them highly vulnerable if there is no flood defence mechanism (Jha *et al.*, 2012).

Urban flooding can be coastal, fluvial or pluvial or even a combination of these types of floods. Coastal flooding is caused by extreme tidal conditions that occur because of high tide levels, storm surge and wave action. Fluvial (River related) flood occurs when the discharge of a river exceeds the capacity of the river channel to contain it. While pluvial flood takes place when the rainfall rate exceeds the capacity of storm water drains to evacuate the water and the capacity of the ground to absorb water (Ball *et al.*, 2008). Pluvial flooding often occurs unexpectedly in locations not obviously prone to flooding and with minimal warning and is not well understood by the general public – hence the term ‘invisible hazard’ (Houston *et al.*, 2011). Pluvial flooding is a characteristic of urban areas where large areas of impervious ground exist and inadequate drainage systems abound. As urban growth increases, the impervious surface area also increases; thereby rendering populations vulnerable to water inundation as natural streams and human-made drainage fails to cope with increased runoff subsequent to heavy rainfall (Youssef and Pradhan, 2011).

While many floods may cause little damage and are usually soon forgotten, except by those most directly affected, some may result in major disaster. This involves structural and erosional damage, disruption of socioeconomic activities, transportation, communications, loss of life and property, displacement of people, destruction of agricultural and contamination of food, water and the environment in general.

Today, global statistics show that floods are the most frequently recorded destructive events, accounting for about 55% of the world’s disasters each year. The frequency of floods is increasing faster than any type of disaster. Much of this rise in incidence can be attributed to uncontrolled urbanization, deforestation, and more recently, the effect of El Niño. Floods may also accompany other natural disasters, such as sea surges during hurricanes and tsunamis following earthquake (United State Agency for International Development (USAID), 2006). In the past years, there have been a number of significant revering floods all round the world that have caused enormous damage both in terms of loss of life and properties. In the past decade, thousands of lives have been lost directly or indirectly from flooding. In tropical and sub-tropical regions, severe flood hazards resulting from heavy

thunderstorms, torrential monsoon downpours, hurricanes, cyclones and tidal wave surges in coastal and estuarine environments are yearly occurrences (Jeb, 2014).

The statistics showed that floods from Asia to the South Pacific broke record after sad record. Up to 300 million people were affected by storm surges, torrential rains, landslips, mudslides and tidal waves. Statistics from Pakistan, China, Bangladesh, India and Papua New Guinea added up to over 100,000 flood-related deaths even before the waters had all subsided (International Federation of Red Cross and Red Crescent Societies (IFRCRCS), 2022). African nations too have had their own share of flood disasters. For example, in West and Central Africa more than 1.5 million people were affected by floods between the months of July and August 2018 following heavy rainstorm in which more than 11,400 homes were destroyed in Senegal; more than 94,000 in Chad and 24,000 homes in Niger (Ocha, 2018). In Nigeria, flooding occurs every year both in coastal hinterlands such as Lagos, Port Harcourt and even in the semi-arid areas like Katsina, Kebbi, Sokoto, Jigawa and Kano. The severity of these floods has often led to loss of lives and disruption properties as well as socio-economic activities. The pattern is similar with that of the world. It was estimated that nearly all the 36 states/FCT were affected with about 286 LGA's and at least 4,870 communities were also affected while about 963 people reported to have dead and about 50,851 person injured while 2,084,679 people registered at IDP's camp, about 77,705,398 population affected, about 597, 476 houses were submerged by water, about 3.9 million hectares of farmland of farmland also destroyed, over 182 schools damages and lastly over 50 markets were also destroyed (National Emergency Management Agency (NEMA), 2022). Annual floods occur along River Niger and Benue causing severe damages in parts of Niger, Adamawa, Benue, Kogi and other States. Because of this, Government spends huge sums of money on compensation and rehabilitation, yet the problems are unabated. It is therefore necessary to know extent and impact of annual flooding such as risk factors associated with flooding, effects of flooding as well as the control measures to be carried out by relevant government agencies or non-governmental organizations not only in the study area but in Nigeria at large.

Statement of the problem

Flooding of different magnitudes occur every year within the study area. The events of significant hazards are not regular annual phenomenon but the potential risk exists in the low-lying settled flood plains. Rapid urbanization and encroachment of settlements into the areas liable to flood is also continuing rapidly and unabated (Mundhe, 2017). For example, Mohammed *et al.*, (2019) report that the built-up areas in Kano metropolis has increased from 6562.61ha in 1990 to about 12547.15ha in 2005.

Urban flooding occurs in Nigeria every year both in coastal hinterlands, Kano metropolis like many cities of the world is faced with recurrent urban flooding (especially during the rainy season) within the recent decades, which have affected several lives, properties and functioning of many social and economic activities. Part of the metropolis is susceptible to

flooding because the landscape is predominantly covered by pavement and impervious surface which results into anthropogenically induced seasonal flooding. Replacing natural landscape (vegetation) with pavement, impervious surfaces (built-up) and tarred roads increased runoff to six times more than it would normally occur and temperature thereby creating circulation of hot air locally referred to as “urban heat island” (Etuonovbe, 2011; Adeoye *et al.* 2009). Mohammed *et al.*, (2019) extensively studied the trend and pattern of rainfall within the study area and have identified persistent increase in annual rainfall amount and intensity throughout the study period, this study in addition to rainfall as a factor focuses on integrating elevation (physical factor) and impervious surface (social factor) in flood hazardscape mapping and monitoring vulnerability dynamics. A study by Sulaiman and Muzammil (2020) reported that built-up areas within the central parts of the city area in kano metropolis have less vulnerable to flooding due to elevation. But however, can still be vulnerable due to combined anthropogenically induced factors. Projections have shown that especially due to climate variability (heavy rains and river discharge) and population growth, flood risks and vulnerability will increase in the future and flood intensity and frequency will threaten many cities across the globe (Nabegu, 2014).

Although flooding is a natural phenomenon, it can also be induced by human interaction with the environment. In 2012, Nigeria experienced unprecedented flood that resulted in large scale loss of lives and properties which happened to be the worst of it kind after 40 years and in 2022 Nigeria loss about 603 person and 2 million others displaced by flood (National Emergency Management Agency (NEMA), 2022). Flood hazardscape and riskscape are highly dynamic and directly related to the settlement location, densities and diffusion patterns over topographical area. Thus, comprehensive flood management is very vital (Markantonis *et al.* 2013). According to Smith and Ward (2018) most floods in the humid tropics result directly or indirectly from climatological events, either extremely heavy or prolonged rainfall. This in recent times happens every year within Kano metropolis. This indeed is a big threat to the progress already made in eradicating extreme poverty and disease. The damage caused by urban flood is on the rise because of the devastating effects of floods, it is important that we consistently study flood characteristic and impact, so that appropriate disaster risk reduction strategies can be put in place to reduce the impact of floods.

Assessment of flood, especially in urban centers need be comprehensively presented and articulated in such a way that identifies the varying associated factors that increase susceptibility/vulnerability of unplanned/unregulated urban centers/areas to flooding. Knowing these factors will not only add to the existing body of knowledge on “the impact of urbanization on flooding”, but will help improve the public awareness on flood plain areas, as well. The assessment will also give better information on flood depth, in order to guide in flood planning; reduce the risk of people, property and infrastructure to flooding; as well as inform the designing of various policies that are geared towards the provision of

high-quality interventional and/or precautionary approaches towards preventing, mitigating or averting flooding in urban centers of Nigeria, and the world at large.

Study area and size

Kano metropolis is the second largest city in Nigeria and the largest city in the Sudan Savanah ecological zone of Nigeria (Nabegu, 2015). Initially Kano metropolis covered 137 square kilometers (53 square miles), and comprised six local government areas (LGAs) namely: Kano Municipal, Fagge, Dala, Gwale, Tarauni and Nasarawa. Now it includes two (peri-urban) additional LGAs which are Ungogo and Kumbotso (Mshelia, *et al.*, 2020). The total area of Metropolitan Kano is now 499 square kilometers (193 square miles). It is located between Latitudes $12^{\circ}05'02''$ to $12^{\circ}22'43.92''$ N and Longitudes $8^{\circ}21'49.95''$ to $8^{\circ}37'24.90''$ E (Figure 1).

Kano Metropolis for centuries been the most important commercial and industrial nerve centre of Northern Nigeria attracting millions from all parts of the country and beyond. Immigration and natural growth rate of 3% is expected to continue in the increase of the population and waste stream in the years to come. Kano metropolis is among the fastest growing cities in Nigeria, with a population presently estimated at 3.5 million and a population density of about 1000 inhabitants per Km^2 within the Kano closed-settled zone compared to the national average of 267 inhabitants per km^2 . It is one of the most crowded cities in Nigeria, hence generation of municipal wastes in heaps on daily basis is enormous (Nabegu, 2019).

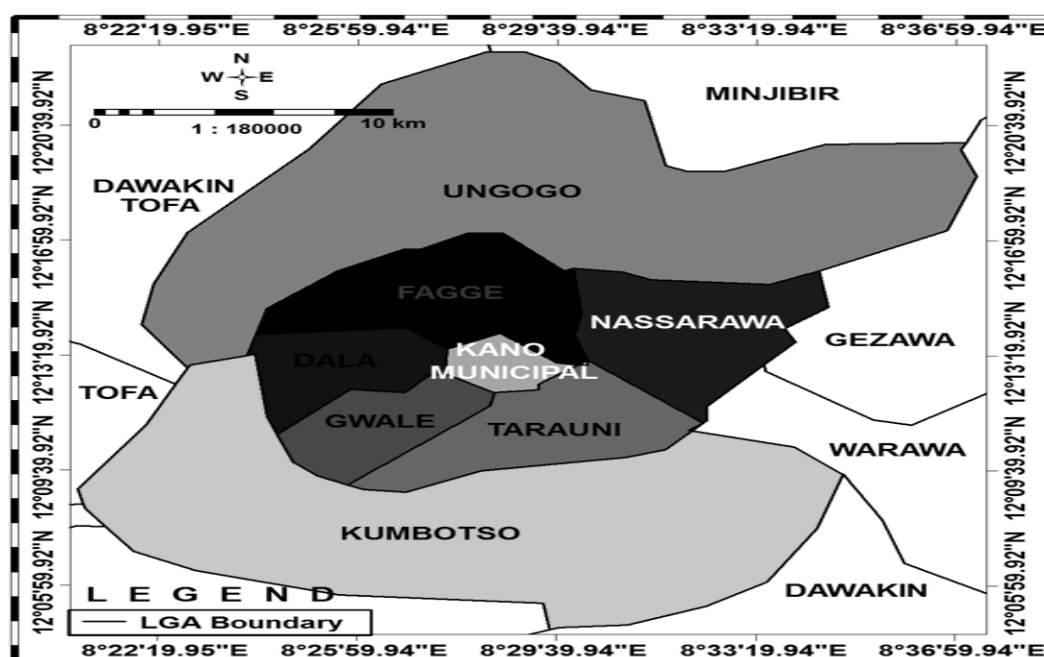


Figure 1: Kano State showing Kano Metropolis.

Source: Modified from Administrative Map of Kano State 2022.

The climate of the study area is the tropical wet and dry Aw going by Koppen's classification. Generally, the area has a semi arid climate, with a mean daily temperature of 30°C. The months of December to February are colder, with the lowest temperature recorded around 20°C. The rainfall regime is characterized by two seasons, namely, the rainy season from May to October and dry season from November to April. The average annual rainfall is about 884mm increasing from north to south. In the extreme south it could reach 1200mm per annum (Gaya *et al.*, 2018; Liman, Idris, and Mohammed, 2014). The climatic nature of the study area its imperative that the area is liable to flood there for requires adequate and proper attention to mitigate or reduce the damage that are likely cause by floods.

Material and Method

In any flood studies, various data were required. In this research, the materials and data used includes: The topographic map of the study area, data on the demographic characteristics of the respondent (Sex, age, and marital status), Data on socio-economic characteristic (occupation, educational qualification and income) of the households, data on quantified economic lost from NEMA office. Primary and secondary sources of data was also used, Field surveys using purposive non-probability sampling techniques were carried out in the residential zones that are affected with the disaster within the metropolis (Kano Urban Area) to understand the factors and identify the impact. The use of both structured questionnaire and oral interview in eliciting information for this study which contain relevant and well-structured questions aimed at eliciting responses whose addresses the aim of the study. Secondary data were also collected using a check list from the government agency (National Emergency Management Agency (NEMA)) responsible for the management of any kind of disaster like flooding was also employed, interviews with stakeholders and field surveys specifically to bridge the prevailing gap on awareness creation to ensure disaster risk reduction and build well informed and resilient societies across the state.

Sampling technique and sampling sizes

The study was conducted in Kano metropolis; the area was selected because it has experienced floods for quite sometimes. The Sampling frame was covered areas that are evident of flooding and its related consequences within the metropolis. In view of the nature of the study purposive sampling technique were applied to select the sample wards for the administration of questionnaires. The reasons for selecting these wards are: They experience higher frequency of flooding during the rainy seasons. The sampling size is determined using the numbers of questionnaire administered were proportionate to the population of each area.

Table 1: Sample Size Based on the Affected Area

Source: Field Survey, 2022 and National Population Commission (NPC, 2006).

S/N	Local gov't area	Population (Census 2006)	Projected population (2022)	Sample size per LGA	Selected locality	Sample size per Locality
1.	Dala	418,759	652,412	59	Kofan Ruwa	47
					Gwanmaja	12
2.	Fagge	200,095	311,741	28	Sabon Gari	23
					Fagge E	5
3.	Gwale	357,827	557,482	51	Dorayi	51
4.	Kano Municipal	371,243	578,384	53	Jakara	53
5.	Kumbotso	294,391	458,651	42	Panshekara	33
					Darmanawa	9
6.	Nasarawa	596,411	929,188	84	Gama Kwari	69
					Dakata	15
7.	Tarauni	221,844	345,625	31	Gyadi-Gyadi	22
					Sallari	9
8.	Ungoggo	366,737	571,364	52	Tudun Fulani	52
	Total	2,828,861	4,407,273	400		400

The respondents for the main survey were selected randomly (by visiting as many households as possible in the thirteen affected areas as highlighted in Table 1) with no regard to any probability in the selection process. Therefore, the selection of the respondents was by chance, and only households that showed interest in responding to the questionnaire were interviewed. This kind of sampling was referred to as "convenience sampling" which Robson in Dabo (2016) described as the most widely used, but the least satisfactory method of sampling.

Discussion

Demographic and Socio-economic characteristic of respondents

Demographic changes are dynamic in the quantifiable statistics of a given population. It seeks to understand population changes by investigating such demographic components as gender, age, ethnicity home ownership, mobility, disabilities, language, knowledge, employment status and location of the people under study. Several studies agreed that the socio-economic characteristic influences the role in protecting themselves and the environment. This section discusses the social, demographic and economic characteristics of respondents which are used to measure their role in environmental aspect. These characteristics involve age, gender, educational level, marital status, type of occupation, their level of income, house type and house ownership.

Table 3: Socio-economic Characteristics of Respondents

Variables	Frequency	Percentage (%)
Sex		
Male	329	86

Female	53	14
Age		
15-24	53	14
25-34	139	36
35-44	151	40
45-54	20	5
55 and above	19	5
Marital Status		
Single	57	15
Married	287	75
Divorced	11	3
Widowed	17	4
Separated	10	3
Level of Education		
No formal education	98	25.7
Primary	83	21.7
Secondary	72	18.8
Vocational	94	24.6
Tertiary	35	9.2
Occupation		
Farming	79	21
Trading (Business)	207	54
Civil Service	65	17
Others	31	8
Income Level (₦)		
Less than 100,000	39	10
110,000-200,000	63	16
210,000-300,000	119	31
310,000-500,000	49	13
500,000 and above	112	29
House Type		
Flat	117	31
Bungalow	33	9
Duplex	15	4
Compound house	186	48
Others	31	8
House ownership		
Personal house	254	66.5
Rented	78	20.4

Government	11	2.9
Others	39	10.2

Source: Field Survey, 2022

Table 2 revealed that 86% of the respondents are male whereas the female constituted 14%. The result could be a function of questionnaire administration and looking at the socio-cultural setting of the study area in which more males were found and reachable during the study than the females because of their role as heads of household.

The age of 35-44 years constitutes the highest proportion of respondents with 40%, followed by those aged between 25-34 years 36% while those with 45-54, 15-24 and 55 years and above, constitutes 5%, 14% and 5% respectively. This implies that majority of the reached population in the study area are within the productive ages of 18-60years as postulated by NPC (2006). The table indicates that 75% of the respondents are married which forms the majority, while 15% are single, 3% each are divorced and separated and 4% are widowed. This result is not surprising as culture still influences marital activities of the area and going by that, there is the prevalence of early marriage in the Northern part of Nigeria as a whole as found by EM-DAT (20015) in which the area of this study is wholly part of the region.

Educational status sometimes reflects the nature of occupation and in turn may also influence the level of income of an individual. All this coupled together influences an individual's knowledge and ideology on the environment. Also, the educational level of people determines to a large extent the nature of their responses and their understanding of the issues at stake this is because our relationship with the environment is always interactive. This means that we affect our environment and our environment also affects us.

Education is always valued as a means of deliverance from ignorance and enables one to perform effectively to any given task within a specified period (Liman *et al.*, 2022). Table 2 also reveals that a high number of the respondents reported not to have no formal education with 25.7% followed by vocational education representing 24.6%, a good number of them acquired primary education representing 21.7% as against secondary and tertiary education who reported to have only 18.8% and 9.2% respectably. This is a negative indicator for environmental education as majority of the people cannot comprehend any effort to promote hygienic urban environment both through public education and enlightenment campaign. This may be disconnected to attend a higher educational level despite the various educational institution situated in the study area like Bayero University, Federal College of Education, Kano State University of Science and Technology, Yusuf Maitama Sule University and many other Institutes; therefore majority of the respondents 50.3% in the area have no formal education as only 21.7% attained primary education and as their level of formal education.

The socio-demographic characteristics further revealed that 17% of the respondents are civil servants; this is followed by respondents that are into trading with 54% while farming constitute 21%, others make up 8% (retired people and those who depend on their children). The high proportion of farmers in the area could be attributed to the low educational attainment of the respondents as earlier indicated. This also indicates that the area is most likely full of agricultural land whose defend mostly on rain fed and dry season farming and most of their houses is located in areas liable to flood and in some cases close to their farmlands. In addition, high number of farmers is expected because NPC (1991) outlined that the majority of Nigerian populations are contributors in agriculture with a total percent of 68.7%. Although the significant number of civil servant in the area is as a result of both formal and informal economic activities. It also implies that educational status sometimes reflects the nature of occupation as earlier shown the educational qualification of the respondent to be more of formal education inclined. The income of the respondents as revealed from the table shows that only 29% of the respondents agreed to earn above N500,000. This is less than those 31% who earns N310,000-500,000 but more than those 16% who earns N110,000-200,000, 13% that earns N210,000-300,000 and 10% who earn less than N100,000. This explains the low income status of the people as a result cannot afford to pay for the desired sanitary services (clearing of waste from the drainage) they need for their wellbeing or to buy a plot of land in the highland area because of its expensiveness likewise to build a drainage channels in-front of their houses.

House type and ownership by household, Adedayo in Dabo (2016a) reiterates that a very vital human need which provides both psychological relief and physical shelter is housing. The issue of housing has always been a global concern, which could be because most human activities are done in, on or under it. Therefore, the type of housing, ownership and even the number of people living in it is crucial towards the enhancement of the lifestyle and wellbeing of people.

The table 2 reveals that majority of the respondents having 48% live in compound house which is considered to be the most complicated to handle with regards to maintenance because it contains more than a household, while those living in flat constitute 31%. Those living in bungalow, duplex and others constitute 9%, 4% and 8% respectively. This implies that house type is greatly influenced by level of income as it can be seen that majority of the respondents earn less than sixteen thousand naira (<N300,000) per annum. But considering what the table presented on house ownership, with 59.4% saying they own the house, 28.2% live in rented house while 3% are in government houses and 9.4% live in others (who live in their brothers or relatives house) respectively. It can therefore be deduced that educational level affects income level which in turn affects housing type as well as ownership. The high percentage for personal ownership present an opportunity for identifying which type of strategy and practice is adopted in the various households, since ownership gives control of sanitary activities are to be undertaken in the house especially with regards to household waste collection and disposal. This is because it is your house,

you have the power to determine how the whole household should approach sanitation. House owners can therefore be seen as key partners determining the sanitary activity of the house hold which end up disposing of waste into the drainage system and later to cause flooding during the rainy season in the study area.

Extent and impacts of flood in the study area

Factors responsible for flooding in the study area

When it rains or snows, some of the water is retained by the soil, some is absorbed by vegetation, some evaporates, and the remainder, which reaches stream channels, is called runoff. Floods occur when soil and vegetation cannot absorb all the water; water then runs off the land in quantities that cannot be carried in stream channels or retained in natural ponds and constructed reservoirs. About 30 percent of all precipitation is runoff, and this amount may be increased by melting snow masses. Periodic floods occur naturally on many rivers, forming an area known as the flood plain. These river floods often result from heavy rain, sometimes combined with melting snow, which causes the rivers to overflow their banks; a flood that rises and falls rapidly with little or no advance warning is called a flash flood. Flash floods usually result from intense rainfall over a relatively small area.

Most authors attributed the causes of flooding to lack of physical drainage as well as good social waste management system, which is common with most urban cities (Sada *et al.*, 2018). He discussed the causes of the most dangerous floods of all that is coastal floods. A hurricane for instance causes damage by the direct action of wind on property, by the accompanying heavy rainfall that causes river to flood. Hence the damage is from three sources, each potentially destructive in its own right, collectively, they are catastrophic (Ologunorisa, 2006). Floods may also be caused by the encroachment of hydraulic structures and cities on floodplains and coastal lands and by blocking of river channels. The Ogunpa river flood in Ibadan on August 30th 1980 for instance was wholly due to the blocking of the river channel with waste deposited by the residents of Ibadan (Ojo, 2007).

The result from figure 2 revealed that 22% of the respondents believe that lack of drainage system is the second most important factor leading to flooding in the study area. As we all know the need for good drainage system in a city is essential for proper water and rainwater to have a free flowing without any obstacle and also waste water disposal so as to go away with stagnant water which leads to breeding sites for vectors such as mosquitoes. Another issue is taking good care of the drainage which is revealed by 21% of the respondent that as the third most important factor causing flooding in the study area. Although is the responsibilities of a particular household to make sure the drainage channels to the house is well clean but they end up dumping refuse waste into it. This is not in line with the findings of Bichi, Adamu, Bichi and Gadanya (2012) which revealed that 54.5% of those living in Sabon Gari LGA in Kaduna State clean their drainage at least twice a week which is a good effort in reducing the impact of floods and at the same time reduce mosquitoes breeding sites.

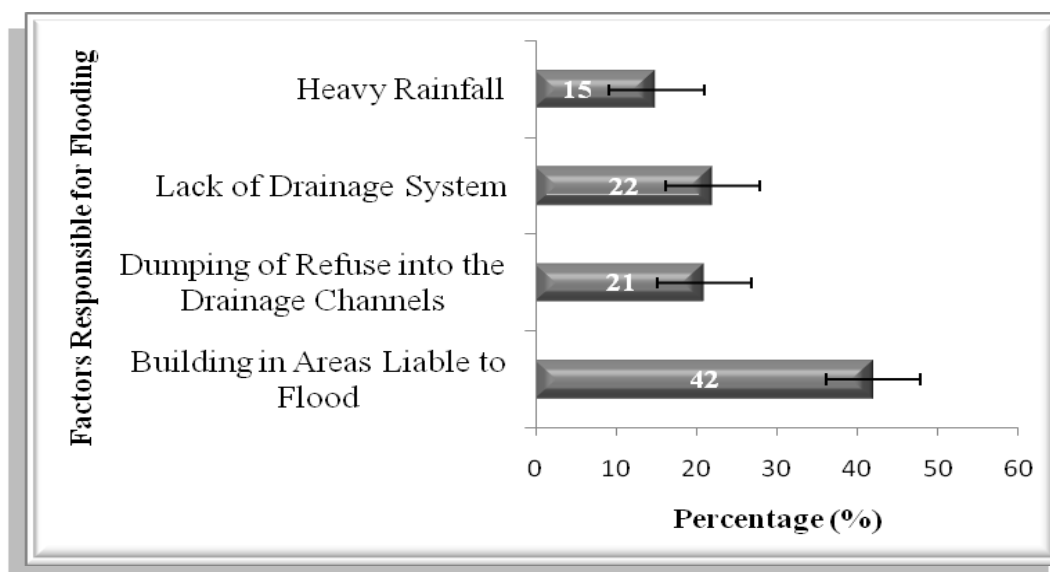


Figure 2: Factors Responsible for Flooding in the Study Area

Source: Field Survey, 2022

With respect to building in areas liable to flood, data during the field survey investigation coupled with the 42% of the respondent revealed that is the major important factor that causes flooding in the affected areas of the study area. This in line with the findings of Jeb (2014) which revealed that urban sprawl and encroachment towards the river or flood plain has been reported the increased of impacts in Kaduna Metropolis. The present study also has similar situation because population and urban growth process are the major factors that have increased the level of vulnerability in the study area. The study showed that areas of high flood impact in the study area include Jakara, Panshekara, Gyadi-Gyadi, Dorayi, Rimin Zakara and Dakata. These parts of the urban area are characterized by high population densities, close proximity of buildings to either the river or flood plain of less than 100 metres.

Areas affected by flood in the study area

Data on flood extent were obtained from each area and the household during the distribution of questionnaire. Flood extent deals with the size of land affected by the flood and the number of people that die during the flooding, properties damage and Agricultures including the farm land. The respondents could recall the size of land covered by the flood during the 2013 because it was one of the most destructive floods that happened to the farmers in the area. After that was the 2012 flood cause by heavy rainfall (See table 1 for the areas affected).

Effect of flooding in the study area

Floods not only damage property and endanger the lives of humans and animals, but have other effects as well. Rapid runoff causes soil erosion as well as sediment deposition problems downstream. Spawning grounds for fish and other wildlife habitat are often destroyed. High-velocity currents increase flood damage; prolonged high floods delay traffic and interfere with drainage and economic use of lands. Bridge abutments, bank lines, sewer outfalls, and other structures within floodways are damaged, and navigation and hydroelectric power are often impaired. Financial losses due to floods are commonly millions of dollars each year.

Floods are one of the most common and widely distributed natural risks to life and property worldwide. Damage caused by floods on a global scale has been significant in recent decades (Jonkman and Vrijling, 2008). In 2011, floods were reported to be the most occurring disaster, after earthquake and tsunami, with 5202 deaths, and affecting million of people (CRED, 2010).

Nigeria lost 2.6 trillion naira to the 2012 flood disaster which were consider to be the worst in 40 years, the disaster, which resulted in 363 deaths, affected seven million people, displaced 2.3 million others and damaged 597,476 houses. The comprehensive Post Disaster Needs Assessment conducted from November 2012 to March 2013 with the support of the World Bank and Global Facility for Disaster Reduction and Recovery, United Nations, Development partners and relevant Ministries, Departments and Agencies put the estimated total value of infrastructure, physical and durable assets destroyed at \$9.6bn. The total value of losses across all sectors of economic activity was estimated at \$7.3bn. The combined value of these damages and losses was \$16.9bn (Daily trust May 19th 2015). Flood has been known to cause damage to lives, land property, household property, business, traffic, drains, surface and underground water.

In Kano Urban Area the socio-economic component is part of the socio-economic system, the flooding affects the day-to-day lives of the population that belongs to the system. The socio component relates to the presence of human beings and encompasses issues related to it e.g. deficiencies in mobility of human beings associated with gender, age, or disabilities. The floods of Kano Urban Area causes lost of lives, destruction of houses, disruption of communications, in the agricultural process, or even fatalities. The economic component is related to income or issues which are negatively affected by flooding. Among them are agriculture (farmland), transportation route (destruction of bridges), education (schools), worship centre (mosque) and even availability of potable water etc.

Table 3: Effects of Floods in the Study Area (2012-2022)

S/No	LGA	Community	Date Occurred	Properties Destroyed	Persons Displaced	No. of Deaths
1	Ungogo	Tudun Fulani	2012, 2016, 2022	13 houses	NA	NA

2	Kano Municipal	Jakara,	2012, 2019, 2022	38 houses, 1 Mosque, 21 Shops	NA	NA
3	Gwale	Dorayi	2012, 2013, 2016	22 Houses, 3 farmland	NA	NA
4	Fagge "	Fagge E, Sabon Gari	2012, 2016 2012, 2022	108 shops, 13 Houses, 3 Schools, 1 brige	NA	NA
5	Dala	Kofan Ruwa, Gwammaja,	2012, 2015, 2022 2015	20 shops, 1 Mosque, 49 houses	NA	NA
6	Tarauni	Sallari, Gyadi-Gyadi	2012, 2016 2016, 2022	30 houses	NA	NA
7	Nasarawa	Dakata, Gama Kwari	2012, 2019 2012	37 houses, 1School	NA	NA
8	Kumbotso	Darmanawa, Panshekara	2022 2022	52 houses, 14 farms	NA	NA

Source: NEMA 2012, 2016 and 2022 Annual and Quarterly Report and Field Survey, 2022

Mitigation of flood disaster can be successful only when detailed knowledge is obtained about the expected frequency, character, and magnitude of hazardous events in an area as well as the vulnerability of the people, buildings, infrastructures and economic activities in a potential dangerous area (Van Western, 2001). Unfortunately, Ifatimehin and Ufuah (2016); Ishaya *et al.*, (2018) reported that this detailed knowledge is always lacking in most urban centers of the developing world especially Nigeria. One way to mitigate the effects of flooding is to ensure that all areas that are vulnerable are identified and adequate precautionary measures are taken to ensure either or all of adequate preparedness, effective response, quick recovery and effective prevention. Before these could be done, information is required on important indices of flood risk identification which are elevation, slope orientation, proximity of built-up areas to drainages, network of drains, presence of buffers, extent of inundation, cultural practices as well as attitudes and perceptions. Majority of flood incidents are both predictable and preventable, yet flood is still one of the most costly natural disasters in the world. Advances in mapping and statistical analysis can help locate safer sites or new areas away from flood. Safeguarding existing areas focuses on two main strategies which include: keeping water out of the buildings/areas to the

greatest degree possible; and limiting the extent of damage when water does enter such areas. The key to preventing flood loss is to understand the exposure to flood site and taking simple steps to protect it. These steps can be found in the flood Checklist. Understanding the hazard flood entails designing and upholding to the emergency response procedures often known as “flood emergency response plan (FERP)”.

Conclusion

Increase in flood risks and hazards in Nigeria today cannot be over emphasized. Every year, tales of untold hardship and calamities from floods in different parts of the country are being experience. Urban flood hazardscape pattern and vulnerability in Kano metropolis has been dynamic and greatly influenced by the combination of anthropogenic and natural factors (increase in impervious surface area, elevation and rainfall). Levels of vulnerability to urban flooding vary according to the pattern of hazardscape. Flood vulnerability dynamics is critical, but can be influenced by the roles of urban planners and policy makers through formulation, updating, influencing and enforcing proper planning and management practices for sustainable urban development. It has been gathered that the attitude of residents on flouting safety and hygienic measures has exposed the area to the recent flooding. Also, indiscriminate dumping of waste on the roads escalated the situation, leading to the city being dirty and vulnerable to flooding and other related disasters. On the other hand, the government has not been effective enough in addressing the root causes of these disasters.

It is therefore recommended that:

- The departments responsible for urban development plan (KANUPDA) and allocation of land should put into consideration urban flood hazardscape in updating future plan and land allocation for sustainable urban development. Where people must reside on vulnerable areas, building codes should be enforced so as to mitigate the impact of the flood. Proper drainage system should be developed to divert the excess run off water so as to achieve safe and resilient urban area in line with the Sustainable Development Goal.
- The study futher recommends that all illegal structures blocking the free-flow of water are being remove no matter who own them, government of Kano state should also construct more and wider water channels and streams across the state to provide the much needed drainage to mitigate the impact of flooding.
- Residential areas, commercial establishment and schools should be relocated above 150m set back as proposed by United Nations International Strategy for Disaster Reduction (UNISDR, 2009) for the safety of dwellers, the government should also construct permanent rehabilitation camps to accommodate people displaced by future disaster and to avoid the use of schools as temporary shelters which may be detrimental to education.

Acknowledgements

We would like to thank God for granting us energy, good health and inspiration to embark in this research. This work could not have been undertaken without consultative and dedicated guidance from various people who contributed directly or indirectly to the successful completion of this research. However, it is impossible to mention each individual who in one way or another contributed in this work. We are indebted to any of those individual for their staunch support and assistance for this research work.

References

- Adeyole, A. J. and Rustum, R. (2011). Lagos (Nigeria) Flooding and Influence of Urban Planning; *Urban Design and Planning*. 164 (3), 185-187.
- Ball, T., Werritty, A., Duck, R. W., Edwards, A., Booth, L. and Black, A. (2008). *Coastal Flooding in Scotland: A Scoping Study*. Report to SNIFFER, Edinburgh
- Bichi A. A., Adamu A., Bichi M. A. and Godanya M. A., (2012). Environmental Sanitation and National Development. *Transcampus Journal* 10 (2), 17-25.
- Centre for Research on the Epidemiology of Disaster (CRED) (2010). Universit  catholique de Louvain, as see on www.cred.be
- Dabo, A. A. (2016). *Impact of Fuelwood Consumption Rate on Vegetation Cover in Zaria and its Environs, Kaduna State, Nigeria*. Unpublished M.Sc. Research Dissertation, Department of Geography, Ahmadu Bello University, Zaria-Nigeria
- Dabo, A. A., Shehu, A. U., Muhammed, H. and Umar, N. A. (2016). *An Appraisal of Environmental Impact Assessment of Some Selected Filling Station in Zaria Urban Area, Kaduna State-Nigeria*. A Paper presented at the 2nd International Conference, Held at Northwest University, Ado Bayero House, Kano, Kano State-Nigeria, between 6th – 9th November, 2016
- EM-DAT, H. (2015). The human cost of weather-related disasters, 1995–2015, Centre for Research on the Epidemiology of Disasters, UN Office for Disaster Risk Reduction (UNODRR), Brussels, pp. 1–25.
- Etuonovbe, A. K (2011). The Devastating Effect of Flooding in Nigeria. Hydrography and the Environment, Innocent Chirisa, Zimbabwe. *FIG Working Week 2011. Bridging the Gap between Cultures. Marrakech, Morocco*. 20, 18-22 May 2011.
- Gaya, F. I., Ali, A., Adamu, M. K., and Zanuwa, M. A. (2018). Impact of solid waste disposal on health and environment in Kano metropolis. *International Journal of Scientific & Engineering Research*. 9 (7), 1404-1416.
- Houston, D., Werritty, A., Basset, D., Geddes, A., Hoolachan, A. and McMillian, M. (2011). *Pluvial (rain-related) flooding in urban areas: the invisible hazard*. University of Dundee, Joseph Rowntree Foundation, York.
- Ifatimehin, O. and Ufuah, M., (2016). An Analysis of Urban Expansion and Loss of Vegetation in Lokoja, Using GIS Techniques, *Zaria Geographer*, 17, 28-36.
- Ishaya, S., Ifatimehin, O. O. and Abaje, I. B. (2009). Mapping Flood Vulnerability Areas in Developing Urban Centre in Nigeria. *Journal of Sustainable Development in Africa*. 4(11), 180-194.
- Sada, S., Ifatimehin, O. O. and Abaje, I. B. (2018). Mapping Flood Vulnerability Areas in Developing Urban Centre in Nigeria. *Journal of Sustainable Development in Africa*. 4(11), 180-194.
- Jeb, D. N. (2014). Flood Risk Analysis in Kaduna Metropolis, Kaduna State Nigeria Using Geoinformation Sciences. Unpublished Ph.D Thesis, Department of Geography, Ahmadu Bello University Zaria-Nigeria

- Jha, A.K., Bloch, R. and Lamond, J. (2012). *Cities and Flooding - A Guide to Integrated Urban Flood Risk Management for the 21st Century*. The World Bank, Washington DC. Retrieved from <http://www.gfdr.org/gfdr/urbanfloods>.
- Jonkman, S. N. and Vrijling, J. K. (2008). Loss of Life Due to Floods. *Journal of Flood Risk Management*, 1, 43-56
- Liman, M., Idris, H.A., and Mohammed, U. (2014). Weather and Climate. In Tanko, A.I. and Momale, S.B. (ed.) *Kano Environment, Society and Development*. Adonis and Abbey Publishers Ltd. Abuja Nigeria
- Liman, Y. B., Babajo, H. and Hari I. (2022). Evaluation of the factors influencing Students' performance in map reading in some selected public senior secondary schools, Tarauni, Kano State. *Zaria Journal of Educational Studies*, 27 (2), 06-110
- Markantonis V, Meyer V, Lienhoop N. (2013). Evaluation of the environmental impacts of extreme floods in the Evros river basin using contingent valuation method. *Nat Hazards*. 69, 1535–1549.
- Mohammed M. U, Hassan N. I. and Badamasi, M. M. (2019): In search of missing links: urbanisation and climate change in Kano Metropolis, Nigeria, *International Journal of Urban Sustainable Development*, DOI..
- Mundhe N.N (2017). GIS Based Urban Flood Vulnerability Analysis in Western Zone of Ahmedabad City. *International Journal of Research in Geography*. 3(4), 41-51.
- Mshelia, S. S., Mbaya A. Y. and Galkaye, E. (2020). Municipal Solid Waste Management Practices in Tarauni Local Government Area, Kano State, Nigeria IIARD *International Journal of Geography and Environmental Management*, 6 (3), 1-12
- Nabegu, A. B. (2019). An Analysis of Municipal Solid Waste in Kano Metropolis, Nigeria. *Journal of Human Ecology*, 31, 111-119.
- Nabegu, A. B. (2015). Institutional Constraints to Municipal Solid Waste Management in Kano Metropolis, Nigeria. *International Journal of Innovative Environmental Studies Research*, 3(3), 13-21.
- Nabegu, A. B. (2014). Analysis of Vulnerability to Flood Disaster in Kano State, Nigeria. *Greener Journal of Physical Sciences*, 4(2), 22–29.
- National Emergency Management Agency (NEMA) (2022). *2022 Annual Report*. Yaliam Press LTD.
- National Population Commission (NPC). *Census 2006*.
- National Population Commission and ORC [Nigeria] Macro (2006). *Nigerian Demographic Health Survey, 2008*. Calverton. Maryland, USA: NPC AND ORC Macro.
- National Population Commission (NPC) (2006). *Census 2006*.
- OCHA (2018): Situation Report 5-Southern Africa Floods. 31 January
- Ojo, A. O. (2007). The Climatic Dilemma, *23rd Inaugural Lecture of the Lagos State University*. Delivered on 19th April.
- Ologunorisa, T. E. (2006). Flood Hazard Perception and Adjustment in Ondo South Western Nigeria. *Journal of Nigerian Affairs*, 4, 172-193.
- Omid Rahmati, Hamid Reza Pourghasemi & Hossein Zeinivand (2016) Flood susceptibility mapping using frequency ratio and weights-of-evidence models in the Golastan Province, Iran, *Geocarto International*, 31:1, 42-70, DOI.
- Omolere, O. S. (2008). *An Evaluation of the Urban Sprawl in Kaduna Metropolis Using Remote Sensing and Geographic Information System*. Unpublished Post Diploma Project, African Regional Center for Space Technology Education in English, Obafemi Awolowo University, Ile-Ife.
- Daily Trust Newspaper (November 2012 to March 2013). *The Comprehensive Post Disaster Needs Assessment Conducted*.
- Smith, K. and Ward, R. (2018). *Floods: Physical Processes and Human Impacts*. John Wiley and Sons. England.

- Sulaiman Y. and Muzammil A. K. (2020). Urban Flood Hazards cape Pattern and Vulnerability Dynamics in Kano Metropolis, Kano State, Nigeria. *Confluence Journal of Environmental Studies*. 13 (2), 2020
- United Nations International Strategy for Disaster Reduction (UNISDR) (2009). *Disaster Risk Reduction for Sustainable Development in Africa*. Guidelines formainstream Disaster Risk Assessment and Development. Accessed; October 10, 2015.
- United Nation Environmental Programme (UNEP), (2018). *Depleted Uranium In Kosovo*. Post Conflict Environmental Assessment. United Nations Environment Programme, Geneva, CH.
- United State Agency for International Development (USAID) (2016). *Lecture Notes for Health Science Students: Disaster Prevention and Preparedness*. Produced in collaboration with the Ethiopia Public Health Training Initiative, The Carter Center, the Ethiopia Ministry of Health, and the Ethiopia Ministry of Education.
- Van Western, C. (2001). *Geoinformation Science and Earth Observation for Municipal Risk Management: The SLARIM Project*. In: International Institute for Geoinformation Science and Earth Observation (Editor), Risk Management. ITC, Enschede.
- Youssef, A. M. and Pradhan, B. (2011). "Flash flood risk estimation along the St. Katherine Road, southern Sinai, Egypt using GIS based morphometry and satellite imagery" *Environmental Earth Sciences* 62(3), 611-623.