Flood Disaster Vulnerability in North Central Nigeria

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***Abstract:-*The vulnerability of residents and their livelihoods to flood disaster was examined in this study.**

In order to achieve this, the study was conducted using questionnaire and field observation. The data obtained were analysed using descriptive and statistical analysis. It was revealed through findings that residents had high level of awareness of flood occurrence. It was also revealed that flood frequency in the study area was high mainly especially in the highly espoused zones. Moreover, vulnerability to flood disaster varies significantly ($p< 0.05$) across the 12 selected Neighbourhoods in the study area. The Neighbourhood with the highest vulnerability was Felele (0.35), followed by Adankolo (1.35), Sabo (1.71), Rijia (2.31), Marine (2.71), and so on while GRA had the lowest (5.15) vulnerability. Although flood frequency was highest in Rijia (38.94), vulnerability in the area is only fourth highest because it has a relatively strong coping capacity (1.5) compared to Felele (1.2), Adankolo (0.8) and Sabo (0.5).To reduce the impact of floods, it is very important to identify and understand the socioeconomic, physical and environmental factors that determine people's exposure, sensitivity and ability to cope with stress or change.

I. INTRODUCTION

Flood remains one of the most frequent and widespread hazards in the built environment as it can simultaneously affect agriculture, settlement, flora and fauna, transportation, education, food security, infrastructure, peace building among others (Grothman, 2017; Ikusemaran, 2017; Percival and Teuw, 2019). The widespread effects of floods as reflected in the 2030 Agenda for Sustainable Development (ASD) linked the disaster to one of the challenges limiting sustainability (UN Habitat, 2019)..This is axiomatic because there are 25 targets that relate disaster risk to sustainability (International Federation of Red Cross and Red Crescent, Commission {IFRC}, 2015).

The occurrence of floods in Nigeria in general and in the North Central in particular have been frequent, intense and disastrous in the last few decades. The 2012 and 2017 flood disasters experienced in North Central Nigeria were the worst ever witnessed in her history with Kogi and Niger topping the chart in terms of damage and material loss (National Emergency Management Agency {NEMA}, 2018). These two states are located in North Central Nigeria. Flooding in these areas has attracted humanitarian assistance from NEMA, Red Cross and other relevant bodies but has not been alleviated. Beyond the Nigerian experience the disastrous effects of flooding in Africa has been linked to her residents' inability to overcome poverty, deprivation and widespread epidemics (Adelakan, 2009). The persistence of flood occurrence in Nigerian in general and in North Central in particular thus became an issue that required research into vulnerability to the disaster in these areas.

The assessment of vulnerability to flood disaster is therefore central to understanding not only risk and potential impacts of floods, but also a key determinant of the overall possibilities of minimising flood impacts. Expectedly, a number of studies have been conducted along this line (Adelekan, 2010; Emmanuel, 2016; Kovacs, Doussin and Gaussens, 2017; Eze, Vogel and Ibrahim, 2018; Itopa, 2018). Most previously conducted studies concentrated on the impacts of floods on agriculture, health, coastal zones, and forestry while some concentrated on the causes of flooding. Specific ones that have examined vulnerability to flood disaster especially in the North Central where flood occurs recurrently are not common. Ikusemanran (2017) assessed the vulnerability of communities to the 2012 flood incidence in North western Nigeria. In the study, vulnerability was classified into four: Highly vulnerable, vulnerable, marginally vulnerable and not vulnerable. The study found that all the 120 communitiesn in the area were described as vulnerable to flood, that is, they were either highly vulnerable, vulnerable or marginally vulnerable. While applying GIS and Digital Elevation Model, Onwuteaka (2014) simulated the extent of exposure to flood in the coastal areas and the vulnerability to sea level rise. It was observed that flood level rose within elevation of 2.3 to about 14 metres and more during the peak of rain.

Eze1, Vogel and Ibrahim (2019) examined social vulnerability of households to flooding in Niger State of Nigeria. It was opined through findings that major socio-economic status such as education background, income, household size and membership of a co-operative significantly ($p<0.05$) influenced their level of vulnerability. Although vulnerability and its various dimensions of measurements (i.e., physical, social, environmental and economic) have been examined across Nigeria it is dynamic, with change in time and space and depends on the level of exposures and the potential hazard. A study on vulnerability in recent time will be necessary in this regard. The current study on flood disaster vulnerability in the North Central of Nigeria is an attempt to bridge this gap; hence this study.

II. BASIC CONCEPT OF THE STUDY

a. Flood

Flood can be defined as a natural process that results in the temporary submerging or inundation with water of a land that does not occur under normal circumstances. Floods, although

a natural disaster, could also be caused by anthropogenic activities and human interventions in natural processes, such as increase in settlement areas or population growth located in areas prone to flooding. Floods are the most reoccurring, widespread, disastrous and frequent natural hazards of the world. (Aderoju, Jantiku, Fagbemiro and Aliyu, 2014).

b. Vulnerability

Several definitions have evolved in trying to explain the meaning of vulnerability in the last few decades. One of the earliest defininition was given by Robert Chambers in 1989. According to Chambers, vulnerability refers to exposure to contingencies and stress, and difficulty in coping with them. Vulnerability has thus two sides: an external side of risks, shocks, and stress to which an individual or household is subject: and an internal side which is defenselessness, meaning a lack of means to cope without damaging loss. Liverman(1990)distinguishes between vulnerability as a biophysical condition and as political, social and economic conditions of society Vulnerability in his own view is defined both in geographic space (where vulnerable people and places are located) and in social space (who in that place is vulnerable).Downing *(*1991*)*identifies vulnerability as possessing three connotations: it refers to a consequence (e.g., famine) rather than a cause (e.g., drought); it implies an adverse consequence; and it is a relative term that differentiates among socio-economic groups or regions, rather than an absolute measure of deprivation. Dow (1992 relates the concept to the differential capacity of groups and individuals to deal with hazards based on their positions within physical and social worlds. Watts and Bohle (1993) explains it in terms of exposure, capacity and potentiality. Accordingly, the prescriptive and normative response to vulnerability is to reduce exposure, enhance coping capacity, strengthen recovery potential and bolster damage control (i.e. minimize destructive consequences) via private and public means. Cutter *et al,*(2000)perceived it as broadly associated with the potential for loss of property or life from environmental hazards.

In recent literatures as indicated in the works of Dollan and Walker, 2005, Intergovernmental Panel for Climate Change (2009), Adelekan (2010), Aderogba (2012b), Akukwe and Ogbodo (2015) vulnerability is defined as the degree to which a system or unit is likely to experience harm due to exposure to perturbations or stress. In a more comprehensive manner, Coburn *et al.,* (2016) sees vulnerability as a measure of how the elements at risk in a landscape would be damaged if they were exposed to the same level of hazard. It is usually seen as being prone to or susceptible to damage or injury. In refining this definition, Samuel *et al.,* (2017) sees it as the characteristics of a person or group in terms of their capacity to anticipate, cope with, resist and recover from the impact of an hazard. Vulnerability can be seen as a way of conceptualizing what may happen to an identified population under conditions of particular risks and hazards. It describes the conditions of groups of people impacted by hazards who are at different levels of preparedness, resilience and with varying capacity to recover. It equally goes beyond the likelihood of a particular hazard injuring or killing a people, to include the livelihood the people are engaged in and the impact of different hazard on them (Cannon, Twigg and Rowell, 2001).

In addition, Auger and Banneth (2013) viewed vulnerability as the circumstances and characteristics of an asset or people which make them susceptible to the damaging effects of hazards. They view vulnerability as independent of the asset's or people's exposure but rather on certain traits. Such traits (circumstances and characteristics) may be physical, social or environmental in nature. The physical aspects relates to quality of buildings, location, size, design, remoteness of communities, state of infrastructure, population density level, dwelling construction materials, condition of open spaces. Social vulnerability refers to the inability of people to withstand the adverse impacts of hazards due to the characteristics inherent in social interactions, institutions, and systems of cultural values. It is linked to the level of wellbeing of individual communities and societies. It includes aspects related to extent of illiteracy and education, existence of peace and security, access to basic human rights, system of governance, traditional belief, social equity and customs. Environmental vulnerability has to do with natural resource depletion and degradation levels within a society.

All the foregoing definitions is a clear indication that vulnerability depends on a system, individual or organization's exposure, characteristics, sensitivity or capacity to withstand adverse damaging effects of a hazards. Vulnerability is reflected in a system's location, features and conditions which make it prone to has tendency to suffer severe loss from extremities. Despite these insights from the literature, it remains unclear as to how people are vulnerable to flood disaster in the African setting, particularly if they are frequently exposed and/or sensitive to the hazards, alternately and concurrently. This leaves a major research gap and calls for a holistic approach to better understand the situation (Yiran, *et al.,* 2015). This study is expected to extend existing knowledge by presenting flood disaster vulnerability focusing on settlements in flood-prone areas in North Central Nigeria. Clearer understanding of vulnerability can thus illuminate who and what are at risk to what threats or hazards and how specific stresses and perturbations evolve into risks and impacts. The study is thus an attempt to highlight the locations and sectors that require more targeted interventions to enable more effective adaptation to the hazards. Vulnerability will be looked in terms of conditions resulting from social, economic physical and environmental factors that increase the susceptibility of an individual and community to disasters.

c. Indicators of Vulnerability

Indicators are a set of prevailing conditions which adversely affect the community's ability to prevent,

mitigate, prepare for nor respond to a hazard (IPCC, 2012). They are essential toolkits in determining vulnerability of a system, individual or organization. They serve as means through which level of exposure, sensitivity, coping capacity, preparedness, marginality and resilience can be measured (Murat and Surat, 2013; Omedo, 2013; Aliyu, 2014). Earlier studies classified vulnerability indicators as social (Ologunlorisa and Tersoo, 2006; Igwe, *et al*., 2007; Yusuf and Francisco, 2009; Igwe, 2012; Dalil *et al.,* 2015; UN-Habitat,2013), physical (Carolina, 2001; Makoka and Kaplan, 2005;Jeje, 2005; Douglas et al.,2007; Adelekan, 2010;Anunobi, 2014; Daffi, 2016), environmental (Alessandra , and Jixi, 2007;Abubarka, 2010; Cooke *et al.,* 2015; Samuel *et al.,*2017) or economic (Chormanski *et al.,*2011; De-moel, 2012;Cammerer,*et al.,* 2015).

Igwe (2012) and UN-Habsitat (2013) identified social vulnerability indicators to include age, unemployment, education, gender, race and exclusion. Ologunlorisa and Tersoo, (2006) further identified indicators such as access to education and training, proximity to information and public health services, likelihood of losing a job and marginality. According to Yiussuf and Francsisco (2009) a socially vulnerable community has weak family structure, lack of leadership for decision making, weak or no community organizations and the one in which people are discrimination on racial, ethnic, linguistic or religious basis. Other social factors such as culture, tradition, religion, local norms and values and political accountability also play a vital role in determining the social vulnerability of a community. Similarly, Bizimana (2015)analysed the social vulnerability of groups in Rwanda to malaria using a composite index method and GIS while Williams (2018) used the MOVE framework with GIS to analyze the social vulnerability of Nigeria's Katsina-Ala local government area to malaria.It was further noted that developing countries are prone to more social stresses than the developed ones. Therefore within the context of developing nation common indicators that are socially inclined reflects issues like psychological, exclusion, marginality, political crisis among others.

Economic vulnerability indicators can be assessed by how varied the community's sources of income are. They encompass risk of poverty, unemployment, excessive debt, recession, financial loss, means of access and control over means of production eg. Farmland, livestock, irrigation, capital among others. Economically disadvantaged populations are disproportionately affected by disasters. For instance, the poor are less likely to have the income or assets needed to prepare for a possible disaster or to recover after a disaster (Morrow 1999; Cutter et al. 2003). Although the monetary value of their property may be less than that of other households, it likely represents a larger proportion of total household assets. For these households, lost property is proportionately more expensive to replace, especially without homeowner's or renter's insurance (Tierney 2006).

Physical determinants on the other hand relate to building structural quality, location, proximity to hazards, material for construction, age of building, size, condition of housing, its physical strength and stability of roof, state of drainage, sewage, streets, roads, and remoteness of settlements. It also depends on the type of hazards in which people are exposed to. For example in a flooded area physical vulnerability will include apart from the ones earlier mentioned flood depth, run off, frequency, intensity and pattern (Sigh, 2013).

The environmental aspect relates to natural resource depletion, degradation, overall neighborhood characteristics, water and air quality among others. Indicators can also either be subjective or objective in nature. The subjective refers to people's opinion about how exposed they can betto hazards. In this regard, perception may be regarded as essential in assessing vulnerability. Definitely, people will have opinions about the same hazards. The objective include tangible things such as condition of the environment, housing, vegetation, infrastructure, transportation and many more. Indicators are generally a function of two components: the effects that an event may have on human (capacity) and the risk that such an event may otherwise referred to as exposure.

In summary the Intergovernmental Panel for Climate Change (2009) classified the aforementioned indicators into sensitivity, exposure and adaptive capacity. **Exposure** is the presence of people, livelihoods, species or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social or cultural assets in places and settings that could be adversely affected. **Potential Impact** are the effects of climate change on natural (e.g. water resources, biodiversity, soil, etc) and human systems (e.g. agriculture, health, tourism, etc).**Adaptive Capacity** refers to the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantages of opportunities, or to cope with the consequences.To reduce vulnerability all of the above factors must be addressed but this requires knowledge and understanding of the local conditions which can in most cases only be provided by local actors. Therefore a comprehensive investigation of the aforementioned determinants of vulnerability and their influence and how they vary from one location to the other will be of benefits in this research. They are repeated events that may strike at random but impact on both human lives and livelihood (Christopher, 2017).A hazard becomes a disaster if it has adverse effects on people leading to human and material loss. A disaster can either be as a result of natural or human induced hazards.

d. Flood Disaster and Flood Disaster Vulnerability

Disasters are repeated events that may strike at random but impact on both human lives and livelihood (Samuel, Adesanya and Ologunlorisa, 2017). A hazard becomes a disaster if it has adverse effects on people leading to human and material loss. A disaster can either be as a result of natural or human induced hazards. The United Nations International

Strategy for Disaster Reduction{UNISDR} (2008) defines a flood disaster as significant disruption of the functioning of a community or society which involves widespread human, material, economic or environmental losses and impacts, which is beyond their ability to cope using its own resources. Ogbonna and Delunzu (2015) similarly opined that flood disasters are the most widespread causing most deaths in many countries. It also takes its toll on properties, the vulnerable and underprivileged. Flood disasters derail socio-economic progress and intensify poverty by making the poor even poorer. Thus the marked difference as regards vulnerability to flooding arises usually from wide gaps in access to resources and capacity for disaster risk reduction associated with poverty and socio-cultural stratification.

Flood disaster vulnerability is the product of disaster drivers, disaster-formative environment and disaster bearers (Murat and Surat, 2010). Disaster drivers refer to extreme weather events that have adverse effect on human life, property, security, etc. For instance, disaster drivers of urban flooding are mainly heavy rain expressed by rainfall duration and intensity. Disaster-formative environment refers to the conditions and surroundings where flood disasters occurred, often influenced by formative factors that mainly result from the combination of both climate variables and underlying surfaces. In this work, disaster-formative environment mainly includes elevation, building setback to rivers to streams and average slope. Disaster bearers on the other hand, depend on the exposure (number of people and infrastructure impacted) and the adaptability and resiliency of the affected area. Therefore, population density and land cover are considered as measuring factors of disaster bearers.

II. STUDY AREA

The North Central is located in the middle region of Nigeria, a country situated in the western part of Africa. The state is located on latitude 7° 30´N and 7° 53´N and longitude 6° 42´E and 6° 48´E with a total land area of 29,833km^2 approximately. It has a population of 3,595,789 in the year 2005 which was the 24th in the ranking of most populous state in Nigeria (Ibrahim *et al.,* 2015). The North Central comprises six states (Kosi, Nasarawa, Benue, Niger, Kwara and Plateau) including the Federal Capital Territory (FCT), Abuja. The concern in this study is the flood prone area which are Kogi, Benue, Niger and Nasarawa.

The land in the North Central rises from about 85 metres along the Niger-Benue conflute, to the height of between 300 and 600 metres above sea level in the uplands. Agbaja plateau, which ranges from 335 to 336 metres above sea level, and the much higher Okoroagbo hills at Ogidi are some of the predominant of land forms. The North Central is drained by the Niger and Benue rivers and their tributaries. The confluence of the Niger and Benue rivers which could be viewed from the top of mount palti is located in Lokoja. The rivers are navigable as far as Garua in the rainy season (Iloeje, 1979). The rivers have wide flood plains such as the portion of the lower Niger in Kogi and Benue states, which is more than 1,600 meters wide at Lokoja, while the small streams have narrow valleys. The general rainfall is undulating and characterized by high hills, Jos plateau and numerous inselberg and elongated ridges. The geopolitical zone has an annual rainfall of between 1,100mm and 1,300mm. The rainy season last from April to October and which dry season last from November to March, is very dusty and of cold as a result of the northeasterly winds which brings in the harmattan. Agriculture is the main concern of the economy and the principal cash crops. There are many farm produce from the state notably coffee, cocoa, palm oil, cashews, groundnuts, maize, cassava, yam, rice, melon and they also raise cattle on the highlands. Mineral resources include; coal, limestone, iron, petroleum and tin.

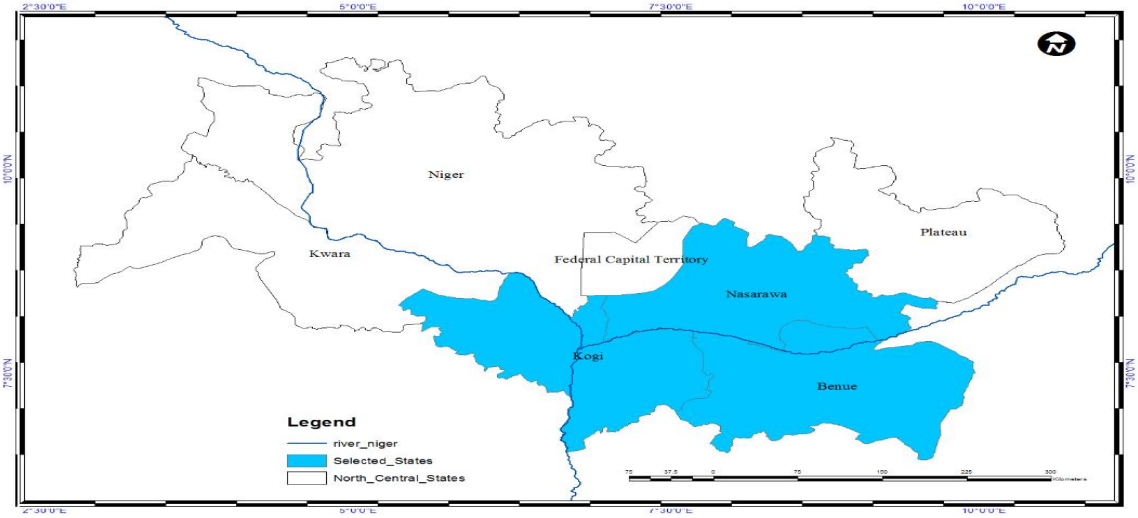

Figure 1: Map of North Central Nigeria Source: Google Earth, 2019

III. MATERIALS AND METHODS

Selection of Samples

The survey design was employed in this study. The study population includes flood-prone areas in the North Central Nigeria. A multistage sampling will be used to select samples for the study. At the first stage, Lokoja, Makurdi and Kainji towns were purposively chosen based on two main criteria. First is based on the location (proximity) of these areas relative to River Niger and Benue and secondly is the high incidence of flood disaster in the last two decades (NEMA, 2018). At the second stage three neighbourhoods experiencing recurrent floods will be selected in each town. Adankolo, Lokongoma and Felele were chosen in Lokoja, Rijia, GRA and Marine in Makurdi, while Mada, Kifi and Sabo were selected in Kainji. The number of streets in each neighbourhood were identified and (one (1) out of every five(5) buildings in each street were selected for interview.

Details of the selection is shown in Table 1. For instance, 98 were selected in Adankolo, 72 in Lokongoma, 50 in Felele, 50 in Rijia, 48 in GRA and 48 in Marine. Similarly, 58 households were selected in Mada, 60 in Kifi and 62 in Sabo. In other words, a total sample of 546 households were selected across the three chosen flood prone areas in the north central of Nigeria,

Table 1. Sample Size of the Respondents per Neighbourhood in the Study Area

Study Area	Selected Neighbourhoods	Number of Households Per Neighbourhood	Sample Size of Respondents per Neighbourhood
LOKOJA	Adankolo	8734	98
	Lokongoma	6444	72
	Felele	5400	50
MAKURDI	Rijia	4533	50
	GRA	3884	48
	Marine	3505	48
KAINJI	Mada	4577	58
	Kifi	5667	62
	Sabo	5445	60
TOTAL		48109	546

Source: Author's Field work (2019)

Flood Disaster Vulnerability Indicators

In this study, flood disaster vulnerability evaluation was defined as a weighted sum of all relative indictors of vulnerability to flood disaster. Based on the indices defined in literature, the flood disaster vulnerability was measured based on socio-economic, physical and environmental indicators. The indicators were employed to assess the components of flood disaster vulnerability which include exposure, sensitivity (susceptibility, and coping capacity (Resilience) of the respondents based on the definition of vulnerability given by IPCC (2009) where vulnerability is defined as " . . . a function of the character, magnitude and rate of climate variation which a system is exposed, its sensitivity, and its adaptive capacity" (pp. 89-90).The indicators of vulnerability used in this study and their determinants (elements) are shown in Table 2.

Table 2. Vulnerability Elements and Indicators

Elements of Vulnerability	Indicators	Description of Relationship with Vulnerability
Sensitivity (Susceptibility)	Previous flood experiences in the fast Awareness of flood occurrence Severity of flood Frequency of flood occurrences	Higher flood experience, awareness, severity and frequency of flood event indicate higher sensitivity to flood disaster
Exposure	Distance from rivers, canals, lakes (meters) Submersion depth (meters) Duration of submersion (hours) Population (number)	The closer the distance from water bodies, the higher the exposure The greater the submersion depth the higher the exposure The greater the submersion duration the higher the exposure The greater the population in the flood risk zones the higher the exposure
Coping Capacity (Resilience)	Income Quality of Building Age Literate Level Sex Infrastructure e.g drainage, culverts, dikes among others	The higher the percentage of residents earning below 18,000 monthly the lower the coping capacity The higher the percentage of building with low quality the lower the coping capacity The greater the percentage of residents less than 15 years of age the lower the coping capacity The greater the population in the flood risk zones the higher the lower the coping capacity The greater the population in the flood risk zones the higher the lower the coping capacity The higher the number and quality of infrastructure provision the higher the capacity to cope

Coping capacity indicators employed in the current study were based on the socio-economic, physical and environmental dimensions that influence the ability of people to adjust to flood disaster. Such indicator include income, age, quality of building, literate level and infrastructure condition. Four sensitivity indicators were used and such indicators include previous flood experiences in the past, awareness of flood occurrence, severity of flood and frequency of flood occurrences. Exposure factors include distance from rivers, canals, lakes (meters), submersion depth (meters), duration of submersion (hours) and population (number).

Thus, flood disaster vulnerability t was calculated according to the equation derived from earlier work by Deressa, Hassan, and Ringler (2008) as follows:

VI = Coping capacity-(Sensitivity + Exposure) (3)

Equation 1 above was expanded as follows:

$VI = ()wX_1+wX_2+ ...wX_n)- (wY_1 +wY_2 ...+wY_n + wZ_1+wZ_2 +...wZ_3)$

where *VI* is vulnerability index, *w* are weights of the first principal component score*s, X_1-Xn* are coping capacity variables, Y_1-*Yn* are sensitivity (susceptibility) variables, and Z_1-*Zn* are exposure variables (Akukwe and Ogbodo, 2015).

Note* the higher the Vulnerability Index the lower the Vulnerability.

Data Analysis

The data collected were analysed using Descriptive (Percentages, Frequencies and Mean Index of Vulnerability) and Inferential (Analysis of Variance) statistics. The analyses were carried out using Statistical Package for Social Sciences (SPSS) version 21. The descriptive statistics were' used to summarize information on residents' socio-economic characteristics, housing characteristics and vulnerability index while the Analysis of Variance was used to determine the significant difference between the level of vulnerability across the selected flood prone areas.

IV. RESULTS AND DISCUSSION

Socio-economic Characteristics of Respondents

The socio-economic characteristics of 546respondents interviewed in the residential areas surveyed are presented on Table 3. 65% percent of respondents were male while 35 % were female. The sample households consisted of different age groups. Those within the ages of 16–35 years accounted for 59.3 % of the total sample while 21.1% were within the range of 36-64years. Those that were 65 years and above accounted for 20.0%. Majority (80.3 %) had a minimum of secondary education, while only 7% had only primary education. Respondents without any formal education were represented by as low as 3% while those that had more than secondary education represented 9.7%. A greater majority (77 %) of the sampled households earn 18,000 Naira or more (equivalent of USD 50) or while 23% earn less than 18.000 Naira per month. A major economic activity among the residents was trading as this accounted for more than one-third of respondents (45 %) engaging in trading and other business types. Other occupations included farming (17.2 %), artisan (16.4 %) and others (10 %).

Table 3. Socio-economic Characteristics of Respondents

Socio-economic Characteristics	**Percentage**
Sex	
Male	65
Female	35
Age	
16-35	59.3
35-64	21.1
65 and above	20.0
Education	
No Formal Education	3
Primary	7
Secondary	80.3
Post-secondary	9.7
Income	
18,000 Naira and More	77
Less than 18.0000	23
Occupation	
Trading Activities	45
Farming	17.2
Artisan	16.4
Others	10

Source: Author's Field work (2019)

Housing Characteristics in the Study Area

It was revealed through findings (field observation) that most (74%) of the buildings were less than 15m from streams, rivers and canals while 16% were within 15 to 20m. only 10% met the required 23m setback distance. It was also observed that majority (70 %) of the households had been living in their residence for not less than 10 years. Many live in mud housing (60 %) and loved it that way and thus were not likely to make structural changes to their dwellings in order to mitigate against flooding (Anunobi, 2914). 63 % of respondents own their houses, about 14 % of respondents live in family housing and the remaining 3 % are squatters. As much as 95% of the dwellings in the area had one major structural defect or the other. For instance, 35% of the buildings were had partially crumbled walls, 24% were without windows, 10% had no ceilings while 31% built with rotten wood.

Table 3.

Residents' Awareness of Flood Disaster

The level of awareness of flood disaster varied across the neighbourhoods.44% had high level of awareness of flood causes, 33% were just aware while 20% had little awareness and only 3% were not aware. Most residents (73%) were only aware that flood is caused by heavy rainfall while 10% were aware that it could also be caused by exposure to hazards (living close to hazards). 12% were aware of other anthropogenic factors that could induce flood disaster such as dumping waste in drainages, dam failures among others.

Residents' Previous Experience with Flood Disaster

Respondents' experience with previous flood events were examined by collecting information on their personal assessment of the flood severity and frequency in their neighbourhood as well as impacts resulting from their perceived worst flood experience. It was revealed through findings that residents' experience varied. Respondents who had between 1 and 6 years flood experience accounted for well above half (70%), while 20 % had more than 6years experience of flooding in their neighbourhood. Majority (68%) considered flooding in their neighbourhood "very severe" while 29% accepted that flooding in their neighbourhood was "a little severe". The respondents opined that flood occurrence two years before the current survey assumed similar pattern as what obtains in recent times. The major flood of 2019 was considered by 40% of households to have familiar pattern as previous ones. A large percentage (65 %) of respondents claimed that they experienced severe losses during the 2019 flood. The flood duration considered as the worst was the 5-7 days flood.

Flood Frequency

38.89% of residents agreed that flood disaster occurrence was very high in Felele because of its closeness it River Niger while 25.3% opined that flood disaster occurred rarely in GRA since such areas were well laid out to plan.

Vulnerability Index

The vulnerability index for the 12 selected neighbourhoods varied significantly. The Neighbourhood with the highest vulnerability was Felele (0.35), followed by Adankolo (1.35), Sabo (1.71), Rijia (2.31), Marine (2.71), and so on while GRA had the lowest(5.15) vulnerability. Although flood frequency was highest in Rijia (38.94), vulnerability in the area is only fourth highest because it has a relatively strong coping capacity (1.5)compared to Felele (1.2), Adankolo (0.8) and Sabo (0.5). Flood vulnerability was low in other areas because they have low flood occurrence and high manageability capacities.

V. CONCLUSION AND POLICY IMPLICATION

Vulnerability to flood disaster in North Central Nigeria was analysed in this study using are vulnerability index and comparing them across 9 Neighbourhoods in the study area. The vulnerability measurement was based on IPCC (2009) earlier definition of vulnerability which comprises coping capacity, sensitivity, and exposure indicators. Vulnerability was assessed with an integrated approach for the study area which involved combining the socio-economic, physical and environmental factors and how the determine vulnerability to flood disaster across the selected flood prone area. The result indicated that Felele had the highest vulnerability with a vulnerability index of 0.35 while Marine was the least with index score of 5.15. There is the need to determine the most vulnerable population/ groups in flood prone communities and thus support their preparedness, coping capacity and manageability for disaster situations. It is also important to assess vulnerabilities of critical infrastructure so as to avert likely major potential and actual dangers that can influence residents' wellbeing.

REFERENCES

[1]. Abdulsamad, M. (2018). Spatio-temporal Analysis of Areas Vulnerable to Flooding in Ibaji Local Government Area of Kogi State, Nigeria. *Resources and Environment, 8(3), 91-98*

[2]. Adelekan, O.I, (2009). Vulnerability of Urban Poor Coastal Communities to Climate Change in Lagos Island, Nigeria. *International Journal of Climatology*, 18, pages 1273 – 1284.

[3]. Adelekan, O.I, (2010). Vulnerability of Urban Poor Coastal Communities to Flood in Lagos Island, Nigeria. *International Journal of Natural Hazards,* 10, pages 1203 – 1214.

[4]. Akwukwe, T. and Ogbodo, C. (2015). Spatial Analysis of Vulnerability to Flooding in Port Harcourt Metropolis, Nigeria. SAGE and Open Access page. www.uksagepub.com.

[5]. *Brown, M.H. (2015). An Analysis of Risk Perceptions and Attitudes towards Climate Change among Residents of South-eastern Louisiana*. M.Sc. Thesis, Environmental Science, Louisiana State University and Agricultural and Mechanical College, Louisiana.

[6]. *Brown, M.H. (2015). An Analysis of Risk Perceptions and Attitudes towards Climate Change among Residents of South-eastern Louisiana*. M.Sc. Thesis, Environmental Science, Louisiana State University and Agricultural and Mechanical College, Louisiana.

[7]. Emmanuel, A. (2016). Socio-economic impact of flooding in the Niger Delta Region. *Advances in Natural and Applied Sciences,* 3(3), 369-377.

[8]. Eze, N. J. Vogel, C., and Ibrahim, P.A., (2018). Assessment of Social Vulnerability of Households to Floods in Niger State. *International Letters of Social and Humanistic Sciences, 24, 22-34.*

[9]. Field, C.B, Barros. V., Stocker, T.F, Qin, D., Dokken, D.J., Ebi, K.L and Midgley, P. M. (2017).Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. *A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, UK, 582.

[10]. Geneve, D. (2016). Environmental Risk in Marginalized Communities in Asia. *Journal of Land Use Policy, 20, 25-40.*

[11]. Grothmann, T.(2017).Assessment of Drivers of Settlements Development in African Riverine Villages under Conditions of Land-use and Climate change: Case studies from Mkomazi and Keiskamma, *Journal of Environment and Development, 8(2), 21-35*. Hazard Mitigation, Sustainability, 7, 2015.

[12]. Ikusemanran (2017) *Remote Sensing and GIS for Flood Surveillance: A Case Study of Kainji Lake Basin, New Bussa, Nigeria.* Unpublished M. Tech Thesis, Department of Geography, Federal University of Technology, Minna.

[13]. International Federation of Red Cross and Red Crescent Commission {IFRC} (2015). Nigeria: Flooding in Kano and Jigawa", Information Bulletin No 2/01 (Final), available at http://www.ifrc.org/docs/appeals/rpts01/ngfl01a2.pdf.

[14]. Itopa, M. (2019). Social Vulnerability to Flooding in Lokoja Metropolis. *Journal of Natural Disaster Reduction,* 5(3), 1-23.

[15]. National Emergency Management Agency, [NEMA] (2018). The 2018 Floods Situation Report. No. 1, 21st September, 2018.

[16]. Onwuteaka, M. (2014). Vulnerability in the Coastal Areas of Nigeria. *Journal of Disaster Risk Reduction*, 20, 11-27.

[17]. Percival, S. and Teuw, R. (2019). A Methodology for Urban Micro-Scale Coastal Flood Vulnerability and Risk Assessment and Mapping. Natural Hazards (2019) 97:355–377https://doi.org/10.1007/s11069-019-03648-7

[18]. Samuel K. J., Ologunorisa.1, E.M., Olusanya, K.A. and Yakubu, S. (2017). Post-Disaster Assessment of Riverine Communities

Impacted by a Severe Flooding Event. *Ghana Journal of Geography*, 9(1), 17–41.

[19]. The United Nations International Strategy for Disaster Reduction {UNSDRI} (2008). Flood Risk Management Strategies in Developed Countries. UNSDRI, 20.

[20]. UN-Habitat (2015). Poverty Alleviation in Developing Countries. Environmental Change, Nairobi.

[21]. UN-Habitat (2018) Adaptions and Mitigating Change. United Nations Habitat Stratégie Plan, Nairobi, Kenya.

[22]. UN-Habitat (2019). First Session of the United Nations Habitat Assembly of the United Nations Human Settlements Programme United Nations Office Nairobi "Innovation for Better Quality of Life in Cities and Communities" 1st United Nations Assembly, 27 -31 1st May, 2019.

[23]. United Nations (2018). Household Size and Composition around the world. Population Facts. Department of Economics and Social Affairs, Population Division, No.2. Retrieved from www.unpopulation.org.

[24]. Vilém, P., Jelínková, E., Kilianová, H. and Machar, I. (2017). Analysis of Fragmentation of Selected Steppe Sites in the Pannonian Region of the Czech Republic. *Acta University of Agriculture Journal,* 61, 765-775.

[25]. Vincent, K. (2017). Uncertainty in Adaptive Capacity and the Importance of Scale, *Global Environmental Change, 17*, 12-24.

[26]. Vincent, K.; Daly, M.; Scannell, C.; Leathes, B. (2018). What can Climate Services Learn from Theory and Practice of Co-Production? Climate. Services. 12, 48–58.

[27]. Wahab, B. and Ojolowo, S., (2018). Drivers and Spatial Extent of Urban Development in Flood-Prone Areas in Metropolitan Lagos. *Journal of Sustainable Development, 11(2), 98-111.*