Climate Vulnerability and Building Flood Resilience Strategies in Jigawa State, Nigeria

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Declaration

I, **YUSUF Abdulmalik Mohammed declare** that this Dissertation titled "Climate Vulnerability and Building Flood Resilience Strategies in Jigawa State, Nigeria", which was submitted in partial fulfilment for the degree of Doctor of Philosophy (P.hD) in Economics (Speciality: Climate Change Economics) at the Université Cheikh Anta Diop de Dakar is entirely mine and has not been submitted anywhere else for the award of any degree or diploma. All the materials utilized for this thesis have been properly acknowledged both in the text and in the reference.

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Dedication

To the memory of my late father: **MOHAMMED ALI YUSUF** and to my beloved mother: **HAUWA'U ABUBAKAR YUSUF**

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Abstract

Climate change and/or climate variability has heightened the frequency and re-occurrence of climate related disasters, particularly floods in the past two decades globally. This is likely to increase vulnerabilities in African Cities, by adding to the numerous challenges already existing and being experienced. Though, there is a consensus that it is impossible to completely eradicate flood risks in urban areas, the focus now worldwide is on how to come up with implementable strategies that will help build resilience of urban areas to floods. In line with the recognition that disaster resilience is key to achieving sustainable development, this study focuses on addressing climate vulnerabilities through building flood resilient strategies in Jigawa State, Nigeria. Using survey questionnaires (covering a cross-section of 251 households) and well-structured interviews, the study broadly examined the underlying vulnerabilities of households to flooding by looking at the roles played by different stakeholders (households, private sector and government) in Jigawa State. This was done with the main goal of finding out how to integrate the efforts of these stakeholders to ensure building a sustainable flood-resilient Jigawa State. Specifically, the study first examined the causes of frequent floods in Jigawa State. The study then proceeded to examine the extent and level of households' vulnerability to flooding. Further, the study examined the coping strategies available to households in relation to flood disasters, and the factors responsible for the adoption of these coping strategies. Lastly, the study estimated the cost and benefits of establishing a flood resilient project for households in the study area, to boost their resilience to possible future flood events. Findings from the study showed that among other factors, heavy and prolonged rainfalls, poor and inadequate infrastructural facilities and mismanagement of water resources were among the main causes of frequent floods in the study area. Secondly, the study found that all the Local Government Areas (LGAs) covered were very vulnerable to flooding, except for Hadejia LGA whose level of vulnerability was relatively better compared to the others. The findings also showed that a number of socioeconomic and socio-demographic features of household were very influential in the choice of their coping strategies (such as bank credit, relocation, safety nets, assistance from friends, etc.). Lastly, the study came up with a cost-effective government funded and private sector operated dam-irrigation project which will beneficial to households through employment gains and also serve as a source of revenue generation for the government. Ultimately, the project will help improve physical resilience and empower households economically, hence boosting the resilience of their communities to floods. The study therefore, recommended the need to restructure the disaster management structure both at national and state levels in Nigeria. Also, there is need for relevant authorities to focus on boosting microeconomic resilience to flood disasters through the provision of social services and empowerment opportunities (particularly, with focus directed more towards boosting non-structural measures of flood control). Furthermore, institutional response to floods must be transformed from its current reactive approach to a more proactive one, hence focusing more on flood risk reduction strategies.

Keywords : Vulnerability, Exposure, Susceptibility, Resilience, Climate Change, Climate variability

Résumé

Les changements climatiques et / ou la variabilité climatique ont accru la récurrence des catastrophes liées au climat, en particulier des inondations au cours des deux dernières décennies dans le monde. Cette situation risque fort probablement d'accroître la vulnérabilité des villes africaines qui font déjà face à des défis majeurs de diverses natures. Bien qu'il existe un consensus sur le fait qu'il est impossible d'éliminer complètement les risques d'inondation dans les zones urbaines, le défi aujourd'hui dans le monde entier est d'arriver à mettre en place des stratégies réalisables qui contribueront à renforcer la résilience des zones urbaines aux inondations. Considérant le fait unanimement reconnu, que la résilience aux catastrophes est la clé du développement durable, cette étude se focalise sur la question de la réduction des vulnérabilités climatiques en élaborant des stratégies résilientes aux inondations dans l'État de Jigawa, au Nigéria. À l'aide de questionnaires d'enquête (couvrant un échantillon de 251 ménages) et d'entretiens bien structurés, l'étude a analysé de manière générale la vulnérabilité des ménages aux inondations en examinant les rôles joués par les différentes parties prenantes (ménages, secteur privé et gouvernement) dans l'État de Jigawa. Cette étude a été conduite dans le but principal de savoir comment intégrer les efforts des parties prenantes pour assurer la construction d'un État de Jigawa durable et résistant aux inondations. Plus spécifiquement, l'étude a dans un premier temps examiné les causes des inondations fréquentes dans l'État de Jigawa. Ensuite il s'est agi de déterminer l'ampleur et le degré de vulnérabilité des ménages aux inondations. En outre, l'étude a examiné les stratégies d'adaptation à la disposition des ménages en cas d'inondations et les facteurs déterminants de l'adoption de ces stratégies. Enfin, l'étude a estimé le coût et les avantages de la mise en place d'un projet de résilience aux inondations pour les ménages de la zone d'étude, afin de renforcer leur résilience face à d'éventuelles inondations. Les résultats de l'étude ont montré qu'entre autres facteurs, les précipitations abondantes et prolongées, les infrastructures inadéquates et la mauvaise gestion des ressources en eau constituent les principales causes d'inondations fréquentes dans la zone d'étude. Ensuite, l'étude a révélé que toutes les zones de gouvernement local couvertes étaient très vulnérables aux inondations, à l'exception de la zone de Hadejia, dont le niveau de vulnérabilité était relativement meilleur comparé aux autres zones. Les résultats ont également montré qu'un certain nombre de caractéristiques socioéconomiques et sociodémographiques du ménage influaient beaucoup sur le choix de ses stratégies d'adaptation (crédit bancaire, réinstallation, filets de sécurité, assistance d'amis, etc.). Enfin, l'étude a permis d'élaborer un projet de barrage d'irrigation financé par le gouvernement et exploité par le secteur privé qui serait avantageux pour les ménages grâce à la création d'emplois et servirait également de source de revenus pour le gouvernement. À terme, le projet contribuera à améliorer la résilience physique et à autonomiser les ménages économiquement, renforçant ainsi la résilience de leurs communautés face aux inondations. Par conséquent, l'étude a recommandé la nécessité de restructurer le système de gestion des catastrophes à la fois au niveau fédéral qu'au niveau des Etats au Nigeria. En outre, il est nécessaire que les autorités compétentes s'attachent à renforcer la résilience microéconomique aux inondations en fournissant des services sociaux et des possibilités d'autonomisation (en particulier, en mettant davantage l'accent sur le renforcement des mesures non structurelles de

lutte contre les inondations). Enfin, la réponse institutionnelle aux inondations doit passer de son approche actuelle qui se veut essentiellement réactive à une approche beaucoup plus proactive centrée sur les stratégies de réduction des risques d'inondation.

Mots-clés : Vulnérabilité, Exposition, Susceptibilité, Résilience, Changement climatique, Variabilité climatique

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List of Abbreviations

BCA	Benefit-Cost Analysis
BCR	Benefit-Cost Ratio
BNRCC	Building Nigeria's Response to Climate Change
CBA	Cost-Benefit Analysis
CV	Contingent Valuation
DEM	Digital Elevation Model
DFID	Department for International Development
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
EM-DAT	Emergency Events Database
FEMA	Federal Emergency Management Agency
FME	Federal Ministry of Environment
FVI	Flood Vulnerability Index
GIS	Geographical Information Systems
IDP	Internally Displaced Persons
HFA	Hyogo Framework for Action
IFAD	International Fund for Agricultural Development
IFRC	International Federation of Red Cross and Red Crescent Societies
IPCC	Intergovernmental Panel on Climate Change
IRR	Internal Rate of Return
ISDR	International Disaster Strategy for Disaster Reduction
KAP	Knowledge, Attitude and Practices
LEMA	Local Emergency Management Agency
LGAs	Local Government Areas or Local Government Authorities
MCA	Multi-Criteria Analysis
MDG	Millennium Development Goals
NAERLS	National Agricultural Extension and Research Liaison Services
NBS	National Bureau of Statistics
NCR	National Commission for Refugees
NEMA	National Emergency Management Agency

NESREA	National Environmental Standards and Regulations Enforcement Agency
NEST	Nigerian Environmental Study Action Team
NFIP	National Flood Insurance Program
NOA	National Orientation Agency
NGOs	Nongovernmental Organizations
NIHSA	Nigerian Hydrological Services Agency
NIMET	Nigerian Meteorological Agency
NOAA	National Oceanic and Atmospheric Agency
NPC	National Population Commission
NPV	Net Present Value
PDP	Partial Dependence Plot
PVC	Present Value Coefficient
RFM	Random Forest Model
SDG	Sustainable Development Goals
SEMA	State Emergency Management Agency
SFDRR	Sendai Framework for Disaster Risk Reduction
SLF	Sustainable Livelihoods Framework
UNDP	United Nations Development Programme
UNDRO	United Nations Disaster Relief Office
UNGA	United Nations General Assembly
UNISDR	United Nations International Strategy for Disaster Reduction
WHO	World Health Organization
WMO	World Meteorological Organization
WTP	Willingness to Pay

CHAPTER 1

1.0 General Introduction

1.1 Background of the Study

It is now common knowledge that climate change is seen as a current reality, contrary to the pre-existing notion which saw it as a distant possibility. This is evident from the observed changing length and timing of seasons, frequency and severity of floods, cyclones accompanied by rising sea levels, etc., (IPCC, 2001; World Bank, 2011). In fact, in the 21st century, there is a consensus that climate change constitutes one of defining challenges for policy makers, civil societies and industries, as its effects cuts across sectors (considered an economic, social, investment and developmental issue). Recently, reports (Sachs, 2015; WHO, 2015) showed that the World's population had reached 7 billion people, the first of its kind since the history of human settlement, with more than half of the populace living in urban areas. According to the United Nations Report (2012), the period between 2011 and 2050 is expected to witness rapid urban population growth in developing countries. The United Nations projections show that cities in Africa will become home to 50% of the continent by 2034. This does not come as a surprise, because Africa is considered the region experiencing the world's most rapid rate of urban population growth since the last half of the 19th century and this trend is likely to continue through the next century (United Nations, 2010; Turok, 2012).

The pace of urbanization globally has been incredible especially in the developing world, as it has brought numerous opportunities to them and will continue to do so. Since it is now evident that cities constitute focal points of innovations, economic activities and wealth creation, cities are expected to experience an increase in population migrating into it to acquire improved living conditions, jobs and services. Though a significant proportion of the migrants to cities are poor, they contribute a lot to economic activities through employment in

services, manufacturing and other sectors (World Bank, 2011). If the projected 70 million people moving to urban areas yearly (which is expected to double by 2030) becomes a reality, it implies that services, infrastructure and available land will come under increasing pressure in cities. These challenges are expected to be aggravated further by associated climate-related risks and natural hazard. Although there is a high concentration of people and economic assets in cities, majority of the cities are located in coastal areas. The makes them vulnerable to weather risks and natural hazards. Though the level of vulnerability to climate-related risks is expected to be low in developed countries, it is expected to be higher in low-and middle-income countries, where between one-third and half of people in cities live in slums. Hence, floods, drought, earthquakes, sea level rise and storm surge will have several impacts on urban areas with such impacts expected to rise overtime (IPCC, 2007; World Bank, 2011; IPCC, 2014).

A few studies (UN Habitat, 2011; World Bank, 2011; Broto & Bulkely, 2013) had been carried out using different methods for different cities under different context, time periods and measurement criteria, to estimate the extent to which urban areas are exposed to climate change and natural disasters. Their results indicated an increase in urban exposure to such risks, which is again expected to increase significantly over the coming decades with increased change in climatic conditions. Available historical data from the World Bank (2011), has shown that between 2000 and 2010, among these events (climate-related and natural disasters), flooding occurred highest (1501 times), followed by storms and cyclones (899 times), then earthquakes (228 times). Others in the rank include extreme temperature (173 times), mass movements (167 times), droughts (133 times), wildfire (101), volcanoes (53 times), storm surge (29 times) and tsunamis (19 times). Figure 1 below also supports the above information.

Clearly, this shows that flooding constitutes one of the greatest threats in the form of natural and climate-related disasters to human existence, and those living in informal settlements in cities will be the most vulnerable group, whether or not such cities are located in coastal areas, inland areas or flood plains. Such individuals live in low-income neighbourhoods characterized by lack of or inadequate infrastructure (drainage, sewers, roads, etc.) and services, poor health care services, unsafe housing and poor nutrition. These living conditions could sometimes explain why natural hazards could turn to look like disasters amounting to loss of lives, destruction of houses, spread of vector and water related diseases, loss of means of livelihoods, etc. (Kolsky, 1998; Muller, 2007; Olorunfemi, 2011).

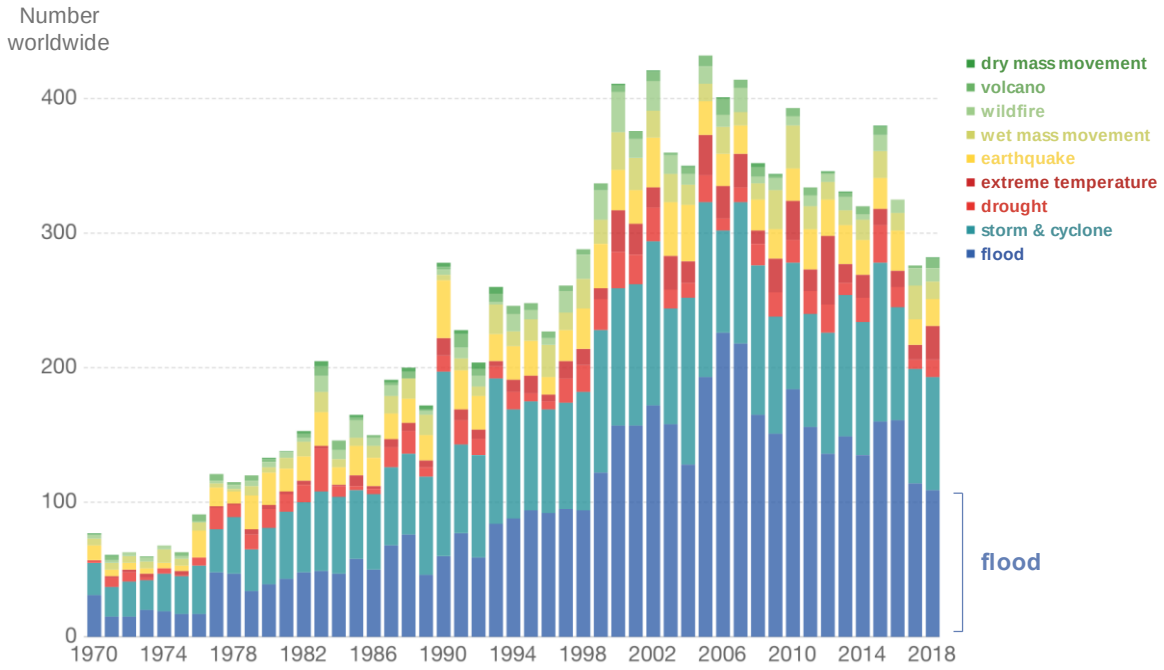

Figure 1: Distribution of Natural Disasters Worldwide (Source: Our World in Data, 2018)

It is not surprising now that the focus of research in recent time has shifted to developing implementable strategies that will help build urban resilience in our cities. In addition, the concept is now becoming more popular in disaster research management (Bosher & Dainty, 2011). Some studies have investigated and applied urban resilience in the area of terrorism, security and natural disasters. The devastating nature of shocks arising from such natural

disasters emphasizes the need to design our cities in such a way that they recover quickly and return to functioning normal in a post-disaster recovery phase. Finally, it is important to draw attention to the fact that resilience has been applied in relation to adaptation to extreme climatic events, mostly in relation to climate change (see, Roaf, Crichton & Nicol, 2009; Gething, 2010).

1.2 Research Problem and Questions

In recent decades, the world witnessed numerous environmental challenges resulting from the effects of industrialization, economic development, population growth, climate change, urbanization or changing lifestyles. Among the climate/weather related events, flood disasters are reportedly on the increase, particularly, negatively impacting on the poor people and generally, urban development with a growing urbanizing world (Alam, Herson, & Donnel, 2008). Hence, to understand the relationship between urban development and urban flood risk, there is an increasing need to revisit our knowledge on urban flood risk (Benjamin, 2008). For such understanding on flood risk to yield knowledge on appropriate flood risk management policies and strategies, it should focus on physical, social, political and technological parameters (see, Olorunfemi, 2011; Barau, Maconachie, Ludin & Abdulhamid, 2015). Global climate and environmental change (with its local effects) however, increases the scale for which there is a need to build and implement resilient strategies (see, World Bank 2012a; IFAD, 2014; von Braun & Thorat, 2014). But the question is:

"Can a City which lacks the capacity to respond creatively to change and reduce vulnerability to crisis, be considered truly 'sustainable'? 'Local resilience' can explain this essential capacity. Hence the need to introduce Sustainable Cities Movement in a new agenda. For a City to be Sustainable, it must be a Resilient one. Also, a Community can only be considered Sustainable if it is a Resilient Community". 'Resilient Communities and Cities Partnership Program proposal, ICLEI, 2004. (Otto-Zimmermann, & Balbo, 2012).

World Bank's (2015) estimate puts Nigeria's population at about 182.2 million people. Urban population growth rate was 4% compared to rural population growth rate which was 1.1% (World Bank, 2009). In addition, urban poverty rate was 43.1%, while 63.1% of its population was living on less than US$1.25 a day and national poverty was 54.7% (World Bank, 2012b). As of 2009, the proportion of urban and rural population below the poverty line was 11.6% and 20.1% respectively (World Bank, 2009). Although some progress is being made on poverty reduction in the country, it failed to achieve the MDG goal to half poverty in Nigeria by 2015 (World Bank, 2015). Nigeria has been listed among one of the most vulnerable countries to flooding in Africa since 2008 (www.floodlist.com). Certain characteristics of urban decay exhibited by Nigerian urban areas place them among some of the worlds' most highly vulnerable cities, with frequent negative impacts of extreme weather events and environmental emergencies.[1] Therefore, these impacts will rise if governments at various levels fail to change the way they work in urban areas. (Olorunfemi, 2011). Most of Nigeria's major cities are highly exposed to floods regardless of whether or not they are located in coastal areas, flood plains or inland areas (Aderogba, 2012).[1]

Major Nigerian cities are prone to most of the challenges facing most African Cities (rapid population growth, inadequate infrastructure, poor waste disposal and waste management systems, dumping of waste in drainage channels, poor urban settlements, poor management of flood risks, etc.), (see, Olorunfemi, 2011; Barau, Maconachie, Ludin, & Abdulhamid, 2015). Worthy of note is the fact that just this year alone, there were several reported cases of flooding in many Nigerian cities, which claimed lives and resulted in loss of properties (NEMA, 2016). Despite the effort of the state government to improve infrastructures and improve response to flood disasters, its occurrence has remained unabated. In the last decade, cases of flooding have been yearly reported in Nigerian cities (Barau, Maconachie, Ludin, &

[1] Urban decay implies the degeneration of buildings and infrastructures in cities/urban areas, a situation which results from poor maintenance, poor urban planning and weak institutional framework, including poor waste management among others.

Abdulhamid, 2015). This is so because the role of the private sector in the Nigerian economy is still limited, with public service largely constituting the engine of economic development, possibly explaining the reasons for the huge infrastructural gaps in Nigerian urban areas and reoccurring cases of floods reported. Some studies that had worked on flood management and risk response in Nigeria had recommended the need to build flood resilient infrastructures through restructuring our cities and the need to involve different stakeholders to participate (see, Olorunfemi, 2011; Barau, Maconachie, Ludin, & Abdulhamid, 2015). However, empirical studies in Nigeria have not been carried out to examine ways to attract and integrate efforts of the various urban stakeholders to contribute to building city's resilience to floods. This is not only a local challenge, rather, it constitutes a global challenge, trying to get all stakeholders contribute to building resilience of cities to floods.

Furthermore, most studies on floods in Nigeria, particularly those that have looked at vulnerabilities and flood disaster risk management efforts had concentrated mainly on it impacts and institutional responses (Olorunfemi, 2011), factors responsible for reoccurrence of floods in some Nigerian cities and flood effects on human activities (Aderogba, 2012), gender as well as urban/rural differentials from flood losses (Adeagbo, Daramola, Carim-Sanni, Akujobi, & Ukpong, 2016) and factors influencing households' and individuals' adaptive capacity to flood disasters (Daramola, Oni, Ogundele, & Adesanya, 2016). However, to the best of our review, we have not come across any study that had tried to look at the cost of building households' resilience to floods. In addition, most of the studies cover the southern part of Nigeria, with little attention paid to flood cases in the northern part of the country. Extant review of literature on flooding in Nigeria has also reported little work on public perception on floods, causes of flooding and urban planning and management in relation to floods (Nkwunonwo, Malcolm & Brian, 2015).

This study therefore, attempts to explore the underlying vulnerabilities and the challenging problem of how to effectively shape human/institutional responses to the risk of natural disasters with a special focus on floods in Northern Nigerian Cities. Particularly, the study goes a little further to examine the cost of building households' resilience to in Jigawa State, through the combined participation of stakeholders (households, private sector and government). With the possibility of environmental challenges likely to be worsened in the face of climate change/variability, urban households are more likely to fall further into poverty unless measures are taken to reduce risks.

Therefore, this study attempted to answer the following research questions:

(a) What are the determinants of persistent flooding in urban areas of Jigawa State?

(b) What are the coping strategies adopted by households to recover from flood losses, as well as the factors responsible for their adoption?

(c) What are the areas and level of exposure and vulnerability of households to flood in Jigawa State?

(d) What are the costs and benefits of improving households' resilience to floods in Jigawa State?

1.3 Objectives of the Study

The broad objective of this study is to examine the role stakeholders (households, private sector and government) can play in building flood resilient urban areas in Jigawa State through addressing the underlying vulnerabilities of households to flooding.

The following are the specific objectives of the study:

(a) To examine the determinants of persistent flooding in Jigawa State.

(b) To examine the coping strategies adopted by households to recover from flood losses and factors responsible for their adoption.

(c) To identify the areas and level of exposure and vulnerability of households to flood in Jigawa State.

(d) To examine the costs and benefits of improving households' resilience to floods in Jigawa State.

1.4 Research Hypothesis

The following hypothesis will be tested in the study:

H_o: Male household heads often relocate more than female household heads as an adaptation strategy to floods?

H_o: Occupational status influences access to bank credit as a means of adaptation

H_o: Education influences access to bank credit as a means of adaptation

1.5 Justification for the Study

This study is timely and necessary for several reasons. First, floods are the most common natural disaster globally, it is the most prevalent climate-related form of natural disaster in Nigeria. With over 800 million people residing in areas prone to floods worldwide, in addition to a yearly estimate of 70 million exposed individuals to floods globally (Peduzzi, Dao, Herold & Mouton, 2009), the apparent worsening economic impact of climate change/variability have become issues of concern at local, national, regional and global level. The estimated economics losses from flooding runs into tens of billions of US dollars over the last 20 years (Guha-Sapir, Hoyois & Below, 2013). Comparing Nigeria with other countries on the global scale, estimates computed from EM-DAT database shows that between 1985 to 2014, the country is ranked 3rd out of 20 of the World's most devastating floods, in terms of economic loss (US$16.9 billion) and number of affected human population (7.7 million people), also making it top on the list in the African continent (Nkwunonwo, Malcolm &

Brian, 2015). With this, the evidence showing that hundreds of thousands of people in Africa (especially in Nigeria) have been thrown into poverty by flooding, due to losses from tangible assets and displacements from homes, indicating the need for urgent action to be taken in this regard.

Secondly, based on NEMA (2016) statistics, more communities in Jigawa State have been affected by flooding between 2012 and 2016 when compared with communities in other States in the Northern part of Nigeria. This is also supported by the listing of Jigawa State among other States (Kaduna, Adamawa, Kebbi, Kano, Cross River and Niger), as one of the States most affected by fluvial floods in Nigeria, primarily due to their situation along the plains connecting the country's major rivers (Agbola, Ajayi, Taiwo & Wahab, 2012). Figure 2 below shows the distribution of flooding across space in Nigeria based on EM-DAT data covering between 1985 to 2014.The map showed that states affected most by flooding between the period under consideration are those under the influence of major rivers in the country (River Niger, River Benue, River Hadeja and Ogun River), with the exception of Lagos whose source of frequent flooding is considered to be as a result of coastal influence (Nkwunonwo, Malcolm & Brian, 2015) In addition, most of the studies on floods cover mainly the southern part of Nigeria, with little attention paid to flood cases in the northern part of the country. Hence the choice of Jigawa State as the study are for this research work.

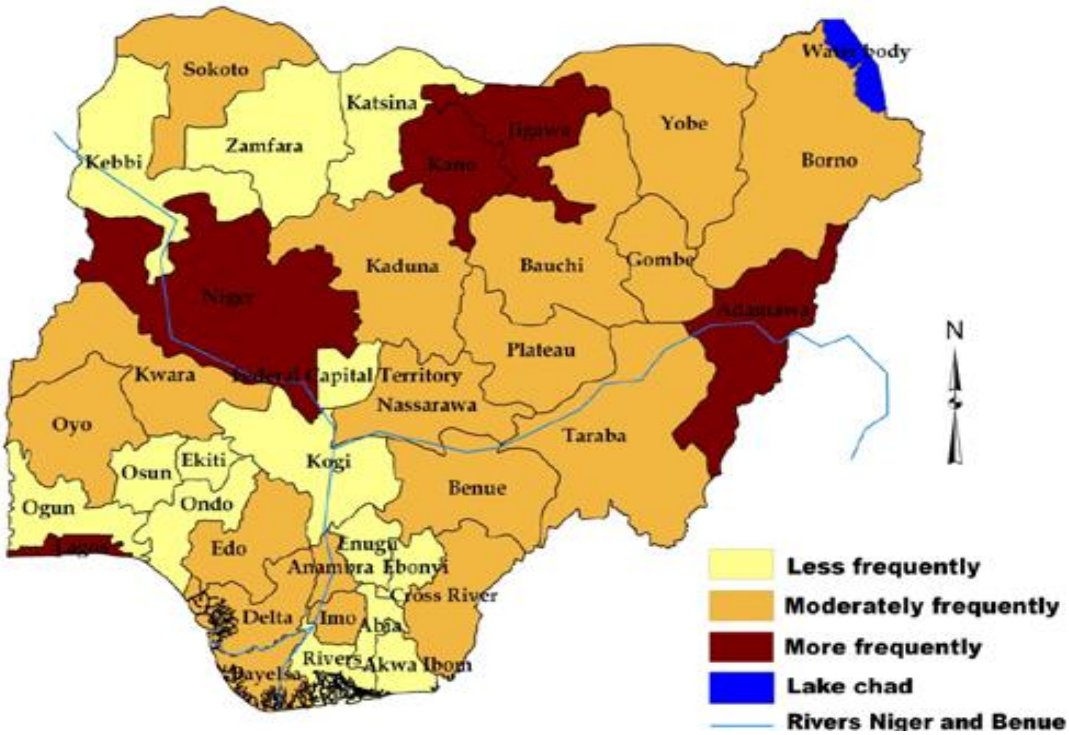

Figure 2: Distribution of Flooding Across Space in Nigeria (Source: Nkwunonwo, Malcolm & Brian, 2015)

Thirdly, most studies on floods in Nigeria, particularly those that have looked at vulnerabilities and flood disaster risk management efforts had concentrated mainly on it impacts and institutional responses (Olorunfemi, 2011), factors responsible for reoccurrence of floods in some Nigerian cities and flood effects on human activities (Aderogba, 2012), gender as well as urban/rural differentials from flood losses (Adeagbo, Daramola, Carim-Sanni, Akujobi, & Ukpong, 2016) and factors influencing households' and individuals' adaptive capacity to flood disasters (Daramola, Oni, Ogundele, & Adesanya, 2016). In addition, most of the studies cover the southern part of Nigeria, with little attention paid to flood cases in the northern part of the country.

Finally, this study is in line with many recommendations in the literature and consensus among resource persons and organizations (Resilience Alliance, ICLEI, ClimateWise, Universities, etc.) in recent global workshops, on the need for collaborative actions between

the key urban resiliency stakeholders (individuals, government and private sector) in building climate resilient cities.

1.6 Dissertation Structure

This Dissertation comprises mainly of four (4) main Chapters. As presented above, chapter one is the general introduction section which is made up of the background of the study, research problem, research questions, research objectives, research hypothesis, justification of the study and the Dissertation structure. Following this immediately is chapter two, that is the literature review, which is further divided into the conceptual literature review, empirical literature review and theoretical literature review This was done in such a way that they align and support the objectives of the study. Chapter three presents the research methodology, giving particular attention to the data and estimation techniques used to achieve the set objectives for the study. This includes the analytical and empirical framework used to examine the level and extent of households' vulnerability to flooding and the factors responsible for the adoption or choice of their coping strategies to floods. Lastly, chapter four presents the descriptive analysis of the variables of interest, discussion and summary of the main findings, and the policy implications.

CHAPTER 2

2.0 Literature Review

2.1 Conceptual Literature Review

2.1.1 Review on the Concept of Resilience and Urban Resilience

There has been a growing debate in the literature on 'resilience' as well as on how to include it in national development plans of countries since the immediate past decade. The debate has brought about mixed views on the concept. While some concentrated on the supply of energy (HM Government, 2010b; DECC, 2011), others focused on food production and supply (HM Government, 2010a; Foresight, 2011; SDC, 2011), water and transport (HM Government, 2011), and energy infrastructure (Foresight, 2008), to mention but a few.

As defined by IPCC (2014), 'resilience is the capacity of social, economic and environmental systems to cope with hazardous events, trends or disturbances, responding or reorganizing in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning and transformation'. Just as the case with the concept of 'resilience', 'urban resilience' has been viewed in different perspectives. As rightly put by

Alberti et al. (2003), resilience is conceived as the extent to which cities can withstand change after which it reorganizes itself around a set of new structures and processes. From an ecological point of view (perspective), urban resilience is referred to as the level to which changes are accommodated by cities before it reorganizes around a set of new structures and processes (Hamilton, 2009). Furthermore, O'Brien & Hope (2010) view it as 'the ability of cities to withstand and adjust to disruptions, while still maintaining its functions'. A broader version urban resilience as put by a network of academics and practitioners ('the resilient city'), defines a resilient city 'as one that has developed the capacities to help absorb future shocks and stresses to its social, economic, and technical systems and infrastructures, so as to still be able to maintain essentially the same function, structures, systems and identity' (www.resilientcity.org). Caputo (2013) defined a resilient city as one with the capacity of sustainable cities which can adjust in response to unforeseen changes, while still performing its initially planned function throughout its expected life span.

It is however important to note that technologies and construction materials are not the only determinants of longevity. Physical performance of structures can be weakened by a number of cultural, economic and social factors which have not been taken into consideration. For instance, a desired consistent attitudinal change is required from residence of a community to ensure structures achieve the intended goal of say, carbon emission reduction and the ability of the community services and infrastructural facilities to be restored in such a way that it withstands present and future flood related events. This emphasizes the need for cities to be structured in such a way that they bounce back to normality after a disaster phase, since such shocks are likely to re-occur. In the literature, urban resilience has been examined and implemented under the lens of anticipated terrorist attacks, natural hazards and adaptation to extreme events, that is, in relation to climate change (Roaf, Crichton & Nicol, 2009; Getting, 2010). This also applies to the drive towards attaining carbon savings and reduction in the use

of heavy fossil fuels. Within the past decade, the increasing debate to come up with several body of work in the areas of resilient water sector (Hamilton, 2009), flood resilience (Lamond & Proverbs, 2009), community resilience (Magis, 2010) and building resilience against terrorism has caught the eyes of academic community.

Since the literature on urban resilience is still being explained within different conceptual frameworks, the theoretical framework of this study relied on the explaining the attainment of economic resilience to flood disaster within the context of the theory of public goods and externalities in economics. This is so because theoretically, resilience entails setting up a certain type of organisation and level of infrastructure to properly address natural disasters, in this case, floods. Apparent in the literature is the difficulty in achieving urban resilience as well as blending the diverse recommendations into urban planning and design. This also makes the attainment of the goal of longevity, which is the main target of urban resilience difficult. Below are the broad categories of the diverse views on urban resilience in the literature:

2.1.1.1 Urban Resilience to Natural Hazards

Natural hazards in the form of earthquakes and volcanic eruptions could cause serious harm to structures within urban settings. Natural hazards could also arise from weather and weather-related events, some of which includes heatwaves, heavy rainfalls, floods, etc. Sometimes, such occurrences are usually linked to the effects of changing climatic conditions (Roaf, Crichton & Nicol, 2009). In advanced countries like the United Kingdom (UK), attention has been given to development of flood resilient structures and communities, given the reoccurring and damaging effects of floods. On an annual basis, the cost of damage resulting from flooding globally is generally huge. Other causes of floods include sewers, man-made infrastructure (reservoirs, dams, etc.), and ground water (RIBA, 2009c). Therefore, policies

and measures to ascertain areas at risk of flooding at the national, state and local government level is needed to prevent improper development (DCLG, 2009; DCLG, 2010a).

Such policies will yield positive results if it includes risk appraisal (mapping flood-risk areas and the level of risk at the local level), risk management (designing local policies in line with assessed risks and prohibiting development in high-risk areas, except in situations where low-risk areas are non-existent), and risk reduction (constructing storage for flood water and building water defences) as well as ensuring flood risk reduction through effective landscaping. This cannot be possible without collaboration between local authorities and environmental agencies (Caputo, 2013). Where it becomes necessary to build structures in high-risk areas, 'a clear difference must be established between resisting the impact of water physically through strong structural frames, preventing water penetration or resistance and the ability of structures to experience minimal damage within repairable limits (resilience). However, in building physical resilience, the social aspect of the area must be given attention. Hence the need to combine different methods involving planning, design and management of public spaces in a sustainable manner as well as mitigation and control of floods (RIBA, 2009a).

Best practice however, requires complete avoidance of flood prone areas in the case of new developments. The role of communities in building urban resilience cannot be taken for granted. The desire and ability of communities to participate in the resilience building process is necessary for successful implementation, mitigation and control measures (Lamond & Proverbs, 2009). This has to do with providing incentives to create awareness, knowledge and a sense of ownership among individuals. Technical, institutional, social and political factors are key to promoting the desired attitude among community inhabitants (Hamilton, 2009). Finally, there must be a well-established link between different levels of intervention for any resilience strategy to be successful.

2.1.1.2 Urban Resilience to Human-Induced Hazards

Human-induced hazards could result from system failure and terrorist attacks, leading to different forms of destruction to infrastructure and buildings, thereby creating a feeling of lack of safety and insecurity within the given urban communities (Hamilton, 2009). Before the notion of urban resilience was introduced, urban design principles included safety prevention measures against crime in its framework (Davies, 2000; CABE, 2002; Nuvolati, 2016). Our 20th century world is currently witnessing a rising spate of radicalization, which is responsible for the increasing social conflicts, thereby directly or indirectly drawing public concerns about safety issues. This has also promoted the drive to build cities' resilience against such human-induced hazards. Such hazards are being addressed through sound planning (ODPM, 2004), by providing exhaustive information on conduciveness, liveability and crime prevention efforts in neighbourhoods. According to the UK's Planning System and Crime Prevention framework, crime prevention entails control of accessibility and movement, structural transformation, surveillance, developing a sense of ownership, physical protection, control of activities, crime management and control of anti-social behaviour.

In this way, security is put into consideration when erecting buildings and putting infrastructure in place. It is also important to maintain consistency in management and maintenance overtime. Conflict sometimes may arise in the process of trying to apply measures to encourage individuals' participation as well as developing a sense of responsibility and putting in place measures that promote security, but through reduction in responsible engagement (Coaffee, 2010; Coaffee, 2016). Coaffee established a link between urban planning and design agenda, with sustainability. There is therefore, the need to link the two, as well as identify their areas of friction in developing such design approaches, particularly for buildings and infrastructure (Bosher, 2009). This is so because it doesn't make sense to develop energy efficient infrastructure in an unsafe environment, for example. Environmental benefits can be achieved through careful examination of opportunities from

some safety measures to be applied (Coaffee & Bosher, 2008). Also, the need to reinforce institutional security plans through building community resilience becomes necessary (Coaffee & Rogers, 2008).

In addition, community networks must ensure proper readiness and coordination among different agencies concerned, for quick response to emergencies at all levels. Local communities should give their backings to such security measures developed to combat terrorism before they are applied (Coaffee & Bosher, 2008; Coaffee, Moore, Fletcher & Bosher, 2008). This entails proper combination of multi-faceted approaches to planning, design and management of public places. Governance structure and practices at city level will determine the implications of counter-terrorism measures on built environment (Briggs, 2005). Lastly, building resilience to human-induced hazards will to a large extent, rely on the feedbacks from individuals and communities.

2.1.1.3 Community Resilience (Social Resilience)

By definition, it refers to building the potentials of communities to redeem itself from disasters and/or to withstand the aftereffect or aftermath of climate change. It is sometimes viewed as the relationship that exists between ecological and social systems, as well as transformations brought about by human activities to the environment (Adger, 2000; Caputo, 2013). Here, the focus is on individuals and communities' capacity to quickly respond to any form of threats. Local networks must collaborate with Non-Governmental Organizations (NGOs), responsible individuals and agencies to build such effective responses. The need to create awareness and provide information on the shared framework to communities is necessary. This will help identify areas of risks and their consequences, remove barriers to participation, and promote cooperation between communities and practitioners. Communities will easily recover with available professional information, guidance and networks. In this

way, knowledge transfer and encouraged social participation promotes social resilience. This aspect is very important in building sustainable environment. Achieving social resilience becomes difficult when there is unwillingness on the part of any of the parties concerned.

While some studies argue that economic condition and social composition determines social resilience, others (Pierce, Budd & Lovrich, 2011) believe that value system of the community is what makes it more resilient. It is the understanding of the economic, social, political and environmental sources of vulnerabilities (through rebuilding cultural and social networks) of cities that can help it bounce back to its normal form and function (Reale & Handmer, 2011). This recovery process requires a well-diversified economy and quality environment to withstand the aftermath of such shocks (Pierce, Budd & Lovrich, 2011). This form of urban resilience becomes effective only with consistent commitment from individuals, local groups and institutions. In sum, information, motivation and capacity are the key ingredients required here (Lambin, 2005). Empirical studies (Alberti et al., 2003; Alberti & Marzluff, 2004; Alberti, 2005) have emphasized the need to connect ecological conditions, urban patterns and economic activities to developmental plans.

This is so because urbanization affects biophysical processes, mainly through its effects on the ecosystem (Musacchio & Wu, 2002). However, the level of influence of urbanization and human activities on ecological systems, communities and their potential to adjust to change remains uncertain in the literature.

2.1.1.4 Urban Resilience to Climate Change

This type of urban resilience covers a wide range of key areas, some of which include natural hazards, resilience to rising temperatures, resilience to floods and resilient infrastructure, to mention a few. In this case, adaptation and mitigation measures are implemented taking into consideration the fundamentals of sustainable development (DCLG, 2007). Here, emphasis is focused on achieving an improved level of self-sufficiency in energy, carbon emission

reduction targets and a reduction in impact of anticipated temperature rise as well as extreme events (Caputo, 2013). Several recommendations have been provided in the literature on how to go about achieving these targets. These comprise protecting and promoting trees and vegetation cover, constructing energy efficient buildings, sustainable drainage systems, decentralization of energy production, protecting infrastructure from disasters and prohibiting development in areas of high risk to flooding. Others include reduced consumption of water to build future resilience to droughts (Kamal-Chaoui & Robert, 2009), designing of implementable flood adaptation and recovery strategies and constructing resilient infrastructure (RIBA, 2009a; 2009b).

Recommendations on design for future climate entails designing for comfort, for construction stability and for water management, that is, water conservation, flooding and drainage (Gething, 2010). Since construction of resilient structure is expensive, and the extent to which climate change will affect the environment is not known, as well as future uncertainties in relation to the magnitude of its impact, there is a need to come up with innovative design techniques (Caputo, 2013). Resilience in mega cities should involve measures to lower vulnerability to stressors (heat, water and health), disaster planning and preparation, and flood risk reduction (Arup, 2011). Roaf, Crichton & Nicol (2009), also acknowledged that the limiting factors to resilience can be identified, although with high uncertainty. However, they linked them to environmental changes, ecological changes, resources as well as social and economic stress. For Resilient City, 'climate change, population explosion and scarcity of resources are the major limiting factors to building resilient cities' (www.resilientcity.org). The principles they provided in their resilience design for carbon emission reduction and safe neighbourhoods (communities) comprise a combination of 'Design, Diversity and Mix' and 'Place Making'. They emphasize the need to come up with design strategies which can be

sustained using local raw materials and labour. Worthy of note is the lack of a theoretical framework which captures all the principles of resilience in the literature.

The foundation laid by Resilience Alliance (2007) in this regard seeks to address climate change through addressing environmental change. Their approach tries to integrate multiple recommendations in the areas of metabolic flows (supply-consumption chains), social dynamics (such as, changes in population, inequality and human capital) and built environment (changes in supply services from ecosystem within the urban terrain). Their framework considers the relationship between transforming cities and ecosystems, in addition to the basis for urban resilience. This gives insights for more theoretical comprehension.

2.1.1.5 Urban Resilience Via Adaptability

In all the forms of urban resilience discussed, physical resilience is a key component. However, since the final goal of building an urban resilient environment is to ensure that buildings and infrastructure stand the test of time, resistance becomes important too (Gething, 2010). Prior to introducing the concept of resilience, studies have been carried out on urban and building adaptability, even though, it was not done in connection to resilience. Government intervention in building urban adaptability usually is done with the aim of improving the social and economic conditions of the place. In other words, this is done to meet the future social aspirations. In the literature, arguments on these issues show that they combine environmental quality with longevity of local communities (Force, 1999; Nuvolati, 2016). Also, changes in infrastructure and cities overtime is explained using the notion of civic evolution (Childs, 2001). By so doing, it will provide urban planners and designers with the skills to come up with resilient and adaptable structures. This requires changes in social practices overtime, and taste or fashion as well as the ability of communities to maintain the life of such structures. This is just like evolutionary processes taking place in the ecosystems. In essence, new varieties of structures replace old ones. In addition, infrastructure put in place

meets time and spatial needs as well as diversity of uses in the communities, including participation of individuals from all income groups (Caputo, 2013).

Therefore, infrastructural failure may not be seen only on aesthetic and functional grounds, but also on the basis of changing social condition and poor management plus poor maintenance in communities (Hall, 2014). Sustainable development in the view of scholars (Carmon, 1999; Bromley, Tallon & Thomas, 2005; Raco & Henderson, 2006) is hampered by unbalanced policies which is usually geared towards promoting economic growth (job creation and improved social conditions), with less attention given to its adaptability to the environmental standards. In conclusion, adaptation through time (civic evolution) is very important in ensuring sustainable urban development[2]. Hence, guidelines on how to 'Build for Life' should be followed in urban planning and development (CABE, 2008). This kind of development must ensure structures adapt to changing economic, technological and social conditions. They should be flexible such that they allow for modifications, both internally and externally overtime (Caputo, 2013).

2.1.2 Distinction between Climate and Weather

The concept of *weather and climate* have been part of some issues in the literature which have come with different interpretations, depending on the context within which they have been applied to. These divergent views in the literature necessitates the need proper clarifications of both concepts. Tough weather and climate belong to the same field or family, they have different meanings, notwithstanding the fact that people often use them interchangeably.

From an agrarian economy view point, *weather* is seen as a form of natural resources endowment available for use to households and farmers in particular. A more direct perspective of the concept as rightly put by an American Scientific Association, defined

[2] Adaptation through time means a deliberate, conscious and consistent effort by members of a community or a city to maintain a consistent culture of obeying established laws governing environmental standards and aiding to authorities to see to the enforcement of such laws over a very long period of time. This culture could be transferred from one generation to others to come in future.

weather as: "… *the state the state of the atmosphere with respect to wind, temperature, cloudiness, moisture, pressure, etc., at a given point in time*" (NOAA, 2010). Following from the above definition, we can see the patterns governing the distribution across the earth, of wind and atmospheric pressure, clearly defines the way in which elements of the daily weather operates in different scales (Ebi, Mearns & Nyenzi, 2003). In the literature, the term '*general circulation*' is also used to denote these large-scale patterns. While the smaller scale patterns (such as troughs, cyclones, etc.) usually could last over days or few weeks, covering hundreds and thousands of square kilometres, the large-scale patterns could span over months. For the meso-scale patterns, a category which accounts for the operation of the other daily weather elements, it usually lasts for a very short period, that is, around 30 minutes or less, covering tens of square kilometres. This meso-scale level represents the smallest scale which the transfer of moisture and heat takes place (Ebi, Mearns & Nyenzi, 2003).

On the other hand, *Climate* have been generally described as the anticipated *average weather* condition of a given geographical location. According to the World Meteorological Organization (WMO), it defined *Climate* as:

"…. *The synthesis of the weather conditions in a given area, characterized by long-term (usually more than 30 years) statistics (that is, mean values, probabilities of extremes, mean variances, and so on), for the meteorological elements in a given area*" (WMO, 2006).

The constituents of these meteorological elements, (that is, precipitation, temperature and wind) are usually referred to as *surface variables*. A broader perspective of the concept is that provided by the Intergovernmental Panel on Climate Change, that is the IPCC (see, IPCC, 1995; 2001b). Similarly, Ebi, Mearns & Nyenzi, (2003), defined a *climate normal* as the certified average value of a given meteorological variable over a period of thirty years, for a given geographical area. This average value of the meteorological element is usually

published every ten years and it is very relevant because past climatic variables can be used to predict the future climatic conditions (Ebi, Mearns & Nyenzi, 2003).

2.1.3 Distinction between Climate Change and Climate Variability

Just as in the case of climate and weather, *Climate Variability* and *Climate Change* has often been used interchangeably sometimes to mean the same thing. While it has been shown in the that it is very easy to establish or link the cause of a climate-related event (such as floods) to climate variability, it is very difficult to attribute the source of such events to climate change. This makes the distinction between the two concepts necessary. Variations in the long-term statistics of meteorological fundamentals estimated for different time periods explains the degree of *climate variability*. The WMO described climate variability as the deviations in climate statistics over a specified long duration of time, corresponding to a well-defined calendar (WMO, 2006). According to Ebi, Mearns & Nyenzi (2003), *climate variability* as:

"*… the variation around the average climate, including seasonal variations, as well as large-scale variations in atmospheric and ocean circulation such as the El Nino/Southern Oscillations (ENSO) or the North Atlantic Oscillation (NAO)*" (Ebi, Mearns & Nyenzi, 2003).

Factors such as natural internal forces and anthropogenic exterior forces (internal and external variability) typically explains the reasons we experience climate variability (IPCC, 2001b). However, alterations in the regularity and scales of extreme events largely experienced from anthropogenic forcing will be triggered by natural variability within the climate system (Karl et al., 2008).

Conversely, *Climate Change* covers all kinds of irregularities within the climate system, notwithstanding their statistical mature or physical origin. Other factors such as variation in solar emissions, prolonged variations in the elements within the earth's orbit, natural and internal processes of the climate system as well as anthropogenic forcing contributes to

climate change. In more limited fashion, *climate change* is usually used to signify a substantial alteration in the mean values of some meteorological variables (especially temperature and precipitation) over very long periods, which could span over three decades or even beyond, with significant social, environmental and economic consequences (WMO, 2006). As defined by the Intergovernmental Panel on Climate Change (IPCC), "…. *Climate change is the state of the climate the can be identified (for example, by using statistical tests), by changes in the mean and/or the variability of its properties, which persists for an extended period, typically for decades or longer*" (IPCC, 2007).

This means that aside the factors differentiating climate change from climate variability, time period is very important in the distinction because climate change takes a far longer time to manifest when compared to climate variability within the climate system. Worthy of note is that significant amount of the destructive effects of climate change have been indirectly or directly linked with water, in the form of sea level rise, floods, storms, droughts, etc. (Stern, 2007).

2.1.4 Weather Risk and Climate Uncertainty

Weather risk and *climate uncertainty* are concepts which are closely linked to the concepts of weather and climate respectively. While there is no common ground in the literature on an agreed definition of *weather risk*, the concept of *climate uncertainty* has been well established. The term *weather risk* is generally described as a condition where the randomness in future weather conditions poses a threat to assets, firms or ventures of households, individuals, groups and the government. In another view, the variability in the operational and financial variables (such as, revenue, net income, production and sales) brought about by unforeseen or hostile meteorological conditions is referred to as *weather risk*. By implication, it is a state of uncertainty about income flow triggered by non-disastrous climate events. It is important to bear in mind that *weather risks* may be considered as one of the greatest and

prolonged risk factors in the world. Economic agents may not suffer economic losses in situations where climate events are not adverse. However, the reverse is the case under the slightest changes in weather conditions. For instance, a given geographical area may experience significant economic damages, when faced with a situation where precipitation is slightly above average and lasts for a few days.

Substantial uncertainty still exists about the state of weather at a given time and in a given geographical area, despite assurances by climate science of fairly stable weather conditions over a given period (SCOR Global P&C, 2012). Very little information, not exceeding a few days, from weather forecasts can be obtained on weather conditions despite improvements recorded in forecasting over the last three decades. This is so because of the difficulty in understanding the complex interactions between the atmosphere and oceans. Because of the difficulty in forecasting weather conditions over longer periods of time, present and future human activities are often interrupted (SCOR Global P&C, 2012).

Climate uncertainty on the other hand, is a feature of the climate system which expresses the extent to which knowledge about future climate is not known. This uncertainty about the behaviour of the climate in future has been attributed to some factors, which include: the complex interactions within the climate system, the inability of developed climate models to forecast present and future climatic conditions accurately and guide society's decisions towards determining the appropriate direction of future climate forcing (Global Commons Institute, 2010). It has been anticipated that there will be a rise in CO_2 emissions around the 21st century, primarily due to rapidly growing population as well as increased consumption of energy (Schneider & Kuntz-Duriseti, 2002). In addition, great uncertainty still remains about the combined effects of climate change and other stressors on natural systems and people. We may also experience an increase in uncertainty, in terms of views on the types and levels such impacts, as people become more knowledgeable about climate science.

In an attempt to distinguish between climate risk and weather risk, Seo (2013) gave an example off a geographical area (village) suffering from occasional weather shocks (that is, experiencing droughts or floods). According to him, if such occurrences do not persist, such areas are classified under low risk zones. But, when such weather shocks persist over a longer period of time under consideration, that is to say, over a period of at least 30 years, such a geographical area should be classified under a high climate risk zone.

2.2 Empirical Literature Review

2.2.1 Review of Cost-Benefit Analysis on Flood Resilience, Disaster Risk Reduction and Management

The role of Disaster Risk Reduction (DRR) in curbing the detrimental effects (social, economic and environmental) of natural disasters (floods, earthquakes, hurricanes, etc.) has been widely discussed in the literature. In the United States (US) for example, studies/reports (as cited in Shreve & Kelman, 2014) have shown that out of 4000 disaster mitigation programmes investments, a mean benefit-cost ratio (BCR) of 4 was reported by the Federal Emergency Management Agency (FEMA). However, in developing countries, the benefits of DRR has often been underestimated considering the frequency and subsequent impacts of these disasters (Shreve & Kelman, 2014). This argument is supported by a case study of Mozambique where post-flood mitigation aid demand was more than the partly financed pre-disaster needs by 203 times (La Trobe & Venton, 2003). One should bear in mind that the BCR from DRR does not always yield a positive outcome as reported in quite a number of studies, some of which are included in this review. Questions have also been posed as to whether or not the estimation of the BRCs for DRR should be taken serious only when the

disaster occurs. For example, the question could be: should the process of constructing a building for long term use from the onset, take flood risk reduction measures into account or not? Are these measures worthy enough to be taken and are the benefits from taking such measures realizable? There are sparse areas of discussion in this regard in the literature, hence, more needs to be done in this area to come up with measures on DRR actions that will give favourable results, whether or not the disaster occurs (Shreve & Kelman, 2014).

Notwithstanding, as the cost of mitigating disasters is on the increase and the politics regarding the justification for the financial commitment to DRR is also rising, there has been an increasing demand by policy and decision makers to clearly spell out the economic gains from investment in DRR (Benson & Twigg, 2004; FEMA, 1997; Hawley, Moench, & Sabbag, 2012; Jonkman, Brinkhuis-Jak, & Kok, 2004; Kull, Mechler, & Hochrainer-Stigler, 2013). Investment in DRR will likely increase if the financial benefits are clarified, despite the high uncertainty surrounding its quantification. Taking the US case (i.e. the work of FEMA) for instance, only 10% of households residing in flood-risk and earthquake prone areas had adopted strategies for DRR mitigation despite damages from floods resulting from year 2005's Hurricane Katrina and Sandy in 2012, costing $100bn each (Kull et al., 2013). Also, this figure is similar to the estimated cost for possible future earthquakes in the US in any of the identified earthquake-prone cities. A number of parameters have been captured in the literature on DRR, covering locations, hazards, time-based scales and DRR measures taken. Also included are techniques which are normally left out, though central to DRR activities which ordinarily should count.

The work of Kull, Singh, Chopde & Wajih (2008), which employed for India, a people-focused resilience-motivated flood risk reduction method found higher economic efficiency, reduced start-up investment costs and investment returns insensitive to the conventional assumptions usually made in Cost-Benefit Analysis (CBA), that is, assumptions on projected

climatic conditions, discount rates, etc. The outcome from Kull's approach was more economically efficient when compared with other measures adopted on flood mitigation within the same region, which are mainly structural-based. Others had established and adopted a technology-based approach in Vietnam, introducing the use of a new boat system for example (Khan, Mustafa, & Kull, 2008). CBA of including First Aid training has been done for the Red Cross (2008) to evaluate the benefits of providing the training in some studies on Nepal (Cabot Venton, Venton, & Sayce, 2008). In an attempt to come up with a more all-inclusive estimate of projected potential costs, Mechler, Hochrainer-Stigler, Kull, Chopde, Singh, & Wajih, (2008), Kull, Singh, Chopde & Wajih, (2008) and Kull et al., (2013) in their CBAs have included climate change scenarios. Since sustainable ecosystems services provision promotes sustainable livelihoods, risks reduction and stability in the ecosystem, Nepal Red Cross (Cabot-Venton, Venton, & Sayce, 2008) have also carried out an evaluation of CBA on ecosystem revitalization approaches like reforestation of rainforest and mangroves in Nepal. There are studies (De Loë & Wojtanowski, 2001; Ganderton, 2005) on CBA which had not provided explicit information on the approach used, as well as complete explanation on data analysis done.

Among the many studies relating to CBA in DRR activities, most were community-centred or community-based (Venton & Venton, 2004; Mechler, 2005; Holub & Fuchs, 2008;Burton & Venton, 2009; Heidari, 2009; White & Rorick, 2010; Ifrc, 2012a; IFRC, 2012b), that is, mainly in relation to floods or flood prone areas. Those done on national scale and in relation to meteorological services (Ganderton, 2005; Godschalk, Rose, Mittler, Porter, & West, 2009; Hawley et al., 2012; Council, 2005; Rose et al., 2007; Whitehead & Rose, 2009; World Bank, 2010) were quite a few. Most of the beneficiaries of the DRR programmes in these studies were those residing in the regions exposed to the disasters (floods, droughts, etc.). This is so because these disasters impacted on the livelihood activities in the various communities, some

of which include farming, fishing and pastoralism. In terms of framing of these studies, it was a combination of forward-looking and backward-looking studies, with most of them concentrating more on the backward-looking approach. This is so because issues relating to climate change and climate modelling are surrounded with a lot of uncertainties as it needs one to clearly comprehend related future risks, making forward-looking studies demanding and problematic (Kull, Singh, Chopde & Wajih, 2008; Daniel Kull, Mechler, & Hochrainer-Stigler, 2013; Venton, 2010). Only few studies attempted using both approaches simultaneously.

In the computations of CBA for the DRR in the literature, a discount rate of between 10% to 12% have been applied in most studies with few applying discount rates of below 5%. These rates were applied based on different arguments put forth in the literature. While some based their arguments for recommending the use of higher discount rates (between 10 - 15%) on the assumption that rapid intervention in protecting the environment today will increase the coping capacities of future generations to such hazards, hence, making them better-off (Daniel Kull et al., 2013), others are of the view that equal value should be attached towards initiating project to protect the future environment as is being done to protect the present environment. Therefore, they recommended a very low discount rate or rather, zero rates be applied (Daniel Kull et al., 2013; Venton, Sidenburg & Faleiro, 2010). To them, applying high discount rates is just like transferring the burden from the present generation to the future generations (by prioritizing their needs over those of generations to come, making the present better-off and the future worse-off). However, it appears that the 10 to 12% rate is the standard used for most development projects in practice. In other to get a clearer picture of the implications of making choices between the two views above, carrying out a sensitivity analysis of rates between 0% and 20% may help (Shreve & Kelman, 2014).

Several BCR has been reported on studies in the DRR domain and this depends on the types of hazards and geographical location. We found that a study in the Sudan on drought reported the highest BCR when compared with all types of hazards, that is, a value as huge as 1800 (IFRC, 2012). Generally, a BCR of 3 to 15 was widely reported for Asian countries like Vietnam, Philippines, Indonesia, etc., though, the mean value for developing countries was around 60 particularly for areas at high risk of exposure to floods (Shreve & Kelman, 2014). This was for programmes like building of say, a meter wall around houses within the regions. An example of such flood risk reduction programme is the mangrove reforestation programme in Vietnam in preparation for flood disaster with a reported BCR ranging between 3 and 68 for programmes that did not take ecological benefits into consideration, and between 28 and 104 for those that included ecological benefits (IFRC, 2011). For DRR studies on volcanic related hazards like in Philippines, though with huge estimated monitoring and response cost (around US$6.5 million), such were the least reported in the literature. Prevented property damage value was at least US$500 million as a result of the initiated project (Newhall, Hendley, & Stauffer, 1997). DRR activities included mounting dykes or levees (structural-based measures) and others, some of which ranges from putting evacuation plans in place to training schemes and setting up community funding schemes (non-structural-based measures) for a significant proportion of these studies. The challenge here however, was the difficulty in estimating the value of some environmental and social components/benefits like perception (feelings) about security situation of the area (non-structural activities), as market for them are non-existent. Such indirect costs are difficult to calculate compared to the situation for structural activities (cost of construction items and servicing of labour) and this seem to explain why they are often left out in the CBA estimation (Shreve & Kelman, 2014).

The activities making up the items valued in these studies can be broadly categorized into various headings: Agricultural (size of farmland used, seeds and productivity of crops), Meteorological Services (setting up early warning systems and dissemination of climatic information), Ecosystem-based services (goods/products, services like recreation, watershed, biodiversity), Emergency Aid Services (labour and transport services costs) and Physical Assets and maintenance cost (construction/building materials, energy services provision), (Shreve & Kelman, 2014). Some have argued that a measure for value of human life be included, though difficult to assign specific value to it (Kunreuther & Michel-kerjan, 2012). In terms of coverage, most studies have done outstandingly in valuing physical assets because they tend to fall under the simplest category to measure. Since most of the studies are done at the community scales, some had also properly integrated the cost arising from loss of means of livelihood, primarily due to floods which is an expected consequence from such a hazard occurring. Such direct costs like wages lost due to temporary market and building closure as well as repairable damages on infrastructure and buildings have been estimated in studies through field surveys and discussions from conducted expert interviews. Loss of means of livelihood can pose challenges on the physical and mental health conditions of flood victims. Only few studies have attempted to quantify the associated costs (indirect cost) in the literature. Studies that have tried to estimate the costs and benefits from the provision of meteorological services (Rogers & Tsirkunov, 2010) have focused mainly on the agricultural and aviation sectors of the economy on national scales. In this regard, some community-based studies have provided estimates for actual losses on agriculture. In addition, challenges arising from inadequate data and difficulty in assigning monetary value to social and environmental goods and services or both, may have been responsible for the existence of few studies that had provided estimates for benefits in most of the CBA for DRR studies (Shreve & Kelman, 2014). Though most of them emphasize the need for valuing benefits from services related to

the ecosystem without doing it in their works, Whitehead & Rose, (2009) had done a great job in this regard. The same narrative applies to the value of human life, as only few studies (Kunreuther and Michel-Kerjan, 2012) again have assigned values to it, though, Khan, Mustafa & Kull (2008), had reiterated the importance of doing so, but would have arrived at a BCR which was much higher than that of Kunreuther and Michel-Kerjan if they had done that for their study estimation (Shreve & Kelman, 2014). Another study (Holland, 2008) for example, had included the benefits accruing from emergency aids financed by Nongovernmental Organizations (NGO). In like manner, few studies have incorporated costs arising from exposure to health-related diseases (malaria, cholera, or diarrhea) as a result of using contaminated water due to floods (Khan, Mustafa & Kull, 2008). Apparent in the literature are many studies that have focused on estimating the physical and economic aspect of vulnerabilities when compared to those that had looked at the environmental and social aspect. In the work of Mechler (2005), he captured extent of vulnerability of the environment to the hazard as well as the economic impact (direct and indirect) resulting from flooding. In another related study, Mechler, Hochrainer-Stigler, Kull, Chopde, Singh & Wajih, (2008) using both qualitative and quantitative techniques, carried out a CBA for Indonesia. In this case, BCR values were computed to cover each of the four categories of vulnerability as earlier discussed in this review. Studies like Khan, Mustafa & Kull (2008), (Daniel Kull et al., 2013) and Cabot Venton, Venton & Sayce (2008), are typical examples that have done CBA giving consideration to the social aspect of vulnerability. These works also serve as illustrations for resilience-based strategies which are people-focused, evaluating individual level interventions. Several studies have presented reports and finding from sensitivity analysis (Burton & Venton, 2009; Schröter et al., 2008; Holland, 2008; Kull, Singh, Chopde & Wajih, 2008; Daniel Kull et al., 2013; Kunreuther & Michel-kerjan, 2012; Venton & Venton, 2004). However, only Kull, Singh, Chopde & Wajih, (2008) and Daniel Kull et al.,

(2013) took into account climate change impact and sensitivity analysis in their CBA. It is not surprising that many CBA for DRR studies have not included climate scenarios and modelling, and this is as a result of the high uncertainty surrounding the prediction of future climate behaviour.

Estimating the benefits of DRR has been the major focus of studies done at national level in this area. Here, for some of these studies (Gunasekera, 2003; Lazo & Chestnut, 2002; Leviakangas et al., 2002; Perrels, 2011; Woodruff & Holland, 2008; World Bank, 2010), the objective was to provided better-quality weather forecasting systems and they have been done for countries like Belarus, Croatia, Georgia, Kazakhstan, Nepal, Samoa, USA, among others. There are national scale studies on floods and earthquake whose focus was on the cost implementing structural measures for DRR, like erecting walls around houses (FEMA, 1997; Ganderton, 2005; Godschalk et al., 2009; Council, 2005; Cabot Venton, Venton & Sayce, 2008; Rose et al., 2007). National scale studies are very rare to come by for continents like South America, Australia and Asia. Most CBA studies on ecosystem were examined at regional scale or sub-national scale for countries like Pakistan, India and Germany (Khan, Mustafa & Kull, 2008; Kull, Singh, Chopde & Wajih, 2008; Schröter et al., 2008) in the area of improving river basin expanse and in Vietnam, on reforestation of mangrove areas (IFRC, 2011). For CBA on rebuilding of ecosystem in and relocation of people out of floodplain areas, the analysis was done hypothetically.

Most case studies in the literature on CBA have concentrated more on droughts, floods and earthquakes, with studies on other environmental related hazards (temperature extremes, heat waves, bust fires, tornadoes, etc.) almost non-existent. It could be argued for example, that the dominance of studies on CBA for DRR for floods and drought in the literature can be explained by the degree of recurrence compared to others, and the ease of computing their cost and benefit. There are hardly CBA studies on technology-driven hazards and pandemics.

Although, some studies have demonstrated the possibility of doing CBA for other forms of hazards (aside floods, droughts and earthquakes), as well as going ahead to suggesting simpler approaches of incorporating them into works on DRR to broaden the scope of calculating BCRs (Newhall et al., 1997). However, studies like Cutter, Boruff, & Shirley (2003), developed a different approach from the usual case study and traditional approaches often used for doing CBA in the literature. In their approach, the computation of a project's cost and benefit was done using a social vulnerability index to environmental hazards and this index was computed using demographic and socio-economic data at country level. In addition, only few studies discussed how long the DRR benefits will last, bearing in mind that cost and benefits will change over time, hence the need to take that into account when choosing discount rates to be applied (Council, 2005). Ecosystem-related DRR studies are becoming common in the literature on DRR with emphasis on the need for the implementation of ecological-infrastructure (including afforestation and agroforestry techniques in DRR and sustainable conservation strategies for floodplains/flood prone areas), as they in one way or another affect the local livelihoods (Abedin & Shaw, 2015), though it is rare to find studies that had done costing in this regard (Gupta & Nair, 2012; Kazmierczak & Carter, 2010; Kousky, 2010; Paleo, 2013). Apart from supporting livelihood, ecological conservation lessens the physical damage on humans, soil and water cycle systems. A lingering question is whether CBA can fully address or capture vulnerability. One clear fact is that the root cause of disasters is vulnerability (Hewitt.K, 1983; Hewitt, 2014; Lewis, 1999; Gervacio & Liong, 2014; Wisner, Gaillard & Kelman, 2012; Wisner, Gaillard, & Kelman, 2011) and social construction determines the level of vulnerabilities, rather than the environment's nature (Hoffman & Oliver-Smith, 1999; Oliver-Smith, 2002). Among the four major categories of vulnerability used in the literature for CBA in DRR, environmental and social impacts tend to be more qualitative in nature while the other two (economic and

physical impacts) are quantitative in nature. Since quantifying the qualitative variables are difficult, some works used a combination of Multi-Criteria Analysis (MCA), that is to capture costs and benefits for the qualitative variables and CBA to capture that of the quantitative variables (Argyrous, 2010; Mechler, 2016). MCA relies on opinions from experts through interviews or focused group discussions, and because of its flexibility, it creates an opportunity to integrate the input of all relevant stakeholders (individual households, privates sector experts and representative of government agencies) in DRR in management programmes for floods. This can also help in determining the cost effectiveness of the programme in the short run and its possible long term socio-economic and ecological impacts as done in Brouwer & Van Ek, (2004). Furthermore, it is important to note that there is no universally agreed standard for carrying out an all-inclusive CBA for DRR, particularly, spelling out all necessary variables capturing vulnerability, time and spatial consideration or even disaster consequences (Shreve & Kelman, 2014). Turning attention to focus CBAs only on the poorest and the perceived most vulnerable groups of the population often does not yield comprehensive results (as in Lewis, 1999; Gervacio & Liong, 2014; Wisner, Gaillard & Kelman, 2012; Wisner, Gaillard, & Kelman, 2011). Additionally, it has been recommended that a comprehensive CBA (especially for long term programmes) requires clearly comprehending the motive behind the decision making at private and public-sector level, and why it changes over time (Deaton, 1987, cited in Shreve & Kelman, 2014). Also, good CBA should promote the potential to attract future investment DRR and form the basis for evaluation initiated pilot programmes, in terms of their successes, challenges and failures (Shreve & Kelman, 2014). BCR computations should be contextualized for policy relevance.

2.2.2 Highlight of Key Issues in the Empirical Literature on Urban/City Resilience

There are several issues raised in the literature on designing, planning and building resilience in urban areas/cities. This section of the literature provides a summary of some of the key issues raised.

The first issue observed stems from the fact that there exist multiple contending views and definitions on the concept of 'resilience' and 'urban resilience' in the literature (Vale, 2014; Vale & Campanella, 2005; Spaans & Waterhout, 2015). In addition, related studies have emphasized on the challenges and difficulty (problematic nature) in attaining as well as in building urban resilience. Although, several studies have come up with design mechanisms and ways for planning resilient cities, as well as how to address and implement climate change policies for sustainable development of resilient African cities (Vale, 2014; Vale & Campanella; 2005; Desouza & Flanery, 2013; Dieleman, 2013), the problem lies with the harmonization of these policy plans, coupled with integrating them into a single, consistent and coherent plan. These policies also include measures to be taken to ensure the achievement of low carbon cities (Feliciano & Prosperi, 2011; Burch, 2010; Alhorr, Eliskandarani, & Elsarrag, 2014; Mat et al., 2016).

Another important issue raised in the literature on urban resilience is the lack of a theoretical framework for planning for resilient cities (Jabareen, 2013). Furthermore, it is also stated in the literature that climate change is likely to aggravate the vulnerabilities already existing in cities, through its consequences (Albers et al., 2015). Studies have further gone ahead to explain the various channels through which these vulnerabilities will likely be increased. The first reason arises from the exponential increase in the population of people moving to cities to live. Records have shown that more than 50% of the world's growing population now live in cities, as cities provide avenues or serve as a hub for technological and social innovations (Vergragt, Dendler, de Jong, & Matus, 2016). The second reason is that the rapid rate of

growth in urbanization and population, if not checked, could worsen the effect and consequences of climate change in both developing/poor countries and developed/rich countries (Kahn, 2008; Tanner, Mitchell, Polack, & Guenther, 2009; Mattoni, Gugliermetti, & Bisegna, 2015).

More so, taking a closer look at the existing literature, it can be observed that so many recommendations have been made in the literature with regards to working towards attaining resilient cities/urban communities (Rahman & Rahman, 2015). One of the key recommendations emphasised the need to tackle resilience using a multidimensional approach, that is from social, economic as well as environmental view point, and the application of a multidisciplinary approach (Stumpp, 2013; Gomez, 2015; Chow, Cheong, & Ho, 2016; Moraci, Bombino, & Fazia, 2016).

The second important recommendation is the inclusion of the community to participate in building climate resilient buildings/housing (Anh, Phong, & Mulenga, 2014). One of the most emphasized recommendations in the literature is to foster stakeholders' (households, private sector and government) inclusion as well as local participation in climate resilience development and implementation of resilience strategies for cities/urban areas (Hordijk & Baud, 2011; Rydin et al., 2012; Castán Broto & Bulkeley, 2013; Kernaghan & da Silva, 2014; Dufty, 2016; O"Neill, McLean, Kalis, & Shultz, 2016). This should not be only at local level, but should include actors at national and international level. Proper energy management (Calvillo, Sánchez-Miralles, & Villar, 2016) with the need for good governance for sustainable urban resilience (Mycoo, 2014) were among other recommendations provided as necessary requirements. Lastly, emphasis was made on the importance of strengthening capacity of institutions for efficient flood-risk management under changing climate (Francesch-Huidobro, Dabrowski, Tai, Chan, & Stead, 2015; Mitchell, Enemark, & van der

Molen, 2015), and the need for knowledge and awareness creation on climate risk related issues (Shemdoe, Kassenga, & Mbuligwe, 2015).

2.2.3 An Overview of Flooding in Nigeria

Introduction

Flooding is a crucial component in the climate system as its occurrence has been unparalleled overtime. This has increasingly been an issue of significant discussion in the climate change economies with over 70 million of world population affected annually. The effective management of flood risk has been a decisive issue over the years because of several environmental and climatic changes such as increasing level of rainfall, fast growing population, among others. There are also some economic implications of flood occurrences as some reports (such as, Guha-Sapir, Hoyois & Below 2013; EMDAT, 2015) have indicated that flood disasters have cost more than billions of dollars over the past decades while also resulting in several hundreds of thousands of deaths, psychological issues (such as depression and anxiety), several degrees of injuries among others in flood prone areas of Asia (Tapsell, Penning-Rowsell, Tunstall & Wilson, 2002; Hunter, 2003; Tapsell & Tunstall, 2008).

However, in some Sub-Saharan African countries such as Nigeria, flood disaster has resulted to numerous dislodgments of several houses and properties (Obeta 2014). Obviously, the country has experienced more disturbing floods which has caused both human lives and properties resulting to amounting to more than millions and billions of dollars (NEMA 2013 report). The relative impact of this disaster in the country may include death, several degrees of substantial injuries, homelessness, transmission and widespread infection and diseases, hunger and famine among others (Fadairo & Ganiyu, 2010, Ogunbodede & Sunmola, 2014). This disaster is commonly connected to global climate changes and inadequate town and regional planning of the susceptible flood areas (Action Aid, 2006; Adeloye & Rustum, 2011).

Nigeria had a bitter experience of flooding in 2012 where the occurrence affected about 32 states of the country and this was recorded as the worst in the country's history when there was heavy down pour for several days in the some of these states (NEMA, 2013 report). The floods extended from July to October that year and affected 7.7 million people with more than 2 million others reckoned as internally displaced (IDPs). More than 5000 people were physically injured along with over 5900 houses which were destroyed. In the past, flooding in Nigeria was accustomed to being fluvial, coastal and pluvial in nature and with rural areas and country sides most affected areas (Douglas et al., 2008, and Bashir, et al., 2012). The Fluvial floods usually account for the major flood pressure witnessed in areas where there are major rivers which cuts across the North-western, Middle belt and the South-south region of the country (Iloje 2004).

What's more, on the mitigation of flood in Nigeria; flood cannot be eliminated as the widespread of this incident is predictable in Nigeria. But in the light of 'best practices' in flood risk reduction and 'lessons learned' from other countries' experiences of flooding, it can be argued that such stake holders' efforts are at best limited most probably due to lack of quality data (Nkwunonwo et al 2015).

Debatably, with the increasing cases of flooding occurrence in Nigeria coupled with the limited sustainable development strategies studies have indicated that the remedies towards prevalence of flooding in country are relatively too pathetic towards in the management of flood risk. Recently studies have examined the effects of flooding as well as the possible ways of mitigating them in communities, geopolitical regions and various states within the country. Nevertheless, the focal point of these studies is that a more all-inclusive perception of the prevalent flooding in Nigeria necessitates wide ranging deliberations as indicated by studies (Adeoye, Ayande & Babatimehin, 2009; Bashir, et al., 2012; Adedeji, Odufuwa, & Adebayo,

2013; Terungwa & Torkwase, 2013; Agbonkhese et al., 2014; Obeta, 2014; Ali & Hamidu, 2014).

Whilst there is lack of clear-cut measures to drastically deal with the occurrence of flood in the country, it has been arguably vast that rigorous efforts in the form of planning strategies, policy directives, international aid and intervention has been decisive in tackling the widespread flood risk in the country have been given a thought (Douglas et al, 2008; Agbola et al., 2012; Bashir, 2012). Other crucial gears required to tackle may not be limited to community based early warning systems, humanitarian aids from government and private sectors as well as appropriate level of preparedness and capacity building (Adeoye, Ayande & Babatimehin, 2009; Adedeji, Odufuwa, & Adebayo, 2013; Agbonkhese et al., 2014). Flood hazard mapping and appraisal of vulnerabilities of lives and properties to flooding are imperative in drafting procedures and factors which play key functions towards building community resilience to flooding.

The significance of strengthening present ability of all agencies may include the joint effort of communities which are vulnerable to flooding within Nigeria to deal with flood risk situations (Obeta, 2014). Even though these studies explored flooding in Nigeria, the major gap of how to mitigate the prevalence of flooding remains an unresolved problem. Another major setback is the unavailability of flood data which has also made the curbing of flood issue a difficult one over the year.

Based on the articulated issues above, there is further call for a more scientific approach in the form of flood modelling which can enhance flood risk management as this move have kept quiet especially in developing countries like Nigeria. Nonetheless, it is eminent that the success of flood threat reduction depends largely on a knowledge-based decision, robust institutional framework and flood risk communication (Ologunorisa & Adeyemo 2005; Raaijmakers, Krywkow & van der Veen, 2008). But these factors appear to be the missing links in

Nigeria which has accounted for the defectively measures in addressing flood in Nigeria. It is also imperative to know that even the knowledge-based decision utilizes the available information relating to flooding to draw conclusions on possible strategies to be adopted for tackling flooding (Nkwunonwo et al 2015). Flood menace communication aims at creating awareness of flooding and its impacts in stake holders and the public (Nkwunonwo et al 2015). Institutional framework on flooding in Nigeria implies the government response procedures and strategies aimed at either managing flood emergency conditions or in assisting flood victims to cope with and recover speedily from extreme flooding events (Obeta, 2014). Prominent studies on flood risk based have indicated that these requisites are essential to information relating to flood vulnerability and its consequences and can be obtained from public opinions, expert knowledge, research findings among others (Sayers, Hall & Meadowcroft, 2002; Sayers et al., 2013; Smith, 2013). Furthermore, it has been argued that various flood modelling approaches are crucial mechanism of flood risk reduction as they are capable of quick, continuous and routine simulation of flood data needed for flood risk assessment (Merz, Thieken & Gocht, 2007; Moel, Alphen & Aerts, 2009; Almeida et al., 2012). Though, it is decisive to admit the key roles flood modelling can play in terms of mitigating flood in Nigeria. Foreign directives on flood management such as those from European Union (EU), The United States flood control policy, national flood insurance program (NFIP) among others have also stressed the importance of flood modelling (Merz, Thieken & Gocht, 2007). The flooding model could assist in driving an improved understanding of flood phenomena and prompt improvements into more robust flood management approaches such as flood forecasting, flood early warning system and flood damage estimation (Nkwunonwo et al 2015).

The implementation of flood modelling in Nigeria would be a huge step in the effort in trying to mitigate the flooding risk as this technique has the capacity of investigating and estimating

of damages caused by flooding as was done in US and Netherlands (Vis et al., 2003; Jonkman et al., 2008; Neal et al., 2011). Hence, in a bid to aid the adaptation of human populations to flooding, as well as providing the necessary backing need by stakeholders to tackle flooding in Nigeria, this study attempts to bridge the gaps in flood risk and vulnerability reduction in Nigeria.

2.2.4 Institutional Approach to Tackling Flooding in Nigeria

Institutional approach geared towards addressing the risk of flooding in Nigeria could be traced back to the earlier years of the 60's with the establishment of federal and state ministries of works (Ibitoye, 2007). Conversely, the increasing regularity and sternness of floods across the country prompted the establishment of Ministries and Agencies such as Federal Ministry of Works and Housing in 1988 and the Federal Ministry of Environment (FME) in 1999 (Obeta, 2009). One of the core objectives of the establishment of these ministries especially the FME was the assessment of flooding potentials and the reduction of flooding risk in Nigeria. For effective disbursement of this objective, there were further agencies created under this ministry to carry out the flooding management in Nigeria. Amongst this include Federal Emergency Management Agency (FEMA), National Emergency Management Agency (NEMA), State Emergency Management Agency (SEMA), Local Emergency Management Agency (LEMA), National Orientation Agency (NOA), National Commission for Refugees (NCR), National Environmental Standards and Regulations Enforcement Agency (NESREA). FEMA is bound with the issues relating to flood insurance are coordinated by the agency which makes federally funded insurance protection policy available for property owners in Nigeria. However, NEMA is a body solely responsible for coordinating activities for disaster risk management in Nigeria. Moves towards addressing the threats of flooding which the agency coordinates include but not limited to policy formulation, leasing with and assessing the state of preparedness of all other

relevant agencies, data collation from relevant agencies, education of the public on flooding and interaction with SEMA towards the distribution of relief materials to disaster victims within states and local government areas (Nkwunonwo et al 2015). In addition, policies relating to assisting flood victim at state and local government levels are coordinated by SEMA and LEMA.

NESREA on the other hand is mandated with the role of flooding checks with other keys roles that include enforces all environmental laws, guidelines, policies, standards and regulations in Nigeria, as well as enforcing compliance with provisions of international agreements, protocols, conventions and treaties on the environment. NIHSA as an agency offers reliable and high quality hydrological and hydro-geological data on an incessant basis for assessing the status and trends of the country's water resources including its location in time and space, extent, dependability, quality and the possibilities of its utilization and control. More so, the agency has been sensitizing and creating awareness on flooding through the motto of *"flood outlook"* initiative. Furthermore, the agency also provides professional advice to various tiers of government on all aspects of hydrological issues, in partnership with NIMET in issuance of flood forecast. Similarly, NIMET provides the country with weather report, and other meteorological information, such as issuance on alerts, early warning and forecast on impending flood disasters within the country. NCR handles the provision of humanitarian needs such as shelter, clothing and floods for internally displaced persons. The NOA is bound to sensitize the importance of local communities being aware of flooding and actively participating in discussions and decisions which might increase their resilience and adaptability to the hazard. In addition, they re-orientate and keep the citizens well informed about ways of taking part on issues that affects them. The poor perception of flooding in the country should be the concern of this agency. The BNRCC's gears towards collaborating with other agencies to promote the capacities of the generality of human populations within the

country to cope with all effects of climate change. Lastly, NEST undertakes continuous research required for enhancing decisions and robust measures towards addressing flooding in Nigeria (Kolawle, Olayemi & Ajayi, 2011; Akintola & Ikwuyatum, 2012).

The odd thoughts of Nigerians towards issues they probably have no resolution to, is to find a possible natural means to adapt. Though, this attitude has resulted in loss of lives and properties during such the occurrence of any these disasters. During several flooding cases in Nigeria, the immediate communities have often rendered assistance to affected victims through evacuation of people especially the old and children as their properties. Most Internally Displaced persons simply seeks their immediate needs inform of shelter and other humanitarian needs from relatives as well as friends whilst waiting for intervention from the relative authorities. However, this is usually met with some disadvantages in the form of crimes and anti-social activities.

Nearly all cases of flood in Nigeria victims have been met some substantial level of humanitarian received humanitarian assistance from foreign organizations such as International Federation of Red Cross (IFRC), United Nations (UN), World Bank, even some religious organization among others.

Notably, credit must also be attributed to the various media and researches about what is known on the flooding occurrence in Nigeria. A lot seems to have been done on the researches with evidence from the online and institutional research publications. Institutions like NEMA, NIHSA have been consistent in their publication of annual reports on flooding incidence in Nigeria among other notable institutions. Essentially, the idea of flood risk reduction is to build the resilience of human populations to flooding (http://www.unisdr.org/files/657_lwr1)

For instance, in developed countries like the US, UK and Netherland, it could be argued that this idea is underpinned by much profound measures for tackling flooding. However, for the

Nigerian case there are some gaps and limitation among which absence of flood modelling and assessment of the vulnerability of the flood in Nigeria.

The crucial gap in flood risk reduction in Nigeria is poor attention to flood modelling and assessment of vulnerability to flooding. Likewise, evaluation of vulnerability to flooding helps in the understanding of differences in human sensitivities, exposures and lack of capacities to cope with floods. These approaches are poorly considered in efforts at tackling flooding in Nigerian (Nkwunonwo et al 2015).

Another major issue is the weak institutional approach to flood risk reduction as this approach has been acutely flawed (Kolawole, Olayemi & Ajayi, 2011; Agbola et al., 2012; Obeta, 2014). Though, the major task within the approach is basically the evacuation and provision of pressing needs of the flood and resolution of any form of dissatisfaction among the victims in their camps. But the fact remains that this factor may not be the reason for the continuous prevalence of flooding in Nigeria even though there hasn't been a significant improvement in this factors in Nigeria (Seto & Shepherd, 2009; Adelekan, 2010; Akintola & Ikwuyatum, 2012).

Perhaps, institutional framework with a multifaceted string of exploit that characterizes Nigeria system may not be the best practice for a country with imperative needs to address the risk of flooding. This is because the occurrence of flooding in Nigeria requires a simpler framework with reduced chain of action and increased authority and responsibilities towards flooding and ways of mitigating its threats.

Susceptibility of local communities to flooding in Nigeria may indicate among other factors an overwhelming level of frivolity towards flooding and ways of approaching the challenges. However, a good number of steps taken by some individuals is quite laudable while some which include the failure to comply with environmental laws and regulations and to adhere to weather warnings are quiet discouraging as well (Aderogba, 2012). The lack of awareness of

the local communities on the issue of flooding is bore down to the institutional failure of the NOA whose part of its objective is to create awareness to the public (Ologunorisa & Adeyemo, 2005; Ajibade, McBean & Bezner-Kerr, 2013).

In Nigeria, there seems to be a controversy between the efforts of the government and the activities people as the people are claiming the government is not doing anything to help in the management of the flooding threats. On the other hand, the government is claiming the people are incapacitating their efforts by not strictly adhering to rule and regulations as well as the environmental management policies. There also exist lack of comprehensive plan and strategy for the relief plan such as disbursement funds and relief materials to the victims of the flood which tend to dent humanitarian support. This could also be attributed to the weak institutions which also pave way for corruption in the process (Obeta, 2014).

Humanitarian actions in Nigeria are generally for post-disaster and emergency situations suggesting some limitation based on what can be achieved through financial support (Nkwunonwo et al 2015). Given that most local communities in Nigeria consist of poor human populations, the mechanism could be termed as a top-bottom approach to deliberate humanitarian supports in the aftermath of the crises rather than prioritizing it towards the improvement the living condition of these people and reduce their chances of being vulnerable to flooding threats in Nigeria (Nkwunonwo et al 2015).

Considering what has been done globally in research (mostly in China, India, UK, the US, Bangladesh and Netherlands) Nigeria in has not been up to par in terms of research on management of flood risks. The learning of science and technology in Nigeria are yet to embrace environmental education and this has been identified (Terungwa & Torkwase, 2013). Even as flooding and climate change are passive subjects in education syllabus in Nigerian schools, advance and trending issues in flood research such as flood modelling, early warning systems, and flood forecasting, vulnerability assessment and climate change models are

deficient in Nigeria. However, the literature publications in Nigeria on this issue look to be reinventing the wheel with no value addition to what is already existing or known.

While the media are sometimes lauded for the dissemination of information to the public on the occurrence of flood, there is sometimes inconsistency in their reporting in Nigeria (http://www.e-ir.info/2013/02/04/the-inconsistency-of-the-flood-narrative-in- nigeria/). It is assumed that there exist some disconnect between the media and agencies such as NEMA handling the flooding case. This looks to have complicated the whole issue on the management of the flood threats. Because of these, most people have relied on the social media for the update on the situation. This condition has part of the reason people have lost confidence and under-reliance on the media for information. This situation tends to also weaken the professionalism of media houses in Nigeria. Furthermore, it is possible that political factors and market competition to a large extent influences the media reports. It is also noteworthy that piloting of perception and awareness of flooding threats to the public and local communities as well as sensitization the alerts and early warning has been compromised in Nigeria (Nkwunonwo et al 2015).

2.2.5 Origins and Types Flooding

In the literature, several factors have been identified as factors responsible for the causes of flooding (Jha, Bloch & Lamond, 2012). Many have attributed it to the combined effect of hydrological and meteorological factors like extreme rainfalls on one hand and overflow of rivers and dams beyond their banks, sometimes linked to one human activity or the other. Others include poor planning and development of buildings in floodplain areas. During extreme weather conditions, these hydrological structures in most cases, are altered, making them unable to hold or control the level of water flowing within its capacity, thereby resulting in flooding situations. Also, the rapid influx of people from rural to urban areas in search for greener pastures and better living conditions usually brings about the development of many

informal settlements and slums within and around urban areas. This makes structures and people living is such areas highly exposed to flooding, because such areas lack proper drainage systems, and sometimes, buildings may be constructed along water pathways. In addition, the absence of defence systems against floods, poor implementation of land use and urban development plans, in the presence of poor drainage systems tend to reduce the penetrability of water into the soil and therefore, increasing the risk of flooding in such areas. With the above discussions, and for clarity purpose, the categorization of the flood types can be properly distinguished as contained in the works of Balica, Wright & van der Meulen, (2012). However, before delving into the categorization of the flood types, the first thing to do is provide an understanding of the meaning of 'a flood'.

As rightly put by Douben, (2006), 'A flood can be defined as a temporary condition, whereby surface water level (this could be from lakes, rivers, dams or even the sea) or discharge surpasses a certain level or amount such that it escapes from its normal confines, though sometimes, this situation does not automatically result in flooding'. Flooding on the other hand, can be viewed as the condition under which rivers, dams, lakes, seas or even streams experience a spill over of water over its normal limits due to heavy precipitation via lack of capacity of drains to hold water, or through melting of snow/ice or the breaking of dams such that areas which are not normally submerged by flowing water are affected (Douben & Ratnayake, 2006). Flood types differ based on a blend of different sources, impacts and causes. With all these combinations, the literature has characterized floods largely into five (5) categories: Fluvial floods (or river floods), Pluvial floods (or overland floods), Coastal floods and groundwater floods (usually attributed to the failure of artificial water systems such as dams, etc.). When the classification of flooding is based on the speed of its onset, the categories we will have include Urban floods, Flash floods, Slow rise floods and Pseudo-permanent floods. All the above-listed flood types may pose devastating effects on urban

areas, hence, they can be broadly categorized as 'Urban floods. In other to understand the likely effects of these flood types on urban areas and the necessary steps required to be put in place to mitigate against their impacts, a clear understanding of the cause and speed of the unset for each type is required (Jha, Bloch & Lamond, 2012). We are increasingly confronted with facts about flooding and the growing incidences of floods in different parts of the world, which have been attributed global warming, which results in climate change based on the reports of the UNDP (UNDP, 2004).

However, in trying to make a distinction between the different flood types, this review will concentrate its discussion only on four (4) of the major types, (that is, Fluvial floods, Flash floods, Coastal floods and Pluvial floods) as discussed in Balica, Wright & van der Meulen, (2012) and Ingirige & Amaratunga, (2013).

(i) Fluvial Flooding

Also called River floods, it is a very common type or source of flooding which usually occurs when surface water runoff, particularly from rivers, rises to an extent that it exceeds the capacity of artificial and natural channels after overflowing the river banks, such that they become unable to accommodate the flow of the water. This excess runoff water after overflowing the river banks tend to spill out into adjacent low-lying areas and floodplains (Balica, Wright & van der Meulen, 2012). Evidences from projections using climate models have made researchers, politicians and development authorities to begin to focus their attention on climate change's potential impacts on fluvial floods (Wilby, Beven & Reynard, 2008). In addition, this finding has also strengthened the belief among European countries of possible future increase in flood risk. Based on the water levels of rivers or its level of discharge, Fluvial floods have been defined within the hydrological context (Ingirige & Amaratunga, 2013).

This type of flood occurs naturally and, in most cases, seasonally in areas situated along rivers during rainy seasons. Unlike flash floods, fluvial floods usually don't happen suddenly, but builds up steadily as a result of continuous significant amount of precipitation over a large area, running into several days. With this condition, water penetration levels in the soil reaches a standstill, since the soil water holding capacity is usually exhausted during such periods. The rainwater flows straight into the rivers as the ground becomes saturated. Examples of places where fluvial flooding occurs are areas around River Nile in Egypt, River Mississippi in the United States and States along River Niger, River Benue and River Hadeja in Nigeria, to mention a few (see Nkwunonwo, Malcom & Brian, 2015). However, it is important to note that the inundations of areas in the floodplains along the River Nile basin and River Mississippi occurs once in every twenty (20) years, impacting on millions of lives, with economic losses amounting to millions of dollars. The lifespan of such floods could be just for some days or a few weeks, though the level of damage depends on the topography of the river. Some of the threats posed indirectly by fluvial floods include the spread of waterborne diseases and other emanating from food contamination (Douben, 2006).

(ii) Flash Flooding

As the name implies, Flash floods are usually abrupt inundation of parts of towns or cities or generally small areas within a very short period of time. This is often caused by periods of strong rainfalls combined with thunderstorms over a small area, normally within an hour or a few hours as the case may be. Because they happen without warning, releasing huge volumes of fast-moving water, they are unfortunately considered as one of the most common, most destructive and deadliest kind of floods. Compared to Fluvial or River floods, their lifespan is very short as they vanish within a few hours (Perry, 2000). Furthermore, the International Federation of the Red Cross (IFRC) has described flash flood as a sudden and extreme amount of water flowing rapidly and causing inundation. Flash floods are difficult to predict

due to its rapid nature, leaving people without any opportunity to escape or secure food materials from the affected areas (IFRC, 2014). As defined by the National Oceanic and Atmospheric Association (NOAA) of the US, Flash floods is seen as one of those peaks experienced during the onset periods of torrential rainfall, lasting around six hours (NOAA, 2014). The increased occurrence and impacts of flash floods globally have been ascribed to climate change. Under situations of flash floods, the risk of businesses and infrastructure experiencing collateral damages is very high. As a result of this, Pitts Review (2008) suggested that in other to improve the predictability of flash floods, it is necessary to map trends of flash flooding in urban areas. In addition to the intensity and duration of rainfall, other factor behind the occurrence of flash floods include the slope of the recipient river basin, quality of drainage systems, soil type and the topography of the affected surface area (Douben, 2006). The susceptibility of urban areas to flash floods cannot be overemphasized. This is so because a significant part of urban surfaces is made up of impervious streets, car parks and waterproof roofs, making runoff to occur swiftly in such areas. The damages faced are worsened by the debris (like rocks, stones trees, etc.) accompanying the high-speed moving water. Flash flooding situations are often worsened by rapid influx of people into urban and sub-urban areas, increasing the inability of land in these areas to quickly absorb water from rainfall. In the developed world (such as the United States, United Kingdom, Japan, etc.) population exposed to flash flooding are protected through structural measures put in place by authorities, unlike in the developing world which have poor drainage and poor infrastructural systems. This confirms the assertation that, because people in developing countries are more vulnerable to other stresses, they lack enough adaptive capacity to floods, global change and climate change in general (UNEP, 2002). The complex nature of flash floods in urban areas has become a growing issue of concern in both developing and developed countries (Jha, Bloch & Lamond, 2012). Sometimes laws regulating the

construction of new buildings or settlements may exist in developing countries. However, the major problems lie in the enforcement of these laws and this not unconnected with political and economic factors as well as other constraints imposed by available resources. When such urban settlement problems exist, the natural flow of water along its pathways is hindered. The only solution needed to mitigate problems associated with the frequent occurrence of flash floods in urban areas is the need for awareness creation among inhabitants of urban areas and a proper synergy between the public, decision makers and authorities saddled with the responsibility of managing flood risks.

(iii) Coastal Flooding

Coastal floods are floods that occur in areas around coastal regions of countries. They occur when high tides coincide with storms (which are typically produced by sea waves also termed as tsunamis). Also, these tsunamis come in the form of unusual massive tidal waves formed by earthquakes or volcanoes in the ocean. Ocean waters can also be driven into land by tropical storms and hurricanes which have the ability to produce heavy rains or drive water into land. In other words, coastal floods happen when an area around the coast experience an intrusion of sea or ocean water into land (Jha, Bloch & Lamond, 2012). Coastal floods differ from cyclical high tides because they emanate from an unanticipated relative upsurge in sea level brought about by a tsunami or a storm. These storms or tsunamis are sometimes called tidal waves triggered by seismic activities. Combined strong winds during storms or hurricanes makes the water on the sea or ocean surface pile up and the dragging effects of the low pressure in the storm produces a mass of rising water within the shores. Once this mass of water draws closer to the coastal areas, the waves created could be forced into land, leading to flooding of such coastal areas. The storm surge that usually triggers the rise in sea levels normally last for a short time span, ranging from between four to eight hours period, though it

could take longer in some areas to revert back to its pre-storm levels (Ingirige & Amaratunga, 2013).

The direct and indirect effects of tsunamis and coastal flooding can amount to very huge economic damages. This can be seen in the effect the tsunami that hit the Japanese car producing industries. Other vulnerable areas to coastal flooding and tsunamis include South Asia, especially South-eastern part and Europe. The effect of coastal floods in terms of societal losses and occurrence time is global, cutting across both developing and developed countries simultaneously. For example, in 2004, the Tsunami that came from the Indian Ocean was triggered by one of the strongest earthquakes witnessed on earth, with its effects amounting to the death of hundreds of thousands of people cutting across fourteen countries plus other economic losses.

(iv) Pluvial Flooding

Pluvial floods, also known or referred to as overland floods originates from heavy rainfalls or melting of large droplets of snow, which land is unable to absorb, thereby causing the water to flow over urban land areas before reaching watercourses or drainage systems. It is a very common kind of flood in urban areas, as the land surfaces in such areas have lower permeability of water, making it difficult for enough rainfall water to be quickly absorbed, hence, leading to flooding. In unusually low-pressure areas, extreme weather conditions and summer storms could bring about fluvial floods. Normally, in such conditions, the rain water overpowers the existing drainage systems, flowing towards lowland areas. This kind of flood usually affects large areas of land over a long period of time, just as in the floods of 2007 that hit the Hull area in the United Kingdom. As extended rainfall water moved into earlier saturated landscape, it overpowered the drainage system there, resulting in the flooding of other areas outside the pluvial floodplains. Based on Pitts Review (2008), at least 50% of the 2007 floods in the UK happened outside areas mapped by the UK Environmental Agency as

floodplains, with pluvial floods accounting for around 60-70% of such areas. Urban areas along regions of tropical climatic conditions are also at risk of experiencing pluvial flood because in such regions, rainfall comes almost on a daily basis during the rainy season, though, might not be very heavy (Ingirige & Amaratunga, 2013). Usually, most of the affected areas by this flood type are areas considered to be socially deprived, of which the people living there, experienced huge economic losses. The best way to mitigate this kind of flood is through totally avoiding development/building in high risk areas. In addition, investments could be made in infrastructure such as drainage systems, innovative surface water management schemes and flood proof building designs (Villordon & Gourbesville, 2016).

2.2.6 Worldwide Records on Flood Disaster Occurrence

This sub-section presents statistics of flood disaster records globally over the period 1974 to 2003, obtained from the International Disaster Database (EM-DAT, 2014). All records included here only covers countries with records of not less than 10 deaths and 100 people affected in the population within the period. Other criteria used include a declaration of a state of emergency and a call for international support during the period under consideration. There are some unavailable records on floods specifically on the period before 1974, as well as on the exact days or months the flood event occurred. These records on flood disaster occurrence between 1990 and 2010 have shown an increasing trend over the last 30 years of the period (that is, from 1970 to 2010). These flood records were basically those of hydrological and meteorological origin.

In terms of economic losses, floods were on top of the list for Africa. This situation was the same for Europe, the Americas and to some extent, the Asian Continent. The figure below shows the present a pictorial view of the numerical statistics of the occurrences of flood disasters globally:

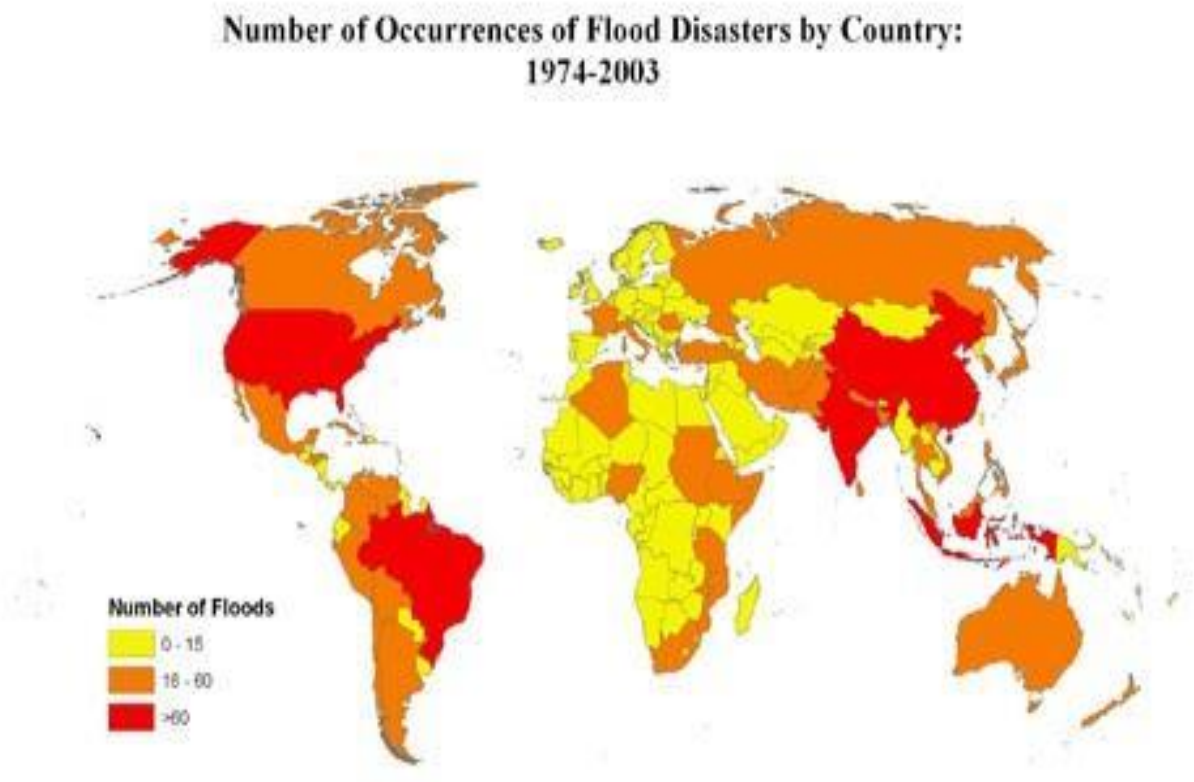

Figure 3: Flood Disaster Occurrence by Country (Source: Villordon & Gourbesville, 2016)

From figure 3 above, it can be observed that Nigeria falls among countries with frequency of flood occurrence within the range of 16-60 occurrences between 1974 to 2003. This is unlike its neighbouring countries (that is Niger, Benin, Cameroun, and Chad) whose frequency of occurrence lies between 0-15 occurrences within the period. In addition, the Latin and North American region, including other countries such as Afghanistan, Algeria, Australia, France, Italy, Iran, Japan, Pakistan, Russia, South Korea, Thailand, Turkey, Vietnam and some other African countries also fall within the group of countries with 16-60 flood occurrences. Lastly, countries like Brazil, China, India and the United States of America falls within the range with the highest number of occurrences (that is, above 60 occurrences) between 1974-2003 (Villordon & Gourbesville, 2016).

2.2.7 Community-Based Flood Risk Vulnerability (FVI) Methods and Framework

In the development and formulation of any Community-Based Flood Vulnerability index (FVI), the right way to go is to ensure that the key vulnerability indicators, such as; the physical environment, socio-economic and socio-demographic characteristics of the victims, housing conditions and the governance structure of the affected area are included in the framework. This framework should also include an assessment of the Knowledge, Attitude and Practices (KAP) of the affected population towards resilience and vulnerability to floods, as well as their exposure to diseases emanating from microorganisms (examples include Malaria/Fever, Diarrhoea and Leptospirosis among others). This is so because the conditions for such organisms to thrive and spread such diseases are usually made favourable during flooding periods. By so doing, the understanding of social vulnerability as well as public health risk is enhanced. In addition, the relationships and correlations between social vulnerabilities and risk indicators can be easily established (Villordon & Gourbesville, 2016). This will help re-direct attention of researchers to an area (that is, Social Vulnerabilities and Public Health Risks) which the literature has not paid much attention to. Normally, to capture these indicators properly, one must have these five (5) key ingredients or components in mind, that is; the economic, social, hydro-climatic, socio-behavioural and politico-administrative components. In the assessment of vulnerabilities to floods, three (3) main components must be looked at and assessed in the right order. The first assessment that must be made is to examine whether or not the affected area/community is 'exposed'. Secondly, questions must be asked to address issues relating to their 'susceptibility' to flooding and finally, addressing questions on their 'resilience' mainly through their knowledge, attitudes and practices (KAP) towards resilience to floods.

Since vulnerability is at the centre of the focus of this study, there is the need to conceptualize the concept within the context of hazards (in our case, floods). The vulnerability of a system

to a hazard/flood can be best understood through addressing the following questions: What are the nature and linkages between humans, their bio-physical environment and the processes within which the system operates? Are their disturbances and stressors that emanating from these processes and conditions? What is the level of the human and environmental exposure and responses to these stresses and conditions, in terms of their impacts, coping abilities, adjustments and adaptation strategies? These questions are very necessary to ask because our nonchalant attitudes and practices towards resilience can affect the susceptibility of the system, hence, this could change the entire system in such a way that it becomes very difficult for it to recover. Therefore, a conceptual framework based on Turner et al., (2003) appears to be suitable for understanding the structure of a Community-Based Flood Vulnerability Framework as shown in the figure below:

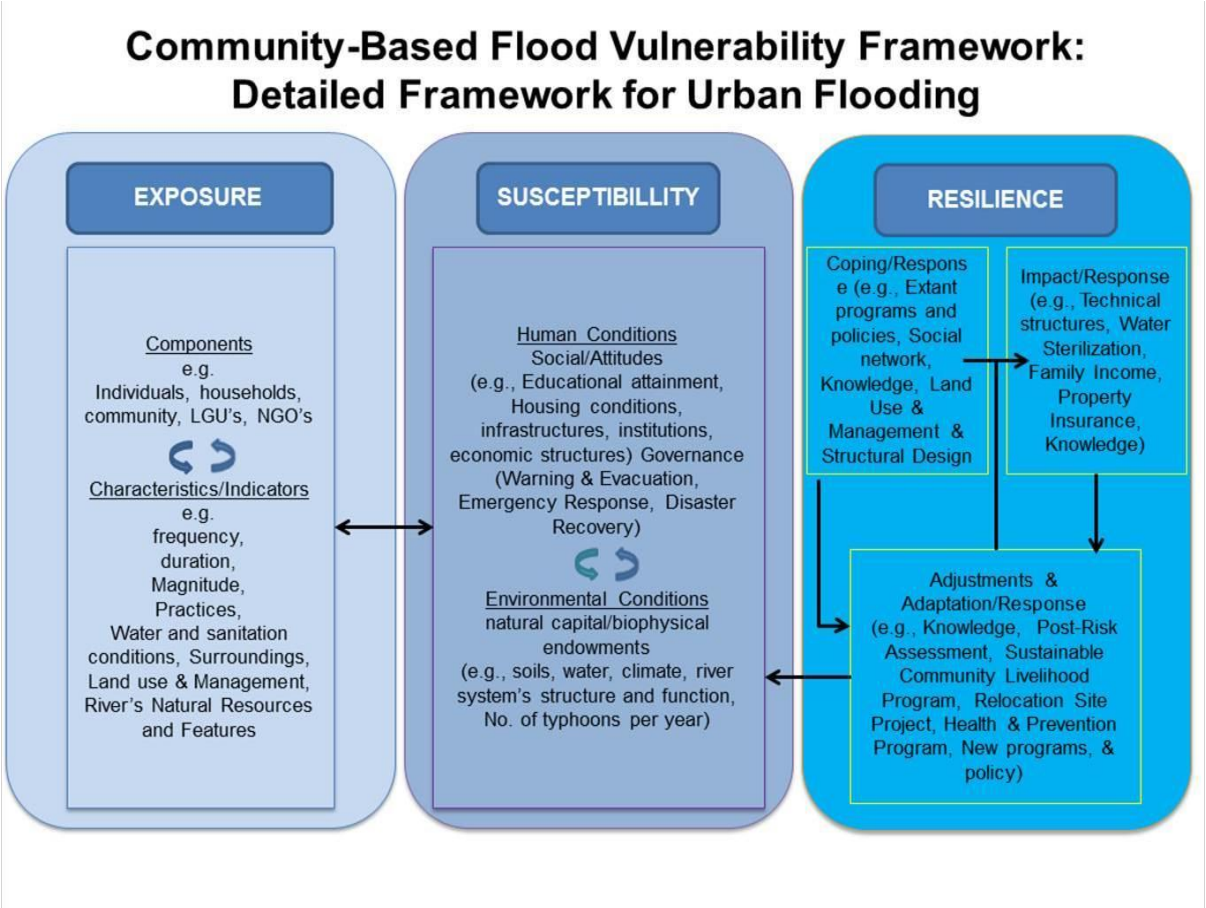

Figure 4: Sustainable Community-Based Flood Vulnerability Framework (Source: Turner et al., 2003)

Looking at Figure 4 above, the various vulnerability indicators (that is, within the scope of the concept of exposure, susceptibility and resilience) and components (such as economic, social, hydro-climatic, socio-behavioural and politico-administrative) were appropriately captured in the diagram.

2.2.8 Factors and Components Responsible for Vulnerability to Floods

This sub-section provides a detailed description of flood vulnerability factors (which includes the components and indicators of flood vulnerability earlier outlined). Furthermore, it explains the interaction between vulnerability component and the vulnerability indicators, and how their relationship affects vulnerability to floods generally. In other words, it looks at the interchange and relationship between them, in terms of the effect or impact of the vulnerability components on the vulnerability indicators. We start by conceptualizing the three (3) important vulnerability indicators, that is, exposure, susceptibility and resilience within the context of vulnerability.

Simply put, Vulnerability can be explained as the degree of damage or destruction which should be anticipated under any given conditions of exposure, susceptibility and resilience. To bring the above explanation within the context of floods, A system is said to be 'Susceptible' to floods as a result of 'Exposure', combined with the system's ability/inability to cope, to adapt, to recover and to be resilient to a great extent. For example, it is possible to find some structural and non-structural measures put in place as strategy for promoting resilience, to protect an initially exposed population, from an imminent flooding situation (Villordon & Gourbesville, 2016). Conversely, we could find an exposed population with little/weak or no flood defences, with such exposed population more prone to flooding, and the resultant loss of life and economic losses emanating from its destructive effects (Balica, Wright & van der

Meulen, 2012). However, in the literature, researchers see vulnerability as the outcome from the interaction among the three categories of the above-mentioned indicators (that is, exposure, susceptibility and resilience). In other to help in identifying the strength and weaknesses of a given community, in terms of obtaining facts about their level of vulnerability to flooding and to help come up with recommendable policies, as well as prioritizing those that matters most, it is necessary to divide the flood vulnerability index into different components, (that is, economic, social, hydro-climatic, socio-behavioural and politico-administrative), and further relating them with the factors of vulnerability (that is, exposure, susceptibility and resilience). Furthermore, the indicators used in the study design for this research is a modified version of that developed in the World Risk Index Report and the work on Flood Vulnerability Index for Coastal Cities, developed by Balica, Wright & van der Meulen, (2012). This is so because these works failed to include global scale indicators such as property insurance, social networks, early warning mechanisms, exposure to air and water borne diseases triggered by microorganisms during flooding and important aspects of Knowledge, Attitude and Practices (KAP) of households on flood resilience. Others include questions on available strategies for adaptation like the incorporation of post-risk assessments, health programmes for the prevention against the spread of air and waterborne diseases, relocation projects, etc., all of which can be facilitated through cooperation between local authorities, Non-governmental Organizations (NGOs) and the Private Sector.

2.2.9 Exposure, Susceptibility and Resilience

The concept of *exposure* as applied within the context of this study relates to material objects and entities situated in an environment, which are prone to the effect of a disaster or hazard event. Among these entities include people, infrastructure, goods and services, ecosystems, production activities and socio-ecological systems (Villordon & Gourbesville, 2016). In other

words, the likelihood of these entities being affected by all forms of floods implies *exposure to flooding*.

Susceptibility to floods relates to the level of awareness and preparedness, that is, before the flood event, and the ways of coping and handling shocks during flooding. In clearer terms, *susceptibility* denotes the possibility to suffer damages or harm when a climate-related hazard (such as flooding) occurs. In this case, the focus is more on people's socio-economic attributes and the system under which these activities thrive. Such attributes include individuals' level of education, their conditions of housing, their occupation, attitude towards flood risk before the occurrence of the flood, the existence of institutions saddled with the responsibility of mitigating floods, existence of early warning systems and flood maps for use during flood periods (Villordon & Gourbesville, 2016). These susceptibility indicators are necessary for evaluating the sensitivity of exposed the elements listed under the discussion on the concept of exposure.

The concept of resilience has been discussed in details in the earlier chapter of this work. The key highlights in the definition are the capacity of a system to cope, resist, learn, transform and retain its existing functions after a flood disaster. The analysis of resilience can be better done through the evaluation of the economic, political, environmental, administrative and social organizational setup of the affected area (Di Mario, 2006). In addition, proper assessment of the adaptive capacities and coping abilities of individuals, in terms of government's contribution to reducing the spread of diseases and the impact of flood disaster on people in the affected area is very important (Villordon & Gourbesville, 2016).

2.2.10 Hydro-Climatic Factors

The hydro-climatic component constitutes a part of hydrological system, as well as the climate or meteorological system. Within the context of flooding, factors such as rainfall patterns, the number of houses penetrated by the flood water, the height of the flood water

(measured in terms of the level the water reached using the parts of the human body, that is, ankle, knee, waist, shoulder level, etc.) and the rate of recurrence (measured on a monthly, half year, yearly basis, etc.) of the flooding in the geographical area, the location of houses (whether in elevated areas, riverine areas or waterlogged areas or otherwise), etc., all fall under the hydro-climatic elements. These factors are also called *exposure factors of vulnerability* (Villordon & Gourbesville, 2016).

2.2.11 Socio-Behavioural Factors

This component is very important in the assessment of vulnerability to flood disasters, even though, they are often not captured in most studies in this area. The component is concerned basically with the assessment of household's knowledge, attitude and practices (KAP) towards resilience to floods. Their knowledge on resilience to floods is assessed in the area of their understanding of hazard risks, exposure, preparedness, response, recovery, organization and strategies to adaptation. Also included is their knowledge of the nature, outbreak and prevention of waterborne diseases and other forms of disease exposure during flooding (that is, malaria, diarrhoea, etc.). It also includes their perceptions about some of the exposures they face during flooding (Villordon & Gourbesville, 2016).

2.2.12 Economic Factors

The economic components focus on the financial and economic status of households within the socio-economic structure they find themselves. This economic factor determines to a large extent, the ability of households to cope in the face of a flood disaster and their level of vulnerability to such disasters. Household vulnerability varies according to their economic status. Factors such as households' income, housing conditions (in terms of the materials used to build their houses), property insurance status, sources of water consumed (or access to clean water and sanitation facilities and cleanliness of their environment are all included in

the economic components, most of which constitutes exposure factors (Villordon & Gourbesville, 2016).

2.2.13 Politico-Administrative Factors

This is one of the most important components in any disaster vulnerability assessment. Here, land use management practices and structural design of buildings and infrastructure is very important. In addition, other considerations include institutions, laws and regulations relating to town/city planning, level of household compliance and the extent to which these laws are enforced. It is also very important to find out if risk and hazards reduction component is included in the structural design of the area, especially when the area falls within locations identified to be of high risk to floods. Also included is the assessment of available critical infrastructures such as drainages and their capacities, efficiency of dikes and bridge systems, the number and types of available water retention basins, etc., (Villordon & Gourbesville, 2016). There is also a need to assess the synergy/partnership between local government authorities (LGA's) and the private sector, authorities at state and national level as well as Non-governmental Organizations (NGOs) in flood disaster risk reduction, management and mitigation. This is very important because it could tell a lot about the vulnerability of the given geographical area. Governance structure in the area of emergency response, evacuation services, health services, community development policies and implementation in the area of flood management and mitigation needs to be given priority. The extent of vulnerability to the impact of flooding on the affected area is significantly influenced by the government's risk reduction efforts. Lastly, the level of awareness and information available to members and leaders of affected communities on flood hazards and risks, and how they utilize this

information in decision making are very important components of post-risk assessment (Villordon & Gourbesville, 2016).

2.2.14 Disaster Risk Management (DRR), Disaster Risk Reduction in the Context of the Hyogo Framework of Action (HFA) and the Sendai Framework (SF)

The concept of Disaster Risk Reduction (DRM) and Disaster Risk Reduction (DRR) has evolved overtime as systematic approaches meant to lessen climate change impacts on built environment (Etinay, Egbu, & Murray, 2018). According to the UNISDR, Disaster is defined as 'a serious disruption of the functioning of a community or a society at any scale due to hazardous events interacting with conditions of exposure, vulnerability and capacity, leading to one or more of the following: human, material, economic and environmental losses and impacts', including the physical and social scale of disasters impacts, and further highlighting the differences between actions related to emergency response and recovery (UNISDR, 2016).

Again, in the views of the United Nations Office for Disaster Risk Reduction (UNISDR), disaster management covers a number of activities falling within the confines of organization, planning and application, which tackles measures relating to disaster preparation, response and recovery (UNISDR, 2016). The concept of DRM became prominent in the early 1960s and took full effect after the Bayan-Zara earthquake which struck Iran, killing over 12,000 individuals. This was followed by the establishment of the United Nations Disaster Relief Office (UNDRO) by the United Nations General Assembly (UNGA). The UNDRO was tasked with the responsibility of encouraging studies on natural disasters, including preventing, controlling and predicting natural disasters with the sole aim of advising governments on pre-disaster planning activities. It was until the period between 1990-1999 that the UNGA formally recognized the need to reduce the impact of disaster on people globally, with specific attention given to developing countries. This period was tagged 'the International Decade for Natural Disaster Reduction' (UNISDR, 2015). It was in the 2000s

when it became necessary to establish early warning systems that focus formally shifted from DRM to DRR, that is, after the establishment of the International Disaster Strategy for Disaster Reduction (ISDR). Following this, the Hyogo Framework for Action (HFA) was endorsed by the UNGA. This was a ten (10) year implementation plan (2005-2015) for countries, meant to ensure we live in a safer world from natural disasters. The framework outlined what should be done by different actors in different sectors to reduce losses from disasters. Inherent in the HFA are five priorities for action, with guiding principles and practical ways of achieving resilience to disasters. In other words, the gaol is to reduce losses of lives, as well as losses to environmental, social and economic assets from disasters in large scales (particularly, earthquakes and cyclones). However, the HFA was deficient in the sense that it did not capture the underlying risks inherent in small scales disasters such as physical damages and economic losses from floods, landslides, etc, most of which results from poor urban planning and governance (Etinay, Egbu, & Murray, 2018).

Both DRM and DRR recognizes two forms of risks respectively: acceptable risk and residual risk. Acceptable risk in the context of DRM is ‘used to assess and define the structural and non-structural measures needed in other to reduce possible harm to people, property, services and systems’ (UNISDR, 2016). On the other hand, residual risk is related to DRR sequential risks ‘that remains even when effective disaster risk reduction measures are in place, and for which emergency response and recovery capacities must be maintained’ (UNISDR, 2016). The Sendai Framework for disaster risk reduction (SFDRR) was later launched following the shortcomings identified in the HFA, and this marked the proper transformation from disaster management to disaster risk reduction. This was necessary because the Global Assessment Report on Disaster Risk Reduction in 2015 pointed out that ‘most resources continue to be invested in strengthening capacities for disaster management, and there has been limited success in applying policies, norms, standards and regulations to manage and reduce risk

across development sectors' (UNIDSR, 2015). To summarize, we identify the relationship and differences between DRM and DRR strategies. First, it important to note that social factors influence preparedness factors, and these social factors may differ according to management agencies and the collective behavioural pattern of a given community (Kirschenbaum, 2002). Hence, the major link or similarity between DRM and DRR measures is 'preparedness'. However, a number of differences can be seen between the two measures. While in addition to preparedness, DRM, covers financial protection, risk identification and risk reconstruction/resilient construction, DRR on the other hand, entails risk mitigation, risk prevention and transfer of the essential risk elements. Hence, preparedness in the context of building urban resilience entails 'enhancing disaster preparedness for effective response and to "Build Back Better" in recovery, rehabilitation and reconstruction' (UNIDSR, 2015). This implies that disaster preparedness here, gears towards achieving one the Sustainable Development Goal (SDG) target (2015-2030) of 'building urban resilience to disasters' is in line with the guidelines of the Sendai Framework for Disaster Risk Reduction (SFDRR) as shown in Figure 5 below.

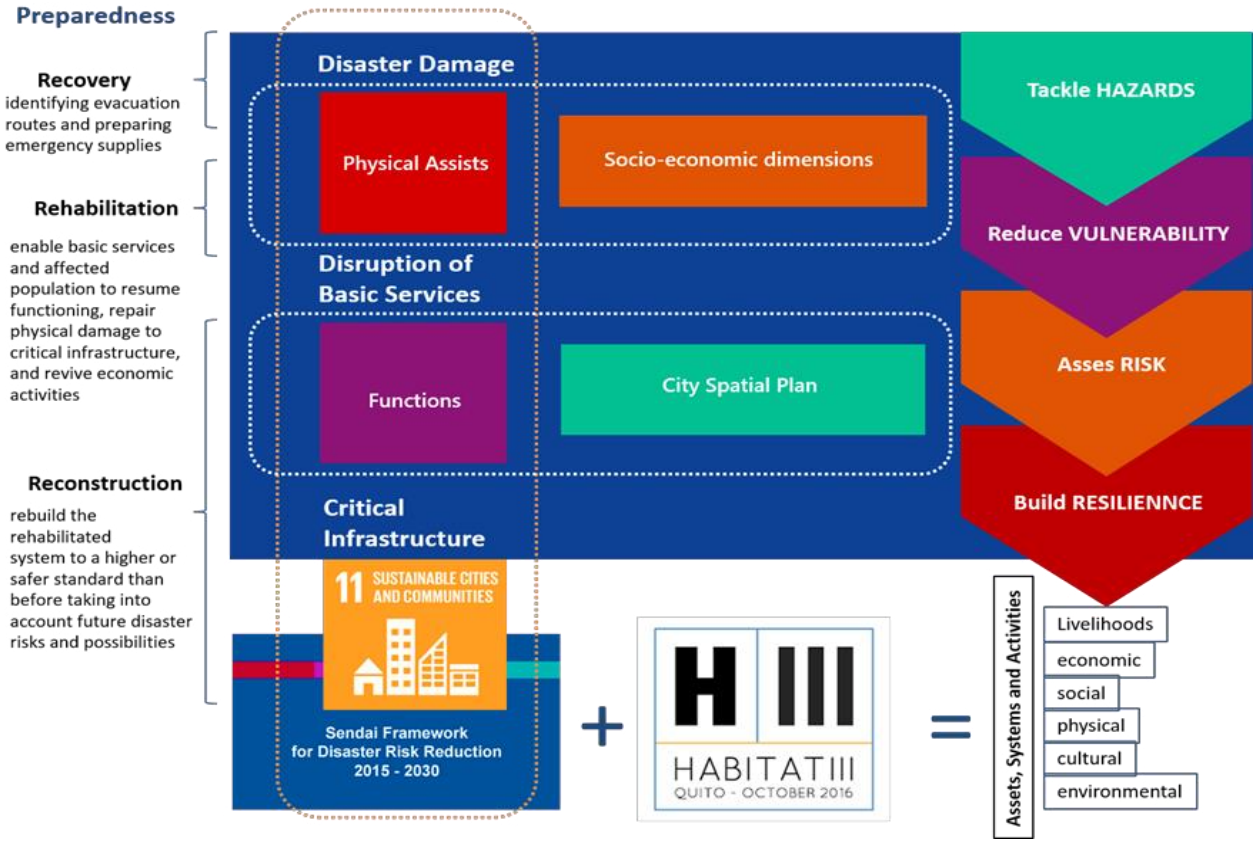

Figure 5: Preparedness for Building Urban Resilience in the SDGs and SFDRR 2015-2030 (Source: Etinay, Egbu, & Murray, 2018).

2.3 Theoretical Literature Review

2.3.1 Sustainable Livelihoods Framework in the Context of Building Resilience to Floods

One of the theoretical frameworks used to explain vulnerabilities to climate-induced floods within the scope of building households' resilience to such catastrophes is the 'Sustainable Livelihoods Framework (SLF). The question to ask here is what is the framework all about and how does the framework work?

The sustainable livelihoods framework is an asset/capital-based model whose primary target is to advance the utilization of fundamental resources base and capabilities in a sustainable manner, geared towards the total eradication of poverty. The model describes the form of assets (capitals) that are critical to enhancing the abilities of individuals or households to cope with stresses and shocks arising from the occurrence of climate-linked disasters (such as floods), in such a manner they will retain their existing and future capacities, as well as their

means of sustenance or livelihood (same as building resilience to floods). This framework was structured based on the recognition that individuals or households possesses certain abilities needed to acquire sufficient amount of assets which they can build upon, to ensure regular and long-term support of the needs of their families, in addition to improving their wellbeing. As defined by DFID (1999), A 'livelihood' is made up of an individual's assets, capabilities and activities essential for his/her survival. Therefore, a livelihood is said to be sustainable when it has the capacity to help the individual cope with and recover from stresses, including shocks (specifically, climate-induced flooding), thereby allowing such an individual to maintain and/or improve on his/her current and future capabilities and assets, without necessarily compromising the natural resource base.

Furthermore, this framework is people-centred (focuses more on people that the resources they use), holistic (integrates the understanding and realities confronting all the relevant stakeholders), it is dynamic (since peoples' livelihood and the institutions that moulds their lives are very dynamic) builds strengths of individuals (that is, it identifies the potentials in them, needed to be improved and remove constraints to its development), provides links between micro-level realities and decision making process at the macro-levels (that is, it bridges the gap between these two levels) and finally, drives towards sustainability (that is, builds resilience to shocks). In summary, the key elements of the SLF can be concisely put below as follows:

"… The framework depicts stakeholders as operating in a context of vulnerability, within which they have access to certain assets. Assets gain weight and value through the prevailing social, institutional and organizational environment (policies, institutions and processes). This context decisively shapes the livelihood strategies that are open to people in pursuit of their self-defined beneficial livelihood outcomes." (Kollmair et al., 2002).

From the above summary, one can identify five (5) key elements contained within the SLF. These elements include: the 'vulnerability context', 'livelihood assets', 'policies, institutions and processes', 'livelihood strategies' and 'livelihood outcomes.

The vulnerability context boarders around looking at the nature and trends of shocks and seasonality (climate change and/or climate variability) that surrounds the external environment people live in. These shocks could have negative effect (by way of bringing harm) on the livelihoods and the general availability of assets to households or people, thereby reducing their capacity to effectively respond to such shocks (increasing their vulnerability or reducing their resilience). As for the livelihood assets, they are made up of the various forms of capitals upon which livelihood depends on, namely; social capital, human capital, natural capital financial capital and physical capital. The relevance of policies, institutions and processes cannot be overstressed here. This is so because they determine the access to the available capital types, the terms within which these capital forms should/can be exchanged, livelihood strategies and the returns accruing to any form of livelihood strategy. They determine peoples' feelings, in terms of their self-esteem and level of participation in relevant decision-making procedures (DFID, 1999). Furthermore, livelihood strategies present the various activities and choices people have to make in the course of trying to accomplish their livelihood goals. Since people who are poor have to compete to meet their livelihood goals, an individual's livelihood strategy may likely have a positive or negative impact of that of another. Lastly, livelihood outcomes are those successes or results from the livelihood strategy adopted by a household. This could be in the form of increased incomes, increased resilience/reduced vulnerability, increased food security and the attainment of sustainability in the use of natural resources.

In summary, with frequent climate change or climate variability, there is the tendency of experiencing increased flood events. Since such catastrophes usually have strong destructive

capacity, assets (capitals) are usually lost in the event they occur. These lost capitals will directly or indirectly affect households' means of livelihood. Such already exposed households will become more susceptible to flood as time goes on (in the near future). This situation will imply increase in vulnerability and hence, reduced resilience capacity to respond to shocks from floods. This is where the application of the SLF becomes very relevant, as there will be need to put all necessary mechanisms in place to replace those lost capitals (assets) and make households more resilient to future flood episodes when they occur. Below are two diagrams that presents a clearer picture of the workings of the SLF. The first figure (Figure 6) shows the structure of the SLF, particularly focusing on its five (5) key components. The second figure (Figure 7) presents a decomposition of the five (5) important livelihood assets upon which households rely on to make a living.

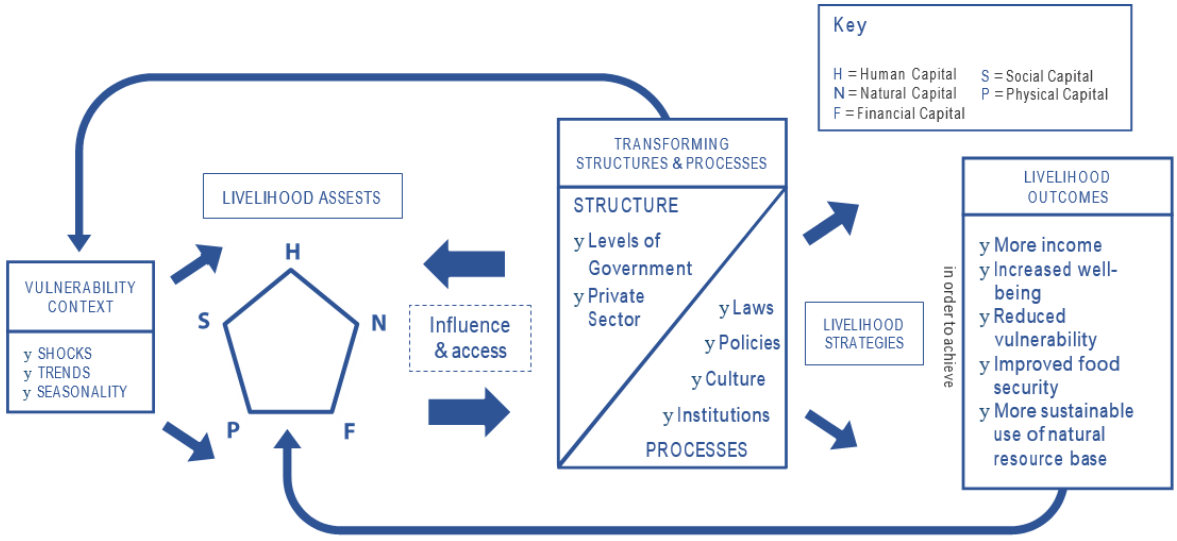

Figure 6: Sustainable Livelihoods Framework (Source: DFID, 1999)

Figure 7: Livelihood Assets (Source: DFID, 1999)

This framework became necessary owing to the fact that most countries within the African continent rely so much on natural resources (mostly of non-renewable sources) for survival. These resources are depleted so much in such a way that nothing may be left for the future generations to use. This necessitates the urgent need for diversification in the use of such resources to ensure sustainability and continuity of development in our society, considering our population growth rate and seasonal shocks (health issues, vulnerability of prices due the effect of climate variability on agricultural outputs, floods, etc.) we face. This is vital to helping boost the coping and adaptive capacities of people (Cahn, 2002). Worthy of note is that the SLF like other developmental frameworks, has its own merits and shortcomings. The SLF framework have a wide application within the local context of developmental activities.

Hence, it can be used as a criterion for assessing suitability of any developmental activity targeted at alleviating the conditions of the poor and vulnerable in our society (Kollmair et al., 2002). It is also dynamic, such that it could fit into the developmental plans of any government without going contrary to it, given that it is people oriented, including the participation of the affected population in the decision-making processes.

However, the SLF has been faulted in relation to presenting the complexity of livelihood systems in a very simple manner (Cahn,2002). This will possibly conceal the relative importance of the key factors identified in the framework as well as the links between them. This is so because for proper implementation of the framework, it requires a lot of time, human and financial resources commitment, in which most developmental projects don't have enough of such to be executed. Also, because the SLF is so much household based, the link between local level institutions/policies and those of other level (state, national and global) becomes very difficult to understand (Clark & Carney, 2008). Others see this framework as overambitious, failing to integrate culture, tradition and gender into the model, all of which have strong influence on the livelihood options and activities of people (Cahn, 2002).

2.3.2 Hypotheses on Climate-induced Disasters (Floods, Cyclones, etc)

The conception that climate-induced disasters could possess the capacity to have a long-term effect on income per capita remains unclear to some extent, because it is often assumed that these disasters provoke more responses on economic fundamentals in a manner distinct from human-caused disasters at the macroeconomic level (such as the financial crisis). With the nonappearance in the literature of a clear empirical evidence in this regard, based on existing literature, there is a consensus among economist on four (4) contending hypothesis which explains the manner in which economic output and income may respond to such climate-linked/natural disasters in the long-run. This is so because there exists no study that have convincingly proved wrong any of these hypotheses, though, what will become of the actual

behaviour of economies when such disasters occur remains uncertain (Field et al., 2012). It is important to note that these hypotheses explain the effect of climate-induced disasters on growth and incomes more at the macroeconomic level than at the microeconomic level as discussed below:

(i) ***The 'Creative Destruction' Hypothesis***: This hypothesis contends that climate-induced disasters may promote growth in output/income of economies provisionally, since the affected population will make efforts to replace assets/capital lost emanating from the occurrence of such disasters through increasing their demand for goods and services. In addition, following the occurrence of these disasters, growth may be induced as a result inflow of international aids and assistance (Skidmore & Toya, 2002). This proposition can be traced to what is often observed in terms of a short-term increased outputs among construction industries, in a post-disaster situation (Belasen & Polachek, 2008; Hsiang, 2010; Deryugina, 2011; Hsaing & Jina, 2014). However, it is unclear if this temporary effect of these catastrophes on this single sector will translate into impacting on the wider economy in the long-run.

(ii) ***The 'Build Back Better' Hypothesis***: This hypothesis begins by arguing that there may be an initial and temporary decline in economic growth, due to loss of valuable/productive capital and human lives from the destructive effect climate-induced disaster. However, there may be a later positive net effect in the form of increased growth in the long-run as gradual effort is made to replace lost capital (assets) with newly modernized ones, since those capital damaged during the disaster may have depreciated or could be old-fashioned and obsolete, hence, formerly producing below efficiency (Cuaresma, Hlouskova & Obersteiner, 2008; Hallegatte & Dumas, 2009). This proposition could be considered valid in a given situation where firms don't upgrade the efficiency of their capital(machines), as such, the benefits accruing from upgrading capital after the occurrence of a climate-related disaster is greater than the loss in productivity emanating from such disaster in the long-run.

(iii) ***The 'Recovery Trend' Hypothesis***: In the case of this third hypothesis, the argument is that normally, after the occurrence of such climate-induced disaster, the economy should experience a very limited period of decline in growth/income. However, this period should immediately be followed by a high-level and abnormal increase in growth, thereby making income levels to revert back to its pre-disaster level/trend. This hypothesis argues that since the occurrence of such catastrophes tend to increase mortality and loss of wealth (capital), this gives rise to increased scarcity of capital and labour, hence, with scarcity present, the rebound in growth should happen, as there will be an increase in the marginal product of capital. This increase in the marginal product of capital will continue until output growth returns to its normal trend (Yang, 2008; Strobl, 2011). Mixed empirical backings have been found regarding this underlying assertion. On the one hand, while some studies were able to show that climate-induced disasters lead to transfer of wealth (capital) into areas affected (Stromberg, 2007; Yang, 2008; Deryugina, 2011), others (Smith et al., 2006; Vigdor, 2008; Belasen & Polachek, 2009; Strobl, 2011; Hornbeck, 2012; Boustan, Khan & Rhode, 2012; Bohra-Mishra, Oppenheimer & Hsiang, 2014) have found zero net migration, implying that the outflow of population from the affected area and the later inflow of population into the affected area is the same. Hence, the long-run net effect of these relocations of the population and capital (wealth) on growth remains unidentified.

(iv) ***The 'No Recovery' Hypothesis***: Finally, the last hypothesis posits that climate-induced disasters brings about declines in economic growth, and this could be through the direct destruction of productive capital or through an indirect destruction of tangible consumption good (such as buildings). This is so because such destruction of tangible capital good and consumables will bring about the diversion of funds meant for productive investments into several recovery mechanisms put in place by authorities. However, because the benefits accruing from such recovery mechanism always fall short of the direct negative effect of the

loss of capital, the economy never recovers from shock arising from the disaster (Field et al., 2012. However, it is important to note that, if the aftereffect of the disaster is such that a decline in consumption ensures that the marginal utility of consumption increases sufficiently to make the post-disaster consumption more preferable compared to the intended investment in capital, then it is better to intensify efforts in investing more on the recovery mechanisms (Anttila-Huges &Hsiang, 2013). In summary, this hypothesis implies that output may continue to grow slowly after a disaster, but this growth will be lower than its trajectory before the occurrence of the disaster. Figure 8 below summarizes the discussion on the four (4) hypotheses.

Since the only way to recover from climate-induced disasters (such as floods in our case) requires putting all relevant recovery measures in place to replaces lost capital, with the sole aim of reducing households' vulnerability to future flood episodes and ultimately, strengthening their resilience, any of the four situations explained above from the four (4) hypothesis discussed could be obtainable in the long-run when efforts are made to invest in lost capitals (assets). Hence, all four (4) hypotheses becomes relevant also in explaining the outcomes of recovery mechanisms put in place to reduce vulnerability and building resilience to floods. This suggests that collectively, the four (4) hypothesis could form the theoretical framework of this study.

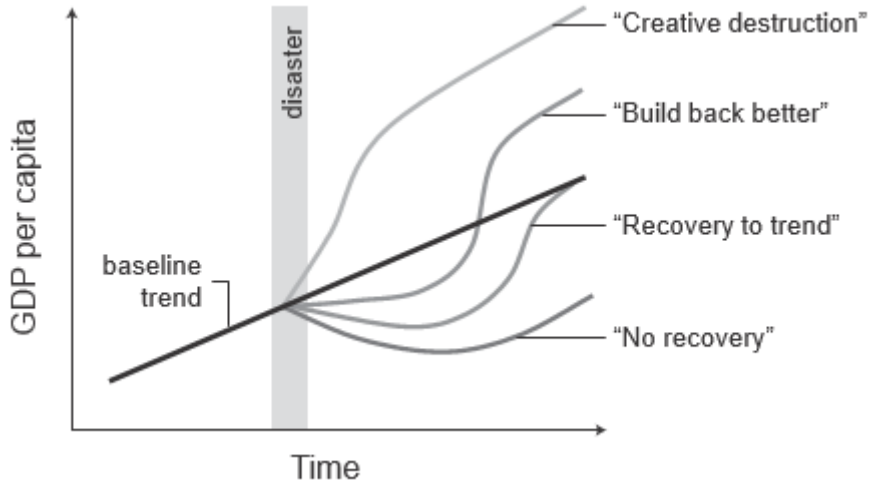

Figure 8: Long-run Changes in GDP per Capita in the Face of Climate-induced Disasters (Source: Hsiang & Jina, 2014)

2.3.3 Decision Making/Choice under Climate Risk and Uncertainty

The purpose of this sub-section is to concentrate on important decision-making frameworks relevant to households in terms of serving as a guide to making choices in the face of climate-related disasters or natural disasters as the case may be. Since climate variability constitutes a major source of risk to households' socio-economic activities (that is, investment, production, employment, etc.), relevant theoretical issues highlighting the role of risk and uncertainty in shaping household's decision making when faced with climate shocks and other related climate disaster impacts become necessary.

In agricultural production for example, depending on the past yield and output experienced, climate variability and climate change negatively affects output, bringing it below optimal levels. In Nigeria for example, the Sudano-Sahelian region (comprising States like Borno, Jigawa, Kano, Katsina, Kebbi, Sokoto, Yobe and Zamfara) has been identified as one of the regions experiencing the highest form of climate variability in the country (Ati, Iguisi & Afolayan, 2007). This is so because the region is frequently faced with several alterations in

key meteorological variables (rainfall and temperature) and the trend of these alterations have continued. With these continuous alterations, the production of crops will continue to come under increased climate risks. In addition, increased risks increase farmers uncertainty about future prices, their choice of what to produce and on the effects of government policies on production and commodity prices (Oladipo, 1993; Ojoye, 2008).

The concept of *risk* is normally related to *uncertainty*, because there can be no uncertainty without risk. In other words, risk breeds uncertainty about future outcomes and decision-making processes. Knight (1921) was one of the first authors who attempted to make a distinction between risk and uncertainty. According to him, while *risk* on the one hand suggests having information (knowledge) on the probabilities of an event occurring, *uncertainty* on the other hand denotes an uncertain outcome about an event for which the probabilities of its occurrence are not known. In the literature, many writers have found it more convenient to view *risk* as a form of exposure to an uncertain or potentially negative economic consequences, while *uncertainty* is viewed within the realm of having imperfect knowledge (Hardaker, 2004). However, both concepts are interchangeably used in practice because they are closely linked to each other. While *risk* places more emphasis on the use of probabilities to explain situations within an environment, *uncertainty* focuses more on the possible negative impacts of the event on the welfare of households. It must be re-emphasized that there can be no risk without uncertainty and vice versa, because most uncertainties generally indicate some level of risk. It becomes paramount here, to comprehend how weather and climate risk affects households' production decisions (Moschini & Hennessy, 2001).

Good decisions require good information. Where information is poor, decision and their outcomes are also likely to be poor. We base our present decisions on past events and future expectations. For example, purchasing durable goods (such as stocks, insurance, etc.) involves uncertainty. One may take risk to buy such assets based on expectations that the future prices

of these assets will increase. But the truth is that such individual is uncertain about whether or not the asset prices will rise or fall in the future. Here, information is key, and the decision to take risks depends also on the individual's attitude towards risk. Individuals have been classified into three (3) categories, based on their attitudes towards risk: that is, (risk neutral, risk loving and risk averse individuals (Sloman & Garratt, 2010). As for the *risk neutral* individual, he will only take a risk to invest in an asset if he is sure the payoffs are favourable and vice versa. If the payoffs are fair or even, he will be indifferent as in, whether to invest in the asset or not. When the individual is willing to invest in an asset even if he knows that the payoffs appears unfavourable, such an individual is a *risk lover*. However, for the last category, that is, a *risk averse* individual, he is one such that he may be unwilling to invest in an asset, even though the payoffs appear to be unfavourable. All these choices are based on assumption that these individuals have complete information about the investment, on which they base their decisions. But in reality, most of the time, we do not know for sure what the payoffs of an investment decision will be in the future. Hence, a utility maximizing individual tends to be *risk averse*. Because of the uncertainty surrounding future payoffs, *risk averse* individuals are usually willing to pay a premium (an additional cost which could be in the form of an insurance) to cover for possible expected future losses, even if the amount they will pay as premium is likely to be higher than their expected future losses (Sloman & Garratt, 2010).

According to von Neumann-Morgenstern (1944), under the assumption of rationality and a well-defined utility function over the payoffs of the individual choices, a *risk averse utility maximizing* individual (or household) head will only invest in an asset if the utility derived from such investment is greater than the expected outcome from his decision to invest. Following this framework, under conditions of weather or climate uncertainty, investment in assets should be lower for a *risk averse* individual compared to other categories of individual

risk preference type. A *risk* averse individual or investor is unwilling to take a stake in an investment which is *actuarially fair*, even under conditions of certainty about its payoffs (Arrow, 1970). As risk conditions changes, they adjust their investments to the observed changes (Jemaa & Mekki, 2007).

2.3.4 The role of Information under Climate Disaster Risk and Uncertainty

When a climate-related natural disaster (such as flood, cyclones, etc.) strikes, the will be need for information about the level and extent of the damages suffered by individuals or households within the said geographical area. This is necessary for resource mobilization and distribution as a form of emergency response to alleviate the plights of the victims. Yet, in such situations, available information is usually limited, or sometimes incorrect and in other instances, cooked up, depending on the devastating nature of the post-disaster condition of the affected area. In such a condition, one is faced with *uncertainty of information*, which could possibly result in further distortions in decision making and economic activities as well. It is not surprising that that only few studies in the literature had integrated information on uncertainty and its effects in their works, despite its relevance in economic analysis (Okuyama, 2003).

One of the criticisms of Knight's distinction of *risk* and *uncertainty* is that his view depends on that ability and inability of an economic agent to assign mathematical probabilities to the randomness of an event. Hence, both concepts have been argued by many economists to be the same looking at it from Knight's view point. (http://cepa.newschool.edu/het/home.htm). In their own view, they see uncertainty as a *knowledge problem*, that is, about the relevant probabilities. This disagreement has divided economist into two schools: the risk schools (that is, holders of the von Neumann-Morgenstern expected utility theory) and the uncertainty schools, that is, holders of Arrow (1973) and Debreu (1987) State-preference approach. However, there is no contention in the disaster literature regarding the definition and

application of risk and uncertainty. In disaster situations requiring emergency response actions, uncertainty has been applied to guide decision making as well as analysis (see, Dacy & Kunreuther, 1969). Their analysis highlighted the problem of information and communication gap, which is actually the key factor behind the existing uncertainty after a disaster.

On the contrary, the Knightian approach is a risk model which relies on the use of objective probabilities, in addition to Savage's (1972) expected utility approach which is based on the use of subjective probabilities. The only issue is that both the risk-based and uncertainty approach did not explain how the probabilities used were arrived at or determined. In Oppenheim's (1980) application of risk and uncertainty, he viewed or used uncertainty to explain a situation trigged by a disaster. As for risk, he sees it as the probabilistic occurrence of a specific damage due to a disaster. In his view therefore, uncertainty is a wider definition of risk. Some other economists have obtained the expected utility derived from decision-making in a disaster situation using risk as the probabilistic occurrence of a disaster (see, Boisvert, 1992; Roth & Kunreuther, 1998). Their focus in this case was more on the pre-disaster situation, with key concentration on disaster risk management and disaster insurance. They were not concerned about the uncertainty created in a post-disaster scenario. In summary, damages faced during a disaster period is referred to as *risk* while *uncertainty* is the situation created after the disaster has occurred, for which probabilities cannot be assigned. This implies that in the long-run, as uncertainty diminishes, there will be an increased availability of credible information about the extent and cost of damages, as well as recovery plans. This is not to say that there exists no uncertainty before the occurrence of the disaster. It may exist at a very superficial level. However, the occurrence of the disaster tends to increase the existing uncertainty during the pre-disaster period (Okuyama, 2003). How long the uncertainty will last depend on the extent of the damages to capital stock and labour.

Other factors such as recovery priorities, damages to other places and release timing of the recovery plan determines the speed of the decline in uncertainty. Just as it is difficult to quantify uncertainty using objective mathematical probability, it is even more difficulty to measure using subjective preferences (Okuyama, 2003). The figure below (figure 7), explains the state and behaviour of uncertainty before, during and after the occurrence of a disaster.

Post-disaster uncertainty usually brings about distortions in economic activities especially in the area of production planning (Okuyama, Hewings & Sonis, 2004). In other to properly cope with uncertainty and to ensure pre-disaster preparedness, the importance of information cannot be overemphasized. More so, there is need to incorporate the effect of uncertainty in the evaluation of the economic impacts of a disaster. This is so because the non-integration may negatively affect decision making on economic activities and recovery plans/efforts, since uncertainty may generate additional distortions in the economy. There is also for studies on disaster to integrate behavioural changes, such as changes in consumption patterns and cooperation (assistance) in their recovery plans (Okuyama, 2003).

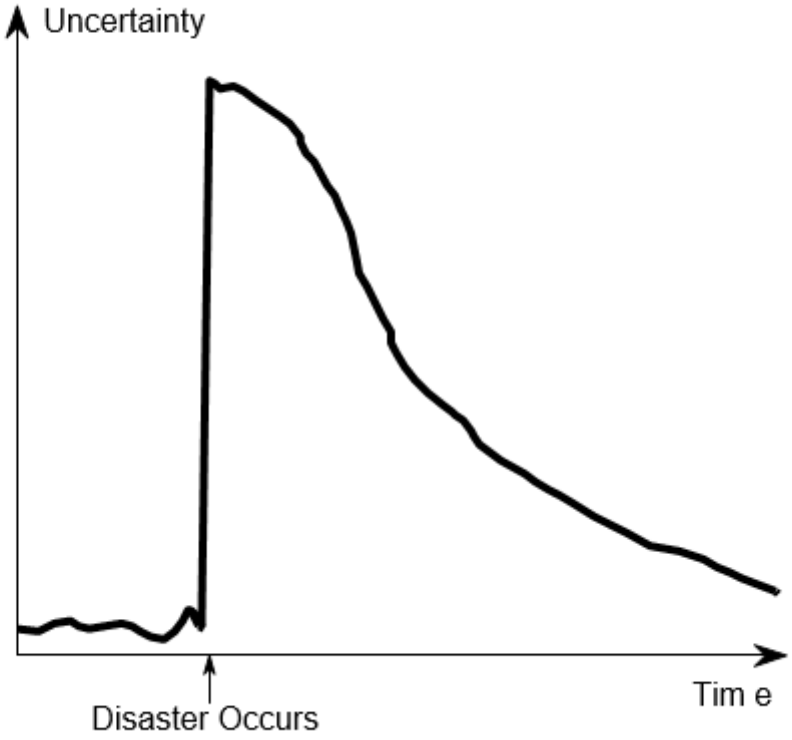

Figure 9: The degree of Uncertainty during and after a Disaster (Source: Okuyama, 2003)

The whole idea behind climate-disaster resilience is to replace lost capital, cope with the situation, learn, recover and reduce vulnerability. However, it the replacement and/or repair of lost or worn out capital, issues relating to technological replacement and investment through savings must be given priority. This is a core aspect in the endogenous growth model where growth is propelled through technological progress in the long-run, that is after the occurrence of a disaster like a flood. In this case, the amount of invested savings in the reconstruction activities will determine the speed of recovery from the disaster.

2.3.5 Revealed Preference Theory of Consumer Behaviour

Another theoretical ancour for this study is the Revealed Preference Theory of Utility Maximization. This theory was developed on the premise that individuals' preferences can be directly observed. Hence, the only way to know this is from direct observation of the behaviour of economic agents or entities. However, this approach strongly relies on the

assumption that over the period of observing such behaviour, individuals' preferences remain constant or the same. Economist believe that preferences (such as tastes) will most likely remain unchanged over a short period of time, but not over a long period of time.

The principle of revealed preference states that 'given the budget or income (I) facing the consumer, if he/she is offered two affordable bundles of goods X (x_1, x_2) and Y (y_1, y_2), at given prices P (p_1, p_2), and he/she chooses bundle X over bundle Y, then X must be preferred to Y'. On this basis, we can infer something about his/her underlying preferences from his/her observed choices between the two bundles. If a third alternative bundle (Z) is included among the options, provided also that bundle Z is affordable, since he/she had already chosen X over Y, then he will always prefer X to Z, given that he prefers Y to Z. Symbolically, this can be written as:

$X \succ Y \text{ and } Y \succ Z, \text{ then } X \succ Z \text{ or } X \succ Y \succ Z.$ This implies no reversal of preferences (Varian & Repcheck, 2010). It follows from the theory that the value attributed to a public good or environmental good or services by households can be obtained by their revealed preferences through their willingness to contribute or pay. If a household feels that an improvement in the provision of public goods or services will improve his/her wellbeing, this will likely make the household to reveal his/her willingness to contribute or pay for it.

2.3.6 Theory of Public Goods and Externalities in the Context of Building Flood Resilience

Most of the arguments among economist in support of government intervention in the economy is backed by the knowledge of the marketplace being unable to provide public goods or handle externalities. Such public goods include the provision public healthcare and welfare programmes, flood defences, roads, national security, environmental sanitation, etc. to mention a few. *Public goods* are non-rival and non-excludable goods by their nature. In a situation where the action of an individual affects the well-being of another individual, and

the market prices does not reflect the vital costs and benefits, then this implies the existence of *externalities*. For example, environmental sanitation benefits both individuals who voluntarily participated in the clean-up, as much as it benefits those who did not participate, even though the non-participants were not charged for the benefits they have enjoyed. This is the case of enjoying *positive externalities* on the part of the non-participants, also known as the *free-rider problem*. On the other hand, pollution from factory production activities poses health risks to residents of a community where the factory is located. Individuals residing in the area incur personal costs for treatment of pollution related diseases which are not covered by the factory owners. This second scenario is the case of *negative externalities*, where the action of an individual brings harm to others in a community.

Natural disasters such as floods in our case, negatively affects both human and natural systems significantly. These negative consequences come in the form of fatalities and casualties. The first task of disaster risk management authorities is to save lives. Next is to provide resilience though building more resistant infrastructure (drainages, bridges and flood defences in general) and buildings (Gitay et al., 2013). Also included in the categories of flood resilience measures is the establishment of early warning systems, development of evacuation schemes, provision of knowledge on flood protection through education and social welfare schemes (Hallegatte, 2012). This is necessary to cover for economic welfare losses incurred (income, output and means of livelihoods), present and future distortions in economic activities (sectoral impacts, taxes and revenue collections, employment, etc.), and ultimately to minimise possible losses from future flood occurrences. *Economic resilience* or community resilience to flood in this context is the ability of an economy or a community to reduce welfare losses from a flood disaster of a given magnitude, as well as its ability to reconstruct and recover from such losses. In line with the Sustainable Development Goals (SDGs) and Phase II of the Hyogo Framework for Action, appropriate indicators have been

provided for the definition and measurement of country-level resilience to natural disaster. With the help of these indicators, progresses made on improving resilience at country-level as well as key target areas requiring more resource investment that can yield the most efficient and desired result can be easily identified. Some countries can also be compared with others in terms of their progress made so far, though, heterogeneity among households, disasters and countries tend to make such comparison difficult (see, Rose, 2014). It is important to note that estimating the value of direct losses to assets is not sufficient enough to know the welfare impact of a disaster, as estimates of the indirect losses to income, output and consumption is very important also. Hence, *microeconomic resilience of households* to floods relies on factors such as the extent to which direct losses can be distributed across households, the ability to meet basic needs, the level of access to credit and insurance cover, ability to smoothen shocks across time via savings and the risk-sharing ability across households through the provision of social protections. This will be properly explained in due course.

The theory of public goods and externalities can be explained in the context of the provision of flood defences, which is an important component in building resilience of households to floods. As pointed out earlier, when a disaster like flood occurs, the magnitude of the damages and losses to households and the environment (community) requires the intervention of the government to correct market failure (the inability of the market to cover for supply needs for recovery and reconstruction, as well as coping requirements). Only government can effectively provide flood defences in other to achieve the desired economic efficiency and still maintain social welfare maximization in a post-flood disaster period. Flood defences are *pure public goods* because they are non-rival and non-excludable. On one hand, once flood defence is paid for and built by government, the benefits accruing from its construction is not only enjoyed by households who contributed to the project, but it is equally enjoyed by other households who didn't contribute to the flood defence project. This makes flood defence a

non-excludable good due to the free-rider problem. On the other hand, if household or individual benefits from the flood defence, it does not prevent another individual or other households from benefiting from the same flood defence project, hence, making it a non-rival good. Government intervention is needed because some individual may deliberately refuse to contribute to the flood defence project or may not have to capacity to contribute to it. Even among those who contributed, some may have contributed far less than their capacity to contribute. Hence, the government have to come in to offset the shortages or balance. The non-rival and non-excludable nature of flood defence leads to market failure because private firms will not be willing to build flood defences since it is not a profitable venture for them, thus, making public provision the only option. Flood defences are usually provided by governments especially in areas classified under high-risk communities to floods. The cost from the damages by floods may run into millions of dollars. For example, if the cost of damage to floods in one year is for a country is roughly $20 million, and ii will cost round $2.1 million to protect over 250,000 houses from future losses of the same magnitude, if these costs are correctly estimated, then it is worthwhile to invest $2.1 million now to avoid possible future losses amounting to $20 million. Such interventions from the government will be efficient because the *net social benefit* from the investment is positive, in as much as there are no other similar projects with higher net social benefit. Government should not invest in the flood defence project if it doesn't have accurate data on the cost of damages from the flood and the benefits from the investment, because it could give rise to high risk of government failure (since it will amount to a waste of economic resources and taxpayers' money). Though, achieving accuracy when considering estimates from environmental losses due to floods may be very difficult. These figures remain estimates and not real figures, and this could vary from one individual to another. However, the estimation process should consider the long-term costs and benefits, that is, it should take in to account the cost of

maintenance of the flood defence project, which usually involves investment of taxpayers' money over a number of years.

Assuming the economy was operating at optimum before the occurrence of the disaster, the aftermath period of the flood disaster for example, will imply distortions in some sectors of the economy. To return the economy back to its optimum level, the asset replacement value must be equal to its market value, that is in the absence of externalities. This is usually not obtainable, particularly in some sectors, where infrastructure or public goods were damaged by the said disaster, because these assets are not traded in the market. As expected, private sector will not use their private returns to fund the replacement of the lost assets. Only a government with the right political will via a bureaucratic process can get the lost assets replaced, considering some policies, like the land-use management structure already in existence. Moreover, output lost during and after the disaster can be better quantified from the social viewpoint. Most public goods (such as infrastructure) damaged by disasters tend to bring about positive externalities, meaning that their societal value exceeds the replacement value such assets (Hallegatte, 2014). For instance, replacement of damages to infrastructure after Hurricane Katrina in 2005, took longer time than expected due to lack of health care services which made it very difficult to attract construction workers to the area. In this case, it is clear that the cost due to the unavailable health care services was higher than the cost of providing the reconstruction services. Hence, in estimating the value of the lost asset or capital (ΔK), it requires the consideration of the prevailing distortions and externalities, in addition to the replacement cost. Practically, this is very hard to achieve.

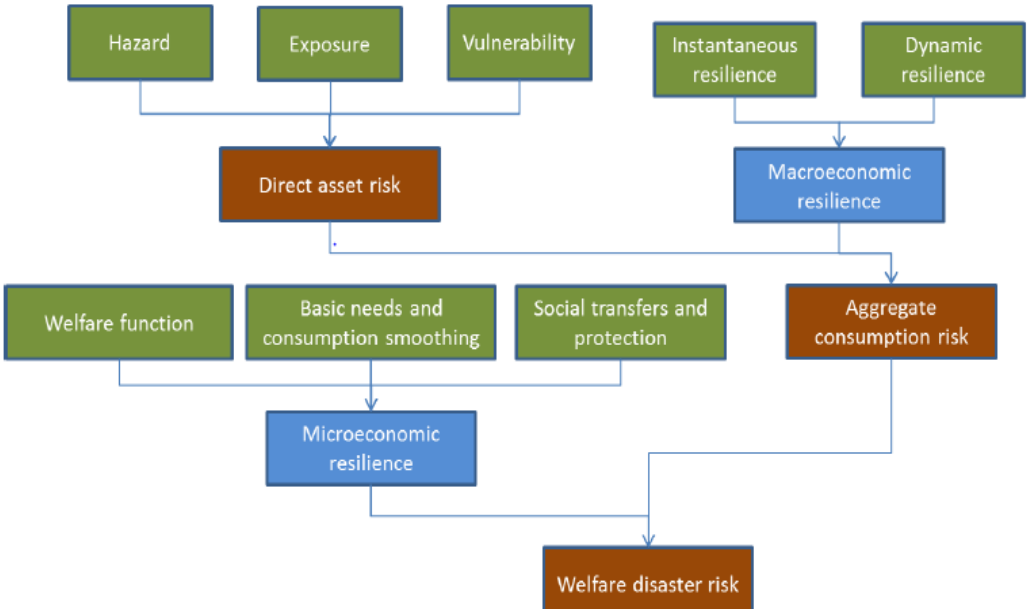

Figure 10: Structure for the Assessment of Welfare Disaster Risk (Source: Hallegatte, 2014)

Accounting for the distributional impacts and coping ability of households to shocks from the disaster is very important in determining macroeconomic impact of the disaster on welfare which emanates from consumption losses (Rose, 2014). This emphasises the need have a broader view of vulnerabilities among the poorest communities as well as the effect of the disaster on increasing inequality among households (Tierney, 2006). Poverty level among households may have increased from its pre-disaster level by some percentage points in the post-disaster period, as in 2009 disaster in Mexico (increasing from 1.5% to 2.5% in some selected municipalities). Because the asset lost assets after a disaster is not much for the poorest group of households, it is impossible to account for aggregate welfare losses in real economic terms for these group of individuals. Hence, relying on economic aggregate in the determination of the disaster impact on welfare in this situation will deceptive. Proper consideration of the differences in distribution of income in the affected area before the occurrence of the disaster and heterogeneity in consumption losses will help provide a better evaluation of the actual welfare impact of the disaster. Unavailability of data makes the application of this approach practically impossible (Hallegatte, 2014).

Considering the framework proposed by Hallegatte for quantifying welfare losses of households from a disaster, it starts by making assumptions on the existence four (4) categories of households in the affected area: the poor, the non-poor, the affected and not affected households by the disaster. The poor were considered as those who live on less than $1.25 a day. The poor households could also represent those who lack access to financial assets, sometimes considered the most vulnerable group, whom are likely to fall back to a position below the poverty line. It is also assumed that both poor and non-poor households suffer the same amount of financial losses from the disaster, which is proportional to their income earnings. This assumption was necessary because the poor households tend to be the most vulnerable to disasters and the amount of losses suffered varies from one household to another.

First, the welfare of the affected community is given as:

$$W^{-} = n_p^a u(\tilde{c_p}) + n_r^a u(\tilde{c_r}) \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots 1.1$$

Where n_p^a and n_r^a represents the number of households which are poor and non-poor respectively, while $\tilde{c_p}$ and $\tilde{c_r}$ represents their consumption respectively. All values expressed in the form $\tilde{x}$ denotes the net present value of the future change, rather than the immediate value at time t. The symbol u denotes a 'welfare function' linking the net present value of consumption with the individual welfare. As long as households can smoothen shocks over time and provided these shocks remains fairly limited in relation to consumption, the assessment of welfare can be done using the net present value of consumption (Hallegatte, 2014).

Hence, the post-shock welfare function (excluding any transfers) takes the form below:

$$W^{+} = n_p^a u(\tilde{c_p} - \widetilde{\Delta c_p}) + n_r^a u(\tilde{c_r} - \widetilde{\Delta c_r}) \dots\dots\dots\dots\dots\dots\dots\dots 1.2$$

Where: $\widetilde{\Delta c_p}$ and $\widetilde{\Delta c_r}$ denote the lost consumption as a result of the disaster at household level (that is, in the form of the net present value of future changes in consumption losses). In this case, there is a possibility that $\widetilde{\Delta c_p}$ and $\widetilde{\Delta c_r}$ combined is less than $\tilde{c}_p$ and $\tilde{c}_r$, making the non-linear component in the equation insignificant, which is then be expressed below as follows:

$$\Delta W \approx n_p^a u'\left(n_p^a\right)\widetilde{\Delta c_p} + n_r^a u'(\tilde{c}_r)\widetilde{\Delta c_r} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots 1.3$$

Households losses of consumption due to the disaster could be directly from productive assets or via employment and capital gains, that is, considering the indirect impacts of the disaster from the point of view of their positions as firms or business owners. If the assumption of linearity of household losses from their income before the disaster occurred holds, this will imply that $\widetilde{\Delta c_p} = \varphi \tilde{c}_p$ and $\widetilde{\Delta c_r} = \varphi \tilde{c}_r$. Hence the aggregate income of the affected area and aggregate lost income is expressed as $\widetilde{C^a} = n_p^a \tilde{c}_p + n_r^a \tilde{c}_r$ and $\widetilde{\Delta C} = n_p^a \widetilde{\Delta c_p} + n_r^a \widetilde{\Delta c_r}$ respectively. Therefore, since $\varphi = \widetilde{\Delta C} / \widetilde{C^a}$, the new welfare function becomes:

$$\Delta W \approx \left[n_p^a \tilde{c}_p u'\left(\tilde{c}_p\right) + n_r^a \tilde{c}_r u'(\tilde{c}_r)\right]\frac{\Delta c}{c^a} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots 1.4$$

Where in the above case $u'\left(\tilde{c}_p\right)$ and $u'(\tilde{c}_r)$ represents standard distributional weights for comparing losses and benefits of households of different income and wealth categories (see, Fleurbaey & Hammond, 2004). The total income of the poor and non-poor group in the affected area can then be defined as $\widetilde{C_p^a} = n_p^a \tilde{c}_p$ and $\widetilde{C_r^a} = n_r^a \tilde{c}_r$ respectively. Hence,

$$\Delta W \approx \left[\frac{\widetilde{c_p^a}}{\widetilde{c^a}}\left(u'(\widetilde{c_p}) - u'(\tilde{c}_r)\right) + u'(\tilde{c}_r)\right]\widetilde{\Delta C} \dots\dots\dots\dots\dots\dots\dots\dots\dots 1.5$$

which when further simplified becomes:

$$\Delta W \approx [\omega_a \Delta u' + u'(\tilde{c}_r)]\widetilde{\Delta C} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots 1.6$$

Note that if we set $\Theta = [\omega_a \Delta u' + u'(\widetilde{c_r})]$, the implies that Θ explains the integrated component of aggregate impact of the disaster on consumption into the welfare function, and this depends on the level of wealth (or equity in income distribution) of a given country and the differential in the level of exposure for both the poor and non-poor group. Also, the component $\Delta u' = u'(\widetilde{c_p}) - u'(\widetilde{c_r})$ represents the difference in the marginal utility of income for both poor and non-poor group during the period before the disaster occurred, usually a positive value which serves as a measure of income inequality. The size of this parameter becomes bigger as the income gap between the poor and non-poor groups increases.

$\omega^a = \widetilde{C_p^a}/\widetilde{C^a}$ is a parameter that describes the proportion of lost consumption from the aggregate initial consumption by the poor and it is a relative measure of exposure of the poor group in relation to the other group of the population left. This proportion of relative exposure is also considered to be that portion of lost assets by the poor to the disaster. This goes further to imply that ω^a can be expressed in the form K_p^a/K^a, where K^a stands for the exposed and affected capital, while K_p^a represents the amount of capital lost by the poor to the disaster, that is, from which income of the poor is derived in the context of public assets.

ω^a as a parameter also explains the particular level of vulnerability of the poor group in a country as described below:

(i) If the disaster equally affected both the poor and non-poor group of the population, then $\omega^a = \widetilde{K_p^a}/\widetilde{K^a} = \widetilde{K_p}/\widetilde{K} = \omega$, that is, the wealth/income distribution in the country.

(ii) If it is only the poor affected by the disaster, $\Rightarrow \omega^a = 1$.

(iii) Lastly, if it is only the rich affected by the disaster, $\Rightarrow \omega^a = 0$.

If the effect of the disaster is more on the poor than the rich and given that $\Delta u'$ is positive, there will be a larger aggregate impact of the disaster on welfare than on consumption

provided ω^a if large. This implies increase in Θ, that is, an increase in the impact on the welfare of the poor due to the disaster is brought about by increased disaster exposure of the poor. The value Θ (the differential exposure on welfare of the poor) rises as inequality between the rich and poor group increases. In the same manner, $u'(\widetilde{c_r})$ (the country's aggregate income level) affects households' resilience to the disaster, since $u'(\widetilde{c_p})$ and $u'(\widetilde{c_r})$ (that is, the marginal utility of consumption for both the poor and rich group in the country respectively) decreases as aggregate country-level income increases, thereby decreasing to vulnerability of households' welfare lost to disaster (that is, Θ).

CHAPTER 3

3.0 Research Methodology

3.1 Analytical Framework or Technique

This study utilized Contingent Valuation technique (benefit-cost analysis), Descriptive Statistics (trend analysis, charts, tables, graphs, percentages, etc.), Multivariate Probit Regression Model and Random Forest Model as tools for estimating and analysing the data obtained, after which the findings were discussed.

3.1.1 An Overview of Contingent Valuation Methods

Contingent valuation survey techniques usually involve the use of questionnaires designed primarily to elicit preferences of individuals. In the case of some public goods (pipe borne water, roads, recreational facilities, drainage, national park services, ecosystem services, hazardous wastes, etc.), whose markets are non-existent or poor, and in most cases, proxies for such markets are difficult to obtain, the only means of inferring preferences from observed behaviour of individuals is through the use of contingent valuation method (see, Boardman, Greenberg, Vining, & Weimer, 2006). This method, though sometimes considered as a hypothetical approach, is used to elicit information on peoples' or households' willingness to pay (WTP) for such public goods because the respondents are not asked to pay for their stated valuations for the goods. The approach is not controversial as long as it is used to value the use or potential use of such goods. In addition, it is used to capture the benefits and costs (BCA or CBA) of the provision of the public goods.

Some steps normally must be followed when carrying out Contingent Valuation (CV) surveys. The first involves identifying a sample from the population to be surveyed. This is then followed with administering questions to individuals or households to examine their valuation of the goods. Next, the information provided by the respondents is then used by the

researcher to estimate their willingness to pay (WTP) for or valuation of the goods. Finally, the average amount expressed by the sampled respondents as their WTP or valuation is generalized to the entire population provided the sample was drawn randomly. To arrive at the aggregate WTP or valuation, the size of the entire population is multiplied by the average WTP or valuation. Because characteristics of the sampled population (such as age, income, gender, level of education, etc.) differ from one location/group to another, it is a necessary requirement that the researcher collects information on these characteristics alongside their WTP or valuation of the goods (see, Boardman, Greenberg, Vining, & Weimer, 2006).

As pointed out in the literature, a well-known economic technique for making comparison between the benefits and costs of providing a well-defined project or activity is the benefit-cost analysis (BCA) or cost-benefit analysis (CBA) as the case may be (Benson & Twigg, 2004; FEMA, 2007; Kramer, 1993; Kull, Mechler, & Hochrainer-Stigler, 2013; Venton, Sidenburg & Faleiro, 2010). Four stages are involved in any CBA. They include definition of the proposed project for which resources are to be allocated; evaluating the project's economic impacts through assessing its net benefits and crowding-out effects; identifying the economically important impacts of the project though providing quantitative estimates of its physical impacts and; providing a monetary valuation, discount weightings as well as conducting a sensitivity analysis of the project (Pearce, Atkinson, & Mourato, 2006; Hanley & Spash, 1993).

However, other writers like Venton (2010) have emphasized that the utility from use of CBAs as a tool should go beyond mere comparison of cost to decision support. Venton (2010), for example, found that some cultural barriers (cultural storage practices) prevented individual households from using community-based silos provided for crop storage, making the project somewhat cost-ineffective to a large extent. This result emphasizes the need for government to always consult communities or community-based organizations to help them come up with

projects that meet the community's cultural values and that which is also cost-effective. Some limitations of doing CBA has also been highlighted in the literature, specifically on issues relating to the environment. They include technical constraints involved in valuing goods without a market (wide life, trees, ecosystem); difficulty in predicting the impacts of the project on the ecosystem; and nonexistence of techniques which takes the problem of uncertainty and irreversibility into account (Pearce, Atkinson, & Mourato, 2006; Hanley & Spash, 1993). Others have criticized the use of CBA in DRR on the grounds of lacking the ability to quantify the distributional impacts of the project (that is, answering the question of who should pay and who should benefit from the project?) (Kull, Singh, Chopde & Wajih, 2008), ethical concerns from assigning monetary value to life (May, 1982) and inability to quantify intangible assets (Shreve & Kelman, 2014). The fact that some social and environmental benefits are qualitative and/or sometimes incompatible in relation to benefits and costs, it becomes difficult for CBAs used for DRR to estimate some project's environment and social impacts.

In spite of its weaknesses, CBA remains the most widely used standard of measurement to communicate benefits to policy and decision makers. Aside using CBA to prepare for future response to disaster-related events, it could be used to form the basis for putting convincing propositions for economic investments in risk reduction (Venton, 2010). The benefit-cost ratio (BCR) will be useful in this regard since it serves as an indicator which provides a summary of all monetary values accruing from a given project. CBA for DRR covering different scales, vulnerabilities, geographical locations and types of hazards have been widely discussed in the literature. Absent in most of these studies is their inability to report CBAs in a systematic way, making it difficult to understand the circumstances under which one method should be appropriate for use over another. As far as measuring economic efficiency within CBA framework is concerned, there are three (3) standard units of measurement used: (i) Net

present value (NPV) method; (ii) internal rate of return (IRR) method; (iii) cost-benefit-ratio (CBR or BCR) method. Often, IRR and NPV measures tend to yield the same result or outcome (Kull et al., 2013). Since this study is intended to have policy relevance for onward communication to decision makers, the focus will be on the BCR method.

3.1.2 Multinomial Logit Regression Model

The Multinomial logit model has been used as an important tool for analysing farmers' adaptation decisions. This approach will be used to analyse households' adaptation to flooding, since the approach is said to be appropriate for evaluating alternative combinations of adaptation decisions (Okoruwa et al., 2009). Primarily, this method will be used to examine the relationship between household's socio-economic characteristics and the coping strategies they adopt to recover from flood related losses.

The model is expressed as follows:

$$P_{ij} = \frac{exp\ (Y_j X_j)}{1 + \sum_{j=1}^{n} exp\ (Y_j X_j)} \quad for\ j = 1, 2, 3, \ldots\ldots\ldots\ldots, n \ldots\ldots\ldots\ldots 1.7$$

Where P_{ij} is the probability of adopting flood coping strategies 1, 2, 3, ….., n and exp = exponent.

$$P_{i0} = \frac{1}{1 + \sum_{j=1}^{n} exp\ (Y_j X_j)} \quad for\ j = 0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 1.8$$

Where P_{i0} is the probability of not adopting any coping strategy.

To estimate the model practically, we will normalize the coefficients of the reference group to zero because the probability of all the choices must be equal to unity (Okoruwa et al., 2009). Hence, taking the natural logarithm of the odd ratios of equation (1.7) and (1.8) will give the estimating equations as follows:

$$ln = \frac{[P_{ij}]}{\|P_{io}\|} = \gamma_j X_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 1.9$$

This denotes the ratio of the probability of each household adopting flood coping strategies 1, 2, 3, ……., n, to the probability of the reference group (that is those not adopting any flood coping strategy).

γ_j represents the estimated coefficients of the explanatory variables and X_i represents the socio-economic variables. The estimated coefficients of each choice reflect the effect of the X_i's on the likelihood of households choosing that particular alternative relative to not adopting any coping strategy (reference group).

The stochastic form of the equation can be specified as follows:

$$Z_i = \gamma_0 + \gamma_1 X_1 + \gamma_2 X_2 + \gamma_3 X_3 + \cdots + \gamma_n X_n + \varepsilon \quad \text{.....1.10}$$

Where Z_i represents the multiple available flood-coping strategies adopted by household i, at any point in time (which could be sometimes more than two at a time), and Z_i is defined as:

0 if household i did not adopt any coping strategy,

1 if household i adopts 1 coping strategy,

2 if household i adopts 2 coping strategies,

3 if household i adopts 3 coping strategies and

n if household i adopts n coping strategies.

However, in using Multinomial logit model, all the errors of the variables must be independently and identically distributed (IID). Once this condition is not met, then we will use the Multivariate Probit Model.

3.1.3 Multivariate Probit Regression Model Framework

In other to provide information on the households' socio-economic characteristics and the coping strategies they adopted, this study used descriptive statistics. Since households have the option of choosing one or more coping strategies at the same time, in other to estimate factors (socio-economic characteristics) influencing households' decision under each coping

strategy option selected, the Multivariate Probit Regression Model is the suitable technique to use for the estimations. This is so because the technique has the advantage of allowing the estimations of the choices involving the simultaneous selection of more than one coping strategies. This helps in understanding the mechanism behind the collective decision-making processes by households (Rahman & Akter, 2014).

The procedure for developing the Multivariate Probit Model as stated in Greene (2012), involves applying a Bivariate Probit model to handle the covariance, where two binary response variables are involved. Looking at this from the perspectives of households affected by flooding, if bank credit and the reliance on support from government are the two coping strategies available to them to select from, the factors influencing the decision behind the selection of any or both coping strategies is autonomous.

Hence, we model for the two simultaneously using the bivariate probit model.

Just like in the case of a univariate probit model, the bivariate probit model as given by (Greene, 2012) is shown below as follows;

$$y_1^* = \mathrm{X}_1^*\beta_1 + \varepsilon_1, \quad y_1 = 1 \textit{if } y_1^* > 0, \textit{ and } 0 \textit{if otherwise}$$
$$y_2^* = \mathrm{X}_2^*\beta_2 + \varepsilon_2, \quad y_2 = 1 \textit{if } y_2^* > 0, \textit{ and } 0 \textit{if otherwise}$$

Hence;

$$\begin{pmatrix} \varepsilon_1 \\ \varepsilon_2 \end{pmatrix} | \mathrm{X}_1, \mathrm{X}_2 \sim N\left[\begin{matrix} 0 \\ 0 \end{matrix}, \begin{pmatrix} 1 & \rho \\ \rho & 1 \end{pmatrix} \right]$$

This also implies that;

$$E[\varepsilon_1 | \mathrm{X}_1, \mathrm{X}_2] = E[\varepsilon_2 | \mathrm{X}_1, \mathrm{X}_2] = 0$$

$$Var[\varepsilon_1 | \mathrm{X}_1, \mathrm{X}_2] = Var[\varepsilon_2 | \mathrm{X}_1, \mathrm{X}_2] = 1$$

$$Cov[\varepsilon_1, \varepsilon_2 \mid \mathrm{X}_1, \mathrm{X}_2] = \rho$$

Based on maximum likelihood estimation procedure, the bivariate normal cumulative distribution function (CDF) can be written below as follows;

$$\Pr ob(X_1 < x_1, X_2 < x_2) = \int_{-\infty}^{x_2} \int_{-\infty}^{x_1} \phi_2(z_1, z_2, \rho) dz_1 dz_2 = \Phi_2(x_1, x_2, \rho)$$

Hence, it follows that the density function would be expressed as;

$$\Phi_2(x_1, x_2, \rho) = \frac{e^{-\left(\frac{1}{2}\right)\left(x_1^2 + x_2^2 - 2\rho x_1 x_2\right)/\left(1-\rho^2\right)}}{2\pi\left(1-\rho^2\right)^{\frac{1}{2}}}$$

To derive the log-likelihood, the following notations are used;

$$q_{i1} = 2y_{i1} - 1$$
$$q_{i2} = 2y_{i2} - 1$$

Thus, $q_{ij} = 1 if\ y_{1j} = 1 and -1 if\ y_{1j} = 0; \quad j = 1, 2.,$ given that,

$z_{ij} = \mathrm{X}_{ij}^{'} \beta_j$, $w_{ij} = q_{ij} z_{ij}$ *and* $\rho_{i*} = q_{i1} q_{i2} \rho$

The bivariate normal distribution of the density ϕ_2 and Φ_2 is indicated by the subscript 2. In this case, the probabilities enter the likelihood functions as expressed below;

$$\Pr ob(Y_1 = y_{i1}, Y_2 = y_{i2} \mid \mathrm{X}_1, \mathrm{X}_2) = \Phi_2(w_{i1}, w_{i2}, \rho_{i*})$$

The, the log-likelihood function is expressed in the form below;

$$InL = \sum_{i=1}^{n} In\Phi_2(w_{i1}, w_{i2}, \rho_{i*})$$

Next, we take derivatives of the log-likelihood function as shown below;

$$\frac{\partial InL}{\partial \beta_j} = \sum_{i=1}^{n} \left(\frac{q_{ij}, g_{ij}}{\Phi_2} \right) x_{ij}$$

$$\frac{\partial InL}{\partial \rho} = \sum_{i=1}^{n} \frac{q_{i1}, q_{i2}\phi_2}{\Phi_2}$$

Where $g_{i1} = \phi(w_{i1})\Phi\left[\frac{w_{i2} - \rho_{i*} w_{i1}}{\sqrt{1-\rho_{i*}^2}}\right]$. This process can be replicated for g_{i1} by replacing the subscript 1 with 2. The maximum likelihood is obtained by equating the two derivatives to zero. After obtaining the maximum likelihood estimates, we can the obtain the partial or marginal effects by evaluating the equation below:

$$\Pr ob(Y_1 = 1, Y_2 = 1 | \mathrm{X}) = \Phi_2\left(x'\gamma_1, x'\gamma_2, \rho\right)$$

A change in X can be expressed as;

$$\frac{\partial \Phi_2}{\partial X} = g_1\gamma_1 + g_2\gamma_2$$

With the information provided above, the multivariate probit model can be expressed below as;

$$y_m^* = X_m^*\beta_m + \varepsilon_m,\ y_m = 1 \ if\ y_m^* > 0,\ and\ \ 0\ if\ \ otherwise,\quad m = 1,..., M$$

Where;

$$E[\varepsilon_{\mathrm{m}} | \mathrm{X}m....\mathrm{X}_{\mathrm{m}}] = 0$$
$$Var[\varepsilon_{\mathrm{m}} | \mathrm{X}_{\mathrm{m}}...\mathrm{X}_{\mathrm{m}}] = 1$$
$$Cov[\varepsilon_{\mathrm{m}}...\varepsilon_{\mathrm{m}} | \mathrm{X}_1...\mathrm{X}_{\mathrm{m}}] = \rho_{jm}$$
$$(\varepsilon_{\mathrm{m}}...\varepsilon_{\mathrm{m}}) \sim N_m(0, \Re)$$

Finally, the log-likelihood function becomes;

$$L_{\mathrm{m}} = \Phi_{\mathrm{m}}\left(\mathrm{q}_{\mathrm{i1}}\mathrm{X}_{i1}'\beta_1,..., \mathrm{q}_{\mathrm{im}}\mathrm{X}_{im}'\beta_m, \Re^*\right)...\varepsilon_{\mathrm{m}}$$

Where $\mathrm{q}_{\mathrm{im}} = 2y_{im}' - 1$ and $\Re^*_{jm} = q_{ij}q_{im}\rho_{jm}$

3.1.4 Random Forest Model

Random forest model (RFM) also known as random decision trees is a data mining technique which is mainly used for classification and regression analysis. In other words, decision trees form the building block of the random forest model. For example, predicting the maximum temperature today requires taking into account many factors, which includes information on past and present weather behaviour. The problem here arises from the diversity in the knowledge people have. So different people will normally provide different answers to the same question. The larger the responses taken from different people, the more the variance in their predictions. Hence using a single decision tree will likely bring complications in the prediction of the maximum temperature today. This usually gives rise to the problem of overfitting, which is associated with the use of a decision tree as information increases. Theoretically, the random forest model doesn't suffer from the large number of features. However, if the included features are not significant in describing the response or highly correlated, the random forest will dilute the significance of the selected features, therefore, there is the need to remove the 'useless' features for better interpretation of the model. By so doing, the random forest model corrects this habit of overfitting associated with decision trees. The aim here is to minimize the variance (errors) in the outcomes from the pooled predictions to arrive at or closer to the right answer. The central idea behind the random forest model is the combination of many decision trees into a single model.

The name random forest is derived from the fact that many decision trees are combined together to form a forest, and each decision tree in the forest looks at a random subset of characteristics while developing the questions, and solely has access to a random set of the training data points. It then chooses the best feature out of the random set of features. The increasing diversity in the forest leads to more robust overall predictions. At the point of making a prediction, the random forest takes the average of all individual estimates of the

decision trees. This is the case of regression, in which are predicting a continuous value of a given target. The model also handles problems involving classification by targeting discrete class labels such as cloudy or sunny situations for example. Here, what the random forest model does is to take a majority vote for the predicted class as shown in the diagram below. In summary, random forests according to Breiman (2001), involves a significant alteration of bagging to form a huge collection of de-correlated trees, which are then averaged (Hastie, Tibshirani & Friedman, 2009). The workings of the model are similar to the concept bootstrap aggregation, which is usually suitable for procedures involving high variance and low bias target as in the case of decision trees.

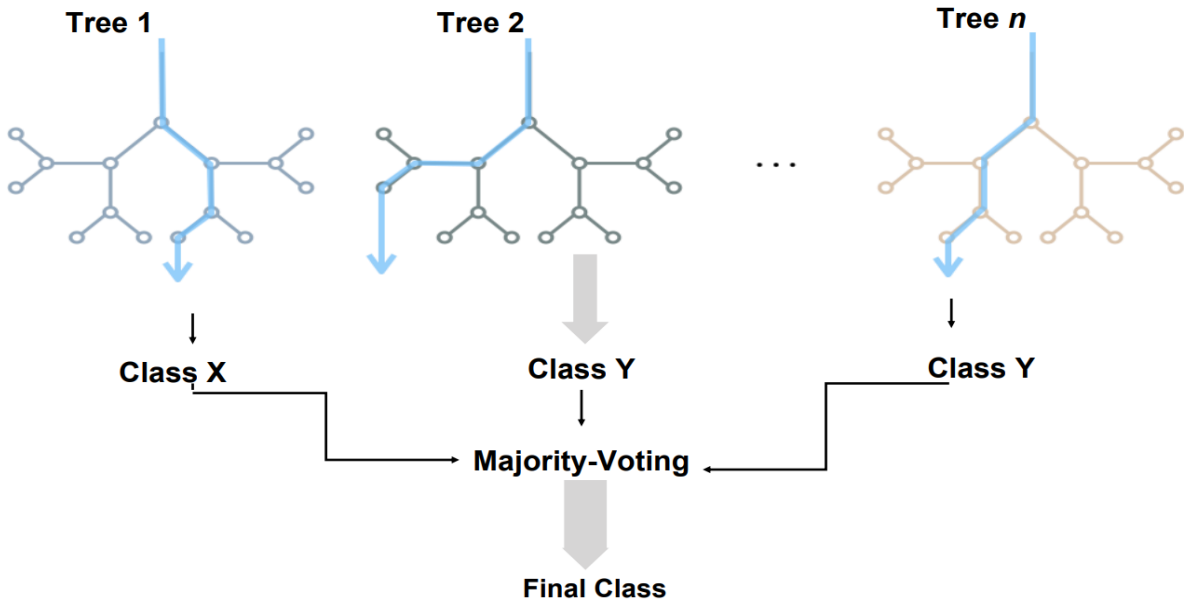

Figure 11: A Simplified Random Forest Model (Author's Construct)

In the case of classification, the first procedure in random forest model will be to do an 'importance ranking' of the predictors (in our case, the selected socioeconomic variables). This is simply to measure the relative influence of each feature in the prediction. Using software packages like python, the scores for the importance ranking can be computed automatically, that is, after training and scaling up the results. Note that when all the values for the importance ranking is added, it sums to one (1). Based on the rankings, a decision is

then made on which of the features to drop, due to the fact that they are going contribute little or nothing to the prediction process. This is necessary in the random forest model because considering many features at a time will result to overfitting. Having identified the two most important predictors in the model, we compute an out-of-bag score for the variables to be predicted. The computer or machines chooses the threshold which these variables reach to be qualified for selection. The process is then concluded with the use of pairs of most influential predictors(estimators) to predict each and every selected variable to be predicted (that is, the flood coping strategies). This can be achieved by using these variables to construct what is referred to as 'Partial dependent plots. The partial dependent plots present a graphical and/or a pictorial view of the extent to which the most important predictors influence the selection of the variables to be predicted. In other words, the random forest model is not a descriptive model, rather it is a predictive one (that is, it predicts relationships among variable in a given dataset).

3.2 The Area of Study

Jigawa State is in the North-Western region of Nigeria (Latitude 12.00^{o}N and longitude 09.45^{o}E) as shown in Figure 8 below. Dutse is the capital of Jigawa State. Jigawa State has a total number of 27 Local Government Areas (LGAs). However, the State covers a landmass area of about 24,742 KM^{2}, with a population projected to be around 5,828,200 people in 2016 (NPC, 2016, NBS, 2016). About 14% of its total landmass of Jigawa State constitutes its Wetlands (Fadama) area.

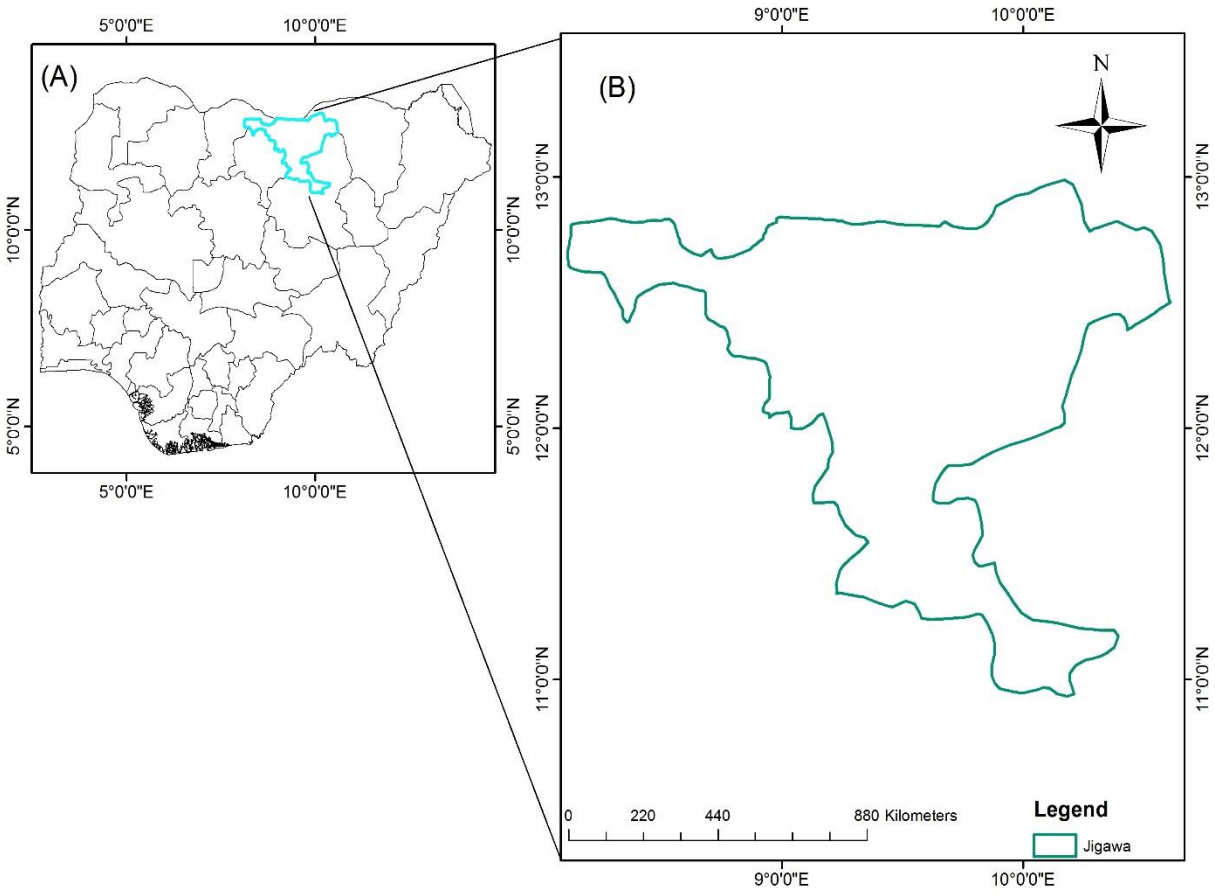

Figure 12: Location of Jigawa State on the Map of Nigeria (Source: Author's Construct)

With a combination of Tropical wet and dry climate (with seasonal rainfall between May to October), the State has been transformed from its natural Sudan Savannah vegetation to what is now called a derived savannah vegetation and these changes have been attributed to human activities (Ahmed, 2010). The City experiences a mean annual temperature of about 30^{o}C. Rainfall variability is pronounced in this area and rainfall distribution (skewed), with an annual average ranging from between 635mm to 899mm, that is, less than 1000 mm (NIMET, 2008). In addition to changing rainfall patterns, several anthropogenic processes have been blamed for the recurring floods in Jigawa State, whose consequences could sometimes be disastrous. For example, a recent report on floods in Jigawa State in 2016 alone, a total number of 792 persons were affected, one live lost, five recorded cases of injuries and 182

houses destroyed with displacement of thousands of people (NEMA, 2016). In addition, nine (9) LGAs (Babura, Malam Madori, Hadeja, Kafin Hausa, Ringim, Jahun, Guri, Dutse and Suletankarkar LGAs) were affected out of 27 LGAs in the State and properties worth millions of Naira lost. Since the study's focus in on building flood resilience in the Northern part of Nigeria, this work will be carried out on Jigawa State because it is the most flood prone State in Northern region of the country, particularly in terms of its frequency of occurrence and the spread over areas affected within the State when compared with other States in the region within the last ten years (NEMA, 2016).

3.3 Data and Source of Data

Both primary and secondary data was for this study. The secondary data was obtained from the National Bureau of Statistics (NBS), Nigerian Meteorological Agency (NIMET) and the Nigerian National Emergency Management Agency (NEMA). The data include, time series data on rainfall and temperature, and flood information. The primary data (cross-sectional) was collected from a cross-section of households with the help of a well-structured survey questionnaires. In addition, series of interviews involving experts Ministry of Housing and Urban Planning, Ministry of Environment as well as those in the National Emergency Management Agency (NEMA) was conducted. This was done with the help of a well-structured interview guides. For the questionnaires, a pilot survey will be conducted first to validate its reliability, after which the final copy of the questionnaire was designed, considering all the omissions and adjustment spotted during and after the conduct of the pilot survey.

3.4 Sampling Technique

This study employed a Multi-Stage sampling technique. In the first instance, we will identify Local Government Areas (LGAs) that lies within Jigawa State, since the study concerns

building flood resilience in the State. By so doing, LGAs within the rural settings will also be included. The next stage involved the deliberate selection of LGAs within Jigawa State that have experienced flooding most in 2016. After identifying these local LGAs most affected by flooding, we drew a random selection of some of the LGAs affected by flooding to include both urban and rural areas to capture the spatial distribution of flooding across the study area. In order to arrive at the sample size (final selection of the number of households) to be drawn from each of the randomly drawn LGAs, the following formulae was used:

$$Sample\ Size = \frac{\frac{z^2 \times p(1-p)}{e^2}}{1 + (\frac{z^2 \times p(1-p)}{e^2 N})} \quad \text{..... 3.5}$$

Where:

N is the population size or number of households in the LGA,

p is the probability of including each household and 1 – p is the probability of non-inclusion,

e is the margin error, usually a percentage substituted in decimal form (e.g., 5% = 0.05),

and z is the z-score or the desired confidence level. In our case, a 95% confidence level was conventionally used (www.surveymonkey.com/mp/sample-size-calculator).

Note, 95% confidence level equals 1.96.

3.5 Sample Size

Based on the data obtained from the Nigerian National Emergency Management Agency (NEMA) on 2016 flood statistics, a Total of 9459 households (Sampling Frame) were affected by flooding in 2016. Using the sampling technique discussed in sub-section of this work and based on 95% confidence interval with a margin error of 5%, we arrived at a sample size of 370 household heads for this study. Furthermore, based on the information on the Local

Government Areas (LGAs) affected, we had a total of Nine (9) LGAs (Babura, Malam Madori, Hadejia, Kafin Hausa, Ringim, Jahun, Guri, Dutse and Suletankarkar LGAs affected in the database provided by NEMA, that is still in 2016. We randomly selected four (4) out of the nine (9) LGAs affected. Hence, the study covered Ringim, Guri, Hadejia and Kafin Hausa LGAs. The questionnaires were randomly distributed among male and female household heads across the selected LGAs. Based on the application of the above formulae, we arrived at a sample size of 370 households out of out of a total of 9459 households affected by flooding in Jigawa State, across 9 LGAs in 2016 based on data obtained from the State Emergency Management Agency (SEMA). Having selected four (4) of the most affected LGAs out of 9 LGAs, the sample size of 370 households were distributed as a proportion of the affected households per selected LGAs to the total number of affected households in the selected four (4) LGAs for the study as shown in Table 1 below:

Table 1: Distribution of Sample Size According to Population Profile

Selected LGAs	**No. of HH affected**	**Sample Size**	**Distribution of Sample Size**	**No. of Response**
1. Ringim	1,525	370	164	106
2. Guri	822	370	88	61
3. Hadejia	525	370	57	48
4. Kafin-Hausa	570	370	61	36
TOTAL	**3,442**	**370**	**370**	**251**

Source: Author's computation based on NEMA 2016 Data

However, out of the 370 sample households intended to be covered, only a total 251 household heads responded to the questionnaires administered (that is, a 67.8% response rate). Hence, we based our analysis on the 251 households that responded. The household surveys were conducted through questionnaires and interviews between December 2017 and February 2018.

CHAPTER 4

4.0 Results and Discussions

4.1 Households' Socioeconomic Characteristics and Flood Coping Strategies

The objective here is to examine the socio-economic characteristics of households and their coping strategies adopted against floods. Then, further to examine the factors influencing the households' choices of adopting the coping strategies. Table 2 below presents some of the important socioeconomic characteristic of the respondent households (victims of 2016 floods in Jigawa State).

Because of the homogeneous nature of the four (4) selected Local Government Areas (LGA) that forms the study area, there is no significant difference in the characteristics of the households across the LGAs, as well as in their experience of floods over the years. Hence, only the overall results on their characteristics and coping strategies are discussed here. More information on the disaggregated results (that is, by LGAs) can be found in the appendix section.

From the summary of statistics of the affected households presented in Table (..) above, the study showed that out of the 251 respondents, a significant majority of them (87.25%) were natives of Jigawa State. Because the respondents are predominantly of the same culture (Hausa-Fulani) and religion (Islam), the study found no significant differences in their responses, as well challenges faced as a result of flooding. This implies that the selected communities (LGAs) for the study exhibit greater homogeneity. The non-indigenes (12.75%) according to the study are mainly immigrants who migrated into the Jigawa State due to reasons such as: employment (25%), Education (3.13%), Marriage (37.5%) and Climate Shocks (34.37%)-leading to search for cultivable agricultural lands which are in abundance in

Jigawa State. Since the target respondents are household heads, the study found that most of the households' heads were men (73.71%), while others were women. In addition, most of the female respondents were primarily widowed, while others were either divorced or separated.

Table 2: Summary of Households' Socioeconomic Characteristics

Variable	***Frequency***	***Percentage***
Origin		
Yes	219	87.25
No	32	12.75
Gender		
Male	185	73.71
Female	66	26.29
Settlement Status		
Rural	97	38.65
Urban	154	61.35
Age		
30 and below	47	18.73
31 - 40	97	38.65
41 - 50	73	29.08
Above 50	34	13.55
Family Size		
1 - 5	78	31.08
6 - 10	135	53.78
11 - 15	37	14.74
16 and above	1	0.40
Marital Status		
Married	202	80.48
Separated	10	3.98
Divorced	6	2.39
Widowed	33	13.15
Educational Attainment		
No formal education	4	1.59
Primary	83	33.06
Secondary	55	21.92
Tertiary	36	14.34
Koranic education	73	29.08
Occupation		
Public sector employee	42	16.73
Private sector employee	10	3.98
Farmer/Fisherman	99	39.44
Artisan	31	12.35
Trading/Business	60	23.90
Driver	9	3.59
Total	**251**	**100.00**

Source: Field survey 2018

Table 2: Summary of Households' Socioeconomic Characteristics (continued…)

Variable	***Frequency***	***Percentage***
Non-farm income (monthly)		
Below ₦ 15,000	88	40.18
₦ 15,000 - ₦ 30,000	60	27.40
₦ 30,000 - ₦ 45,000	36	16.44
₦ 45,000 - ₦ 60,000	18	8.22
₦ 60,000 - ₦ 75,000	12	5.48
Above ₦ 75,000	5	2.28
Farm income (annual)		
Below ₦ 60,000	32	13.73
₦ 60,000 - ₦ 120,000	83	35.62
₦ 120,000 - ₦ 180,000	54	23.18
₦ 180,000 - ₦ 240,000	24	11.16
₦ 240,000 - ₦ 320,000	20	8.58
Above ₦ 320,000	18	7.73
Housing Status		
Self-apartment	163	64.94
Tenant	20	7.97
Squatter	25	9.96
Compound house	43	17.13

Source: Field survey 2018

This is not surprising because the cultural norms of the people require that only men are regarded as heads of households. In other to capture the spatial distribution and differences of the respondents in terms of their experience of floods, the selected LGAs for the study comprised both urban and rural settlements. This explains why 38.65% of the total respondents had rural settlement status while 61.35% resided in urban settlements.

Looking at the age distribution of the respondents, it can be observed that only 13.55% of the respondents were above 50 years. This supports the national statistics on the age distribution of the population of Jigawa State which shows that majority of the people fall within the youthful category of the population (see, National Population Commission, 2016 report), implying the availability of a strong labour force available for economic activities, especially agricultural related activities which constitutes one of the major occupation of the people in

the study area. More than half (53.78%) of the households under study have a family size of between six (6) to ten (10) individuals per head. Generally, the average number of persons per household across the entire sample is 7. This suggests a population with high birth rate and high fertility rate. This is not surprising because the national average of individuals per household in Nigeria is 6. Most of the households' heads (80.48%) examined in this study were married, whereas, others were either separated (3.98%), divorced (2.39%) or widowed (13.15%). It is important to note here that none of the households considered had not experienced losses from floods of one form or the other in the past. About 69.33% of the respondents had at least, a minimum of primary school education. This figure is not impressive especially looking at their distribution from the perspective of the different individual levels of education. This result is not surprising though, considering the recent report by the National Bureau of Statistics (2018) which ranked Jigawa among one of the most educationally disadvantaged States in Nigeria. This also explains the reason why translation of the survey instruments was necessary in some cases to ensure the respondents understood the questions appropriately. In terms of occupation, farming/fishing (39.44%) was the most predominant activities, followed by trading activities (23.90%), most of which were in agricultural goods. Not so many of the respondents were employed in the public sector (16.73%) as expected. Across the sample, none of the household had insurance cover for their properties and business ventures. This explains the tendency to increase households' vulnerabilities to flooding in the study area. It also explains the need for increase education and sensitization of households on the benefits of taking insurance cover against floods. Furthermore, a significant proportion of the households (64.94%) live in apartments they own. Some others live in rented apartments (7.97%) and shared or inherited family compound houses (17.13%). It is important to note that the average number of years households have lived across the selected communities under study is between 23 and 34 years. In terms of

income from non-agricultural sources, 97.72% of the households earn less than $207 (₦ 75,000) on a monthly basis. This suggests that a significant proportion of the households may not be financially buoyant enough to cater for their basic needs considering average family size of 7 individuals per household. Over half of the respondents (58.8%) earn agricultural income of roughly between $165 to $497 (₦ 60,000 to ₦ 180,000) annually, while only 7.73% of them earn above $885 (₦ 320,000) per year. This sounds impressive though not surprising, considering the fact that agricultural activities are the most prominent in the study area among others.

Table 3: Households' Flood Coping Strategies

S/NO	List of Selected Flood Coping Strategies	Frequency	Rank
1	Use of savings from income	172	1st
2	Access to loans from cooperatives	137	4th
3	Access to loans credits banks	38	12th
4	Financial assistance from friends and family members	144	3rd
5	Flood insurance contribution	0	15th
6	Assistance from government	93	7th
7	Assistance from NGOs	19	13th
8	Communal safety nets	92	8th
9	Non-erosive flood recovery knowledge	108	6th
10	Access to flood emergency infrastructure	47	11th
11	Access to transport and communication, services	53	10th
12	Information from early warning systems	10	14th
13	Relocation of households	66	9th
14	Communal distilling of chocked gutters	151	2nd

15	Fencing of land	126	5th

Source: Field survey 2018

The distribution of household heads according to the coping strategies adopted against floods is presented in Table 3 above. The study revealed that 68.5% (172 out of 251 respondents) of the surveyed households adopted savings from income as a coping strategy against floods. This was ranked first among the coping strategies selected. Communal distilling of chocked gutters (60.2%), financial assistance from friends and family members (57.4%) and access to loans and cooperatives (54.6%) were ranked second, third and fourth respectively, in terms of households' adoption of the flood coping strategies. Access to credit from banks was one of the least adopted coping strategies to floods (that is,15.1% of the respondents). This is not surprising considering the low educational attainment of the respondents and unimpressive share of households working in both public and private sector of the State. This could explain to some extent, their inability to provide or meet the collateral security requirements of banks for issuing such loans during periods of need. More so, contributions from flood insurance was the least of adopted coping strategies. In fact, the study showed that none of the households affected by the flood event had their properties or farmlands insured against possible flood losses. This calls for greater education of households on the need and benefits of taking insurance cover for their farmlands and properties, and also the need to cooperate with local cooperative societies to better manage households' savings and contributions. These could also explain to some extent, the level of households' vulnerability to floods in the study area.

4.2 Causes of Frequent Flooding in Jigawa State

Several factors have been found to be responsible for the persistent flooding cases recorded in Jigawa State. From the household survey and interviews (Elders and Institutions) conducted, finding show that the causes of frequent flooding in the area ranges from heavy and prolonged

rainfalls, inadequate drainage facilities, mismanagement and dams and reservoirs located outside Jigawa State, infiltration of river/water pathways by weeds, topography of the area and vegetation of the area. Before discussing these findings, it is important to first of all provide proper details flood risk assessment of the study area, the hydrological structure of the study area, as well as the topography and vegetation of the study area. This will be very useful in providing better understanding of the causes observed.

The study first, categorizes the entire study area according to the level of risks and exposure to floods mainly into three (3) categories: high risk areas, moderate/medium risk areas and low risk area to floods. This was done to understand the differences in flood severity within the 27 LGAs of Jigawa State. With the help of Geographical Information Systems (GIS) and the Digital Elevation Model (DEM). The risk mapping was done using the Arc-GIS software and the results are presented in Figure 13 below.

Based on the mapping of the study area according to severity of flooding, the results showed that while 55% of the entire study area falls under high risk areas, 43.5% was within the moderate risk zone and the remaining 2.5% fell within the low risk areas to flood disasters. Specifically, we can see from the map that Local Government Areas (LGAs) like Auyo, Babura, Gagarawa, Gumel, Guri, Hadejia, Jahun, Kaugama, Kazaure, Kiri Kasamma, Malam Madori, Miga, Ringim, and Taura had most and in some cases, part of the areas falling under high-risk areas to flooding. LGAs such as Buji, Birninkudu, Dutse, Gwaram, Kafin Hausa, and some sections of Jahun and Roni fell within the moderate risk areas. However, low risk areas were found in parts of LGAs like Babura, Birniwa, Gwiwa, Kazaure, Maigatari, Roni, Sule Tankarkar and Yankwashi.

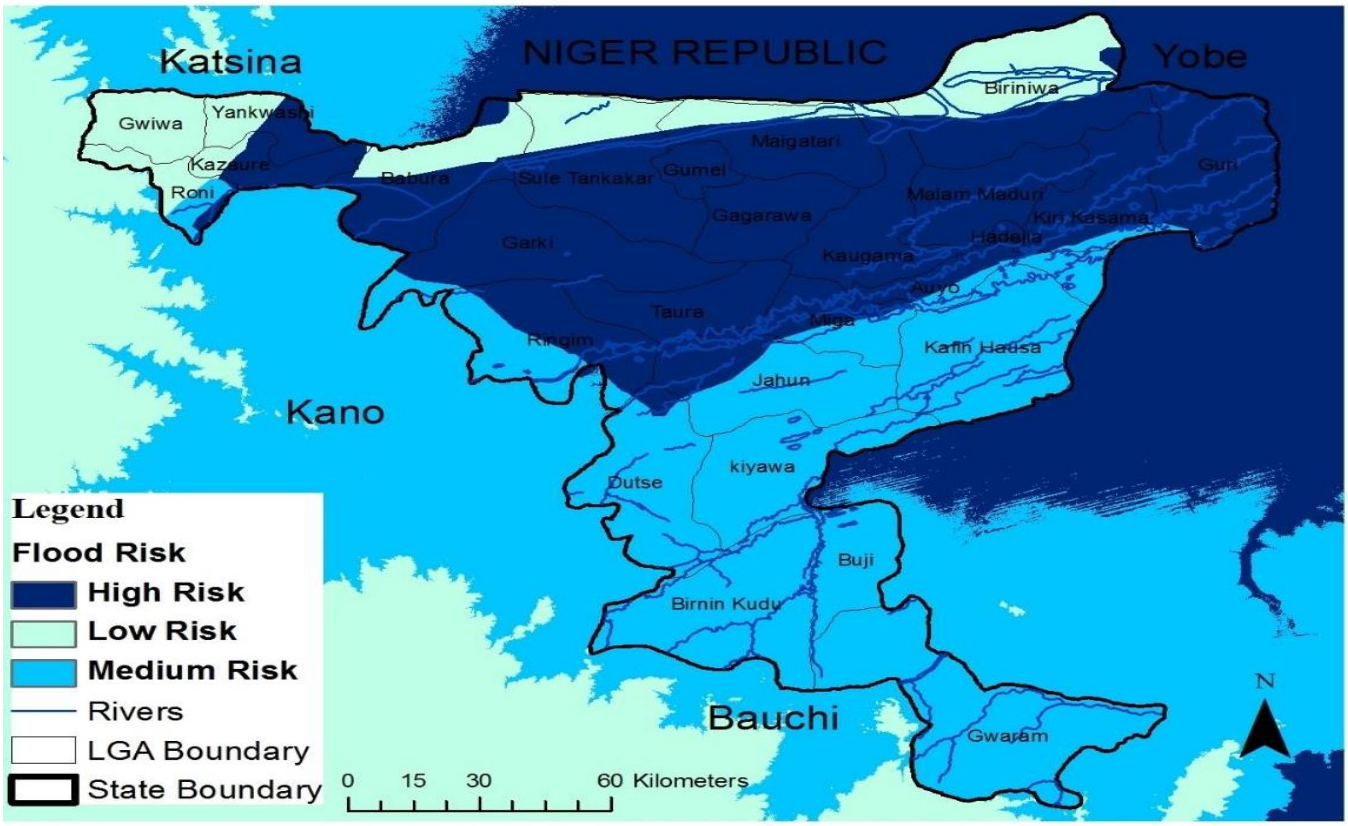

Figure 13: Mapping of Jigawa State by Flood Risk Level (Author's construct)

The Nigerian Hydrological Services Agency (NIHSA) has classified the hydrology of Jigawa State to lie within the Lake Chad Basin Hydrological area. Hadejia are Jama'are rivers are the major rivers stretching along the study area (cutting across a number of other States) and sometimes, influencing the flooding happening within LGAs located within the study by changing the activities taking place in both rivers. The construction of Tiga and Challawa George dams along the Hadeja river (located in Kano State) as well as the Kafin Zaki dam (located in Bauchi State) along the Jama'are river has really changed the natural drainage pathways of the rivers (Usman, Sunday & Alkali, 2016). Hence, during peak periods of rainfall, particularly in August and September, when the volume and flow of water increases, such that it outweighs the holding capacities of the dams and rivers, excess water flowing from these rivers results in flooding of communities located within some of the LGAs in Jigawa State. The situation is even worsened in wetland areas which constitutes about 14% of

the total land area in the State. Considering that at least 80% of Jigawa's landmass is arable, a lot of agricultural activities relies on water from these rivers and valley constructed during the dry season. It is not surprising that at least 85% of the population of the state engage in agricultural activities of different kinds as a means of sustenance. The diagram below gives a clearer picture of the hydrology of the study area:

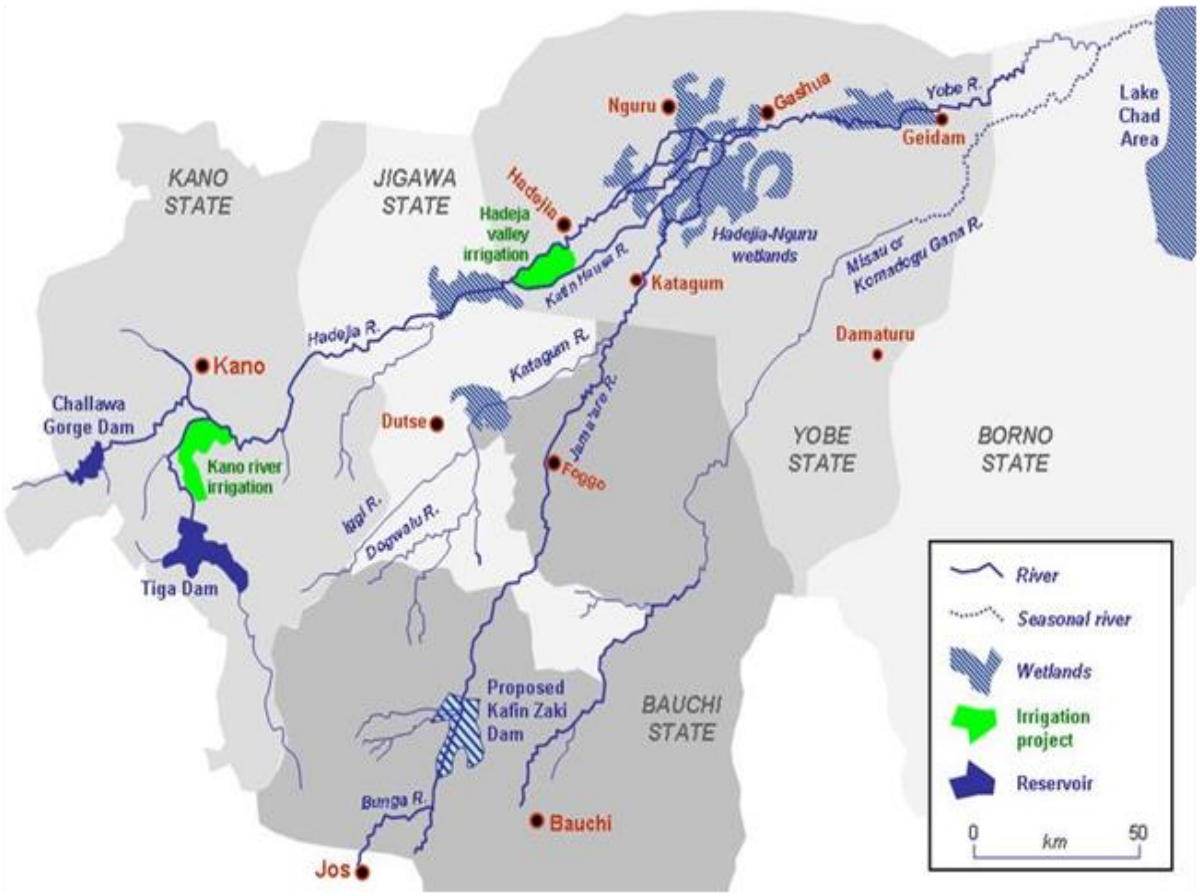

Figure 14: Hydrology of Jigawa State (Source: Suleiman, Creswell & Dami, 2014)

On the topography of the area, the soil type is mainly a combination of clay and silt soils. Other prominent features observed in the study area includes a combination of undulating land with sand dunes of different sizes stretching over several kilometres, as well as lowland areas, some of which is estimated to be around 297 meters above sea level. These lowland area harbours most of the floodplains in the area. Since the water retention capacity of the soil is not very high as expected if it was purely composed of clay soils, the lowland areas are

worst hit by the flooding during peak periods of raining seasons, which is further complicated by excess water discharge from overloaded dams and river channels. This reinforces the findings that mismanagement of dams and water reservoirs also contributes to the flood cases recorded in Jigawa State. In addition, results from interviews conducted with elders and institutions (NEMA) showed that river channels and dams are often blocked by water weeds and sand, thereby, reducing their water holding capacities. This implies that regular dredging of dams and rivers is necessary to reduce floods risk arising from excessive water discharge from these water bodies. Others, particularly, elders from Guri LGA were of the view that the chief cause of flooding in the area can be traced to the cultivation of rice along river valleys. All the elders were of the unanimous view that flooding started in the area when government-funded rice cultivation along the river valleys commenced. This is not neglecting the drainage infrastructural shortages identified in the area. It appeared to be nearly absent in the entire community (that is, Guri LGA). The residents therefore, recommended the need for the state government to provide rice farmers alternative locations for cultivation. They also emphasised the need to provide their communities with drainage infrastructures, particularly gutters and flood barriers to safeguard them against possible future flood disaster impacts.

In addition, findings based on the perception of households on the causes of frequent flooding in the area, it showed that 74.1% of them were of the view that heavy and prolonged rainfall was the major cause of flooding in the area. This perception is supported by data on the rainfall distribution for Jigawa State, obtained from the Nigerian Meteorological Agency, which showed that in nearly the last four to five decades (1986-2014), the average rainfall volume received in Jigawa State exhibited an increasing trend as shown in the Figure 15 below. Furthermore, the findings from the entire samples from all the four (4) LGAs covered showed that 13.9% were of the view that frequent flooding was caused by poor and/or lack of drainage infrastructure in their communities. The same views were also shared in responses of

elders and representatives of institutions who were interviewed. More so, the study found that only 8.33% of building materials used for construction of houses in the entire communities covered were made of concrete and bricks (made from a mixture of sand and cement). This suggests that 91.67% of the houses constructed or located in the area are likely not to withstand strong winds and flow of flood waters during peak periods of rainfall. Usually, peak periods of rainfall spans from mid-August to mid-September every year, and it is within this period that most of the cases of flood disasters are recorded. Therefore, the findings on the composition of building materials suggest one of the factors responsible for household vulnerability to flooding in Jigawa State. Lastly, the vegetation of the area falls under the Sudano-Sahelian type, with at least 70% of the area falling within the Sudan Savanah region, leaving the remaining parts under the Sahel type. This vegetation is mainly covered by grasses with few drought resist trees (Acacia, Gum Arabic, and date palm trees) which are sparsely scattered all over the region. Hence, the vegetation type or cover will not sufficient to provide enough cover for inhabitants against floods.

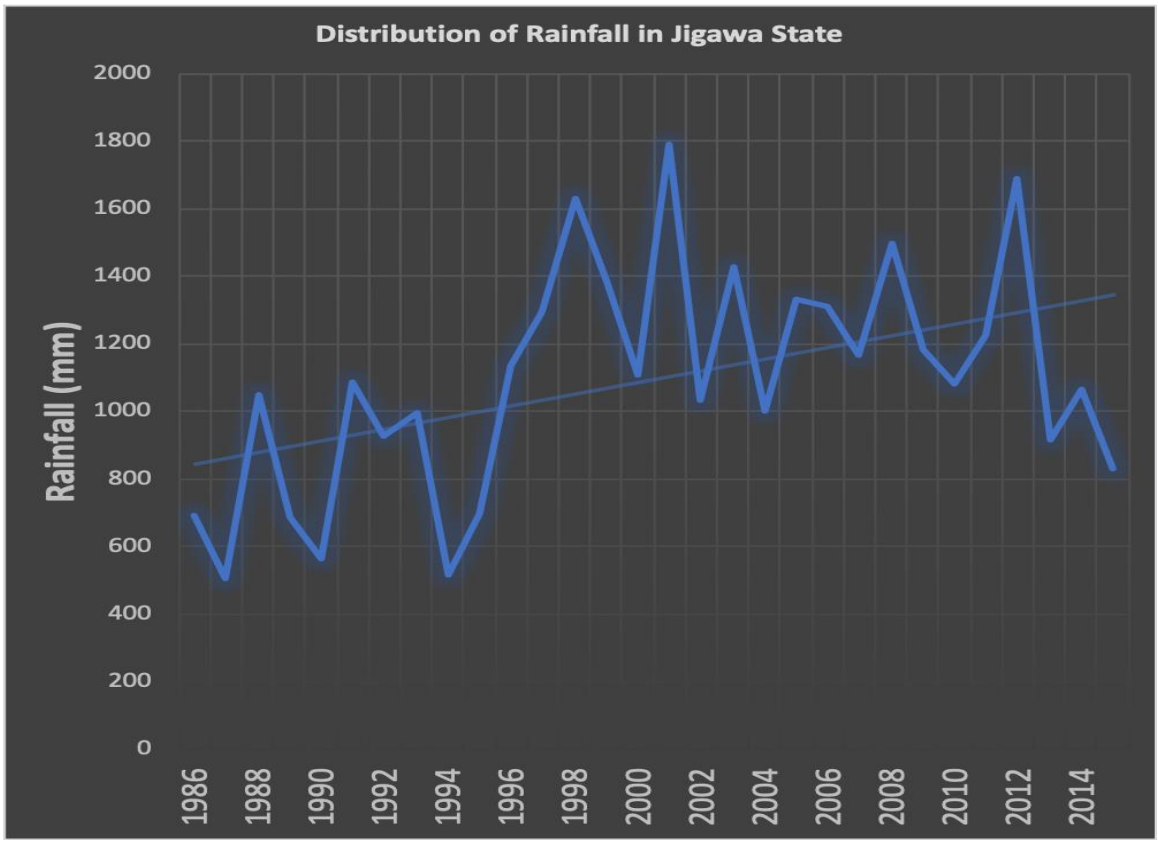

Figure 15: Trend of Rainfall Distribution in Jigawa State (Source: Author's construct based on NIMET Data)

4.3.2 FVI Results for Guri LGA

The Table below (Table 6) presents the Flood Vulnerability Index (FVI) for Guri LGA. From the table, the Hydro-climatic Flood vulnerability index (FVI) for Guri LGA is 90.30%, which shows a very high vulnerability in terms of this component. This very high vulnerability can be linked to very high exposure in terms the extent to which the flood water penetrated the houses affected (91.80%) and a very high exposure arising from a significant number of affected houses not located in elevated areas (88.52%). However, the proportion of affected households who indicated that the flood water height reached at least, their waist level was not that significant (21.43%), implying a very low exposure in relation to this indicator. Also, in terms of the regularity of flood occurrence, just above half the respondents (52.46%) indicated they experienced flooding every year (showing moderate exposure for the indicator)

Table 6: Flood Vulnerability Index (FVI) for Guri LGA

Components	Exposure		Susceptibility		Resilience		FVI
	Indicators	%	Indicators	%	Indicators	%	%
I. Hydro-Climatic	i. RFO ii. FH iii. HPFW iv. HNLEA	52.46 21.43 91.80 88.52	i. ANFY	21.00	i. LUMDS	14.78	90.30
II. Social	i. OAWD ii. RLR	94.11 16.39	i. LEA	35.79	i. WPTP	3.39	100.00
III. Economic	i. HWIS ii. HWWS iii. ARS iv. AWAS	100.00 22.95 93.44 81.97	i. HM	73.77	i. HHI ii. PIS	3.70 0.00	100.00
IV. Socio-Behavioural	i. PHFR	38.70	i. AHFR	60.45	i. KHFR	38.40	60.92
V. Politico-Administrative	i. RNRFMP ii. LUMDS	78.69 85.22	i. G	2.19	i. PFRAIP ii. SCLWP iii. RSP iv. DPP	6.56 4.92 0.00 1.64	54.72
Aggregate Mean FVI							81.19

Just as indicated in the discussion of FVI results for Ringim LGA, since the average number of flood cases per affected State in 2016 was 3.72, representing approximately 21% flood occurrence per state, we maintained the same valued for Guri LGA, as the average number of flood events recorded in Jigawa State in the same year. Hence, this value was maintained throughout the whole study for the other affected LGAs or communities. As part of commitments to ensuring resilience, the presence of the community's land use management and structural design (LUMDS) was about 14.78%, implying very low level of implementation of the LUMDS structure, thus, explaining the low resilience and high vulnerability in relation to these indicators.

For the social component, the FVI value was 100%. Open households' animal waste disposal was largely observed (94.11%) across the affected population in Guri LGA. Also, a significant proportion of households (83.61%) indicated their willingness to relocate to a new location if asked by the government do so, knowing fully well that the community they reside is one of high risks to flooding and due to the value attached to safety of lives and properties. In terms of educational attainment, only 35.79% of households had attained secondary and primary school education (basic education). This is unimpressive and this could constitute an important factor influencing the vulnerability of households to flooding in the area. Water purification and treatment practices (resilience factors) was very low (3.39%) or nearly absent among the inhabitants of the community. Again, this explains the very high flood vulnerability index for the social components. Hence, education of community members in this LGA on water treatment and sterilization practices must be taken very seriously to avoid possible outbreak of waterborne diseases during future flood episodes.

The economic FVI value for Ringim LGA is 100%, indicating a very high vulnerability as regards this component. This is simply explained by the very high exposure indicators except for the very low proportion of respondents (21.43%) who don't have access to quality

drinking water sources. While the study found that all households examined (100%) have no access to quality and improved sanitation services, 93.44% of them indicated the presence of rats in their vicinity, in addition to 81.97% of the affected households who live in waterlogged areas. Furthermore, the study showed that only 26.23% of the selected houses in the area can withstand strong winds and invasion of water during periods of heavy rains and flooding. In addition, while none of the selected flood victims had insurance cover for their properties and farmlands, only a very slim proportion of the population of household heads (3.70%) earns non-agricultural income not less than $165 per month. Hence, a very high exposure and very low resilience value accounts for the very high vulnerability index obtained for the economic component in Guri LGA.

For the socio-behavioural component, the FVI is 60.92%, indicating a high vulnerability. This value indicates that the community is likely not to be significantly affected by diseases associated with high risk flood areas, and its attendant effects, particularly during and after such natural calamities. Here, the vulnerability index was calculated in terms of households' knowledge, attitude and practices (KAP) of resilience to flooding (see, appendix section for more on the respective calculations) and this was assessed in relation to hazards, risks, exposure, preparedness, response, recovery, coordination and adaptation strategies. On this basis, 38.40% of the flood victims examined here demonstrated some knowledge in relation to building resilience to floods, 60.45% indicated they have positive attitude towards flood resilience, while approximately 38.70% claimed they do not practice the knowledge they have in the area of ensuring resilience to floods. Hence, this result shows that the fairly low exposure, high susceptibility and fairly low resilience accounted for the high FVI value for the socio-behavioural component for Guri LGA.

The politico-administrative FVI value is 54.72%, which indicates moderate vulnerability. This is so because it showed a high exposure vulnerability (81.96%), arising from poor attention

given to river and natural resource features management programmes (78.69%) and poor or inefficient land use management and design structure implementation (85.22%). Though, the susceptibility indicator, that is, governance was much very low (2.19%), resilience effort was also much very low (3.28%). This explains the moderate FVI value for the component. It is of importance however, to note that the average value of four (4) indicators: Post-flood risk assessment and integration (6.56%), sustainable community livelihood welfare programme (4.92%), relocation site projects (0.00%) and disease prevention programmes against malaria and diarrhea (1.64%) formed the resilience value.

The overall FVI for Guri LGA is 81.54% which falls within the very high vulnerability range. However, only 21.31% of the community members are actively involved in activities related to river and natural resource management, protection and implementation. This is again, a major source of concern, considering that river flood is the most dominant flood type in the area. Another area of concern is inefficient or low level of implementation of existing land use management and design structure or system (14.78% compliance). There is the need to incorporate both concerns into policies and building standards relating to hazard risk reduction and management. This cannot be possible without sensitizing and educating the community on the benefits and need to comply with land use policies and standards. Such outreach, combined with enforcement of these policies to ensure compliance will better the community, thereby boosting it resilience against future flood events. In addition, to ensure self-sufficiency and reduce overreliance on government, there is need to invest more in social capital development through ensuring greater skills acquisition in this community. This will help reduce peoples' vulnerability to hazards and improve the capacity to recover from flood disasters.

There is also the need for authorities to improve on post-flood assessment and integration, considering that its current state is not encouraging. There is also the need to provide

sustainable livelihood welfare programmes and establish relocation site projects for affected communities. The study has shown that such programmes and projects are nearly absent in this community. Furthermore, there is need to invest greatly in the area of evacuation and early warning systems in such communities. The establishment of disaster disease prevention programmes in necessary to prevent risk of disease outbreaks during and after periods of flooding. These must be taken seriously, and the disaster risk and management authorities must change their approach towards disaster response from its reactive approach to preventive approach. Assisting the vulnerable population with financial and technical support in relation to flood recovery and post-flood reconstruction activities is also necessary. More so, there is a need to invest in drainage infrastructure in the Guri LGA, as they appear to be almost non-existent in the affected flood areas. Drainage deficits and quality has been identified as one of the main contributors to flood vulnerability in this community just like others. The construction flood barriers around river boundaries is also very important boost the water holding capacity of rivers and prevent overflow during periods of heavy rainfall, which usually leads to flooding.

4.3 Determining the Level and Extent of Households' Vulnerability to Flooding in Jigawa State

Having conducted an extensive review on vulnerability index, we then proceeded to identify the relevant indices and components based on the guideline provided in the World Environmental Risk Index Report (2011), and existing studies like Balica et.al, (2012), Villordon & Gourbesville, (2016), among others. The components were upgraded to a more comprehensive format such that it could accommodate the use of country level data and facilitate community-level analysis on flood vulnerability. This was also made possible by categorising the indicators in such a way that it captures vulnerability to flooding in urban areas. By so doing, this aided the modification of existing Community-Based Flood

Vulnerability Index (FVI) equations, mainly due to the fact that these indicators were classified under exposure, susceptibility and resilience factors as shown in Table 4 below. The groupings of these indicators were further decomposed into five components: Hydro-Climatic, Social, Economic, Socio-Behavioural and Politico-Administrative components, such that they can be directly or indirectly linked to the vulnerability of people to flooding in the selected study area.

The calculation of the Community-Based FVI was done based on the relationship between the components and their respective indicators as shown in Table 4 below. The Guidelines of the World Environmental Risk Index Report, and from existing studies like Balica et.al, (2012) and Villordon & Gourbesville, (2016), were used as a guide in selecting the FVI indicators. Equal weights were assigned to most of the components and indicators after careful examination of the variables by the researcher showed a very marginal difference in the way the respondents evaluated the variables, even though, they considered some variables to be more important than others. In addition, a corresponding score was assigned to each question, depending on the respective answers provided per question.

Components of Flood Vulnerability	Indicators of Flood Vulnerability		
	Exposure	**Susceptibility**	**Resilience**
I. Hydro-Climatic Components	i. Regularity of flood Occurrence (RFO) ii. Flood Height (FH) iii. Houses Penetrated by Flood Water (HPFW) iv. Houses not Located in an Elevated Areas (HNLEA)	i. Average number of Floods in a year (ANFY)	i. Land Use Management and Design Structure (LUMDS)- Compliant
II. Social Components	i. Open Animal waste disposal (OAWD) ii. Reluctance to leave and be relocated (RLR)	i. Level of Education Achievement (From Secondary School Level and Below) (LEA)	i. Water Purification and Treatment Practices (WPTP)
III. Economic Components	i. Houses without access to better-quality sanitation services (HWIS) ii. Houses without access to better-quality water sources (HWWS) iii. Availability of rats in surroundings (ARS) iv. Availability of water logged Areas in surroundings (AWAS)	i. Housing materials (semi-concrete, tent and light materials, plastics, etc) (HM)	i. Household Head Income (Those with income above ₦60,000 per month) (HHI) ii. Property Insurance Status (PIS)
IV. Socio-Behavioural Components	PRACTICES of Households on flood resilience (in relation to hazards, risks, exposure, preparedness, response, recovery, coordination, adaptation strategies) (PHFR)	ATTITUDE of Households on flood resilience (in relation to hazards, risks, exposure, preparedness, response, recovery, coordination, adaptation strategies) (AHFR)	KNOWLEDGE of Households on flood resilience (in relation to hazards, risks, exposure, preparedness, response, recovery, coordination, adaptation strategies) (KHFR)
V. Politico-Administrative Components	i. River and Natural Resource Features Management Programme (RNRFMP) ii. Land Use Management and Design Structure (LUMDS-Non-compliant)	i. Governance (warnings, emergency response, evacuation and post-disaster recovery programmes) (G)	i. Post-Flood Risk Assessment and Integration Programme (PFRAIP) ii. Sustainable Community Livelihood Welfare Programme (SCLWP) iii. Relocation Site Project (RSP) iv. Disease Prevention Programmes (DPP)

Table 4: Relationship between the Flood Vulnerability Components and Indicators

For instance, yes and no answers were assigned scores 1 and 2 respectively (that is, yes = 1 and no = 2). Those with answers seriously, very seriously, lightly and very lightly, scores were assigned as follows: 1 = seriously, 2 = very seriously, 3 = lightly, 4= very lightly. Others include scores like 1 = strongly agree, 2 = agree, 3 = somewhat agree, 4 = disagree. Hence, the composite score, expressed in percentage (%) was arrived at by dividing aggregate of the item score by the highest score possible, then multiplying it by 100. Frequency tables accompanied by their corresponding frequencies (%), including their respective average scores were used to present summaries of the results. Values for standards deviations were used to capture the differences in responses where necessary.

The estimation of the Community-Based Flood Vulnerability Index (FVI) was done based on the general formulae for calculating flood vulnerability index as derived from the World Risk Index Report, as developed by Cendrero & Fischer (1997), who expressed vulnerability as function of exposure, susceptibility and resilience. and this is expressed below as follows:

$$FVI = \frac{E \times S}{R} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots . (1)$$

As pointed out earlier, the identified flood vulnerability indicators categorized into five (5) flood vulnerability factor components (Hydro-Climatic, Social, Economic, Socio-Behavioural and Politico-Administrative components) were integrated into the general FVI formulae shown above in equation (1).

Where: E represents exposure indicators/factors, S signifies susceptibility indicators and R stands for resilience factors. By implication, the FVI is calculated by dividing the product of exposure and susceptibility indicator by the indicators of resilience. This implies that an increase in the exposure and susceptibility indicators will increase the households' vulnerability to flooding, hence the situation of both indicators at the numerator. More so, the

resilience indicator is situated at the denominator, implying that an increase in household resilience decreases their vulnerability to flooding and vice versa (Cendrero & Fischer, 1997).

When the five flood vulnerability components are integrated into the general formulae for calculating FVI, the following FVI equations are obtained for each flood vulnerability component:

$$FVI_{hydro-climatic} = \int \frac{RFO, FH, HPFW, HNLEA \times NFY}{LUMDS} \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

$$FVI_{social} = \int \frac{OAWD, RLR \times LEA}{WPTP} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

$$FVI_{economic} = \int \frac{HWIS, HWWS, ARS, AWAS \times HM}{HHI, PIS} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

$$FVI_{socio-behavioural} = \int \frac{PHFR \times AHFR}{KHFR} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

$$FVI_{politico-administrative} = \int \frac{RNRFMP, LUMDS \times G}{PFRAIP, SCLWP, RSP, DPP} \ldots\ldots\ldots\ldots (6)$$

Therefore, to obtain the overall measure of the flood vulnerability index (FVI) is then obtained by taking the average of the parallel summation of all the individual measures of the FVI components (that is, by adding up equations 2 to 6) as shown below:

$$Overall\ FVI = \left\{ \frac{RFO, FH, HPFW, HNLEA \times NFY}{LUMDS} + \frac{OAWD, RLR \times LEA}{WPTP} + \frac{HWIS, HWWS, ARS, AWAS \times HM}{HHI, PIS} + \frac{PHFR \times AHFR}{KHFR} + \frac{RNRFMP, LUMDS \times G}{PFRAIP, SCLWP, RSP, DPP} \right\} \ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

Equation (7) gives a global FVI which combines different components of the system into one unit. Generally, and for better understanding, FVI values ranges between 0% and 100%. 0% and 100% indicates the lowest and highest possible FVI values under study respectively. Hence, the rankings of the Community-Based FVI in percentiles can be expressed in the following forms: 80% to 100%-very high vulnerability; 60% to 79%-high vulnerability; 40% to 59%- medium vulnerability; 20% to 39%-low vulnerability; and 0% to 19%-very low vulnerability. Therefore, the interpretations of the Community-Based FVI will be done following these guidelines. Furthermore, this implies a well-prepared community for flood events will have a very low flood vulnerability index, just as a low FVI index implies that the community in question is prepared for a flood event. More so, if the FVI is medium, it means some more effort is required to improve the community's resilience to floods. However, a high FVI suggests the need for authorities to give special attention to such communities by making effort in addressing areas of high vulnerability rankings, while a very high FVI implies more effort and greater attention needed areas of very low rankings.

The tables below present the individual results for the four (4) Local Governments Areas (LGA) or communities chosen within the study area, for which the application of the Community-Based Flood vulnerability index in urban areas is to be applied. This is then followed by the analysis and discussions of the results. The survey done to collect the data was necessary to examine the feasibility of the FVI indicators and components used. Though, inherent in this approach are a number of strengths and weaknesses, mainly arising from decision on the appropriate weights to assign and the restriction of the maximum FVI value to 100% (which means that any FVI value above 100% must be considered 100%). The aim here is to provide make comparison and provide explanations as to why a particular LGA or community is more vulnerable than others. Testing this methodology will make it easy to

point out the inherent strengths and weaknesses in the selected indicators and hence, the accuracy of the data.

4.3.1 FVI Results for Ringim LGA:

Table 5 below shows that the Hydro-climatic Flood vulnerability index (FVI) for Ringim LGA is 90.40%, which shows a very high vulnerability for this particular component. This very high vulnerability can be attributed to very high exposure in terms of the regularity of flood occurrence, that is on a yearly basis (83.96%) and the extent to which the flood water penetrated the houses affected (92.45%), as well as high exposure arising from a significant number of affected houses not located in elevated areas (65.09%). However, only 34.69% of the affected household indicated that the height of the flood water reached their waist level and beyond (waist level-32.65%; shoulder level-1.02%; roof level-1.02%), implying low exposure in this regard.

Table 5: Flood Vulnerability Index (FVI) for Ringim LGA

Components	Exposure		Susceptibility		Resilience		FVI
	Indicators	%	Indicators	%	Indicators	%	%
I. Hydro-Climatic	i. RFO ii. FH iii. HPFW iv. HNLEA	83.96 34.69 92.45 65.09	i. ANFY	21.00	i. LUMDS	16.04	90.40
II. Social	i. OAWD ii. RLR	88.89 14.15	i. LEA	34.80	i. WPTP	9.37	100.00
III. Economic	i. HWIS ii. HWWS iii. ARS iv. AWAS	67.92 16.04 90.57 62.26	i. HM	54.72	i. HHI ii. PIS	11.96 0.00	100.00
IV. Socio-Behavioural	i. PHFR	37.81	i. AHFR	63.09	i. KHFR	45.63	52.28
V. Politico-Administrative	i. RNRFMP ii. LUMDS	77.86 83.96	i. G	15.41	i. PFRAIP ii. SCLWP iii. RSP iv. DPP	20.75 4.72 1.89 3.77	100.00
Aggregate Mean FVI							88.54

Given that the study focused on victims of 2016 flooding in Jigawa State, data showed that a total number 67 flood cases were reported across 18 States of Nigeria in 2016, including Jigawa State. However, the average number of flood cases per affected state was 3.72. This represents approximately 21% flood occurrence per state. Hence this was considered a fair number to be used as the average numbers of flood events recorded in Jigawa State in 2016. Hence, this value was used throughout the whole research work.

As part of commitments to ensuring resilience, the presence of the community's land use management and structural design (LUMDS) was just 16.04%. This implies a very low level of implementation of the LUMDS structure, hence, explaining the low resilience and high vulnerability in relation to these indicators.

The FVI for the Social components was 100%. Open households' animal waste disposal was observed significantly (88.89%) across the selected population in Ringim LGA. In addition, a significant proportion of households (88.85%) indicated their willingness to relocate to a new site when advised by the government. This was so due to their recognition that they area they are located is one of high risk to floods and there was need to relocate for safety of their lives and properties. In terms of educational attainment, only 34.80% of households had attained secondary and primary school education (basic education), therefore, constituting an important predisposing factor. Water purification and treatment practices (resilience factors) was significantly low (9.37%) among the examined population. These explains the very high flood vulnerability index for the social components (that is, very high exposure and low resilience indicators). Also, this suggests the need give very important attention to water treatment and sterilization practices in future to avert possible outbreak of waterborne diseases during flood periods.

The economic FVI for Ringim LGA is 100%, indicating a very high vulnerability as regards this component. Far above half of the households (67.92%) have no access to quality and improved sanitation services. Fortunately, households without access to better-quality water sources stood around 16.04%. A very significant presence of rats (90.57%) was observed in this LGA coupled with 62.26% of households living in waterlogged areas. Also, the study showed that 54.72% of the housing conditions is incapable of resisting strong winds and invasion of water during periods of heavy rains and flooding. More so, considering an average number of 5 individuals per household, only about 11.96% of households earn non-agricultural income of at least N 60,000 ($165) per month. This implies that 88.04% of household live of income of less than $165 per month. It was also not surprising that none of the households had their houses, properties or farmlands insured. Therefore, the high exposure and very low resilience, in terms of the indicators of the economic component accounts for its very high vulnerability index or value.

For the socio-behavioural component, the FVI is 52.28%, representing a moderate vulnerability. This is value indicates that the community is likely not to be significantly affected by diseases associated with high-risk flood areas, and its attendant effects, particularly during and after such natural calamities. Here, the vulnerability index was calculated in terms of households' knowledge, attitude and practices (KAP) of resilience to flooding (see, appendix section for more on the respective calculations) and this was assessed in relation to hazards, risks, exposure, preparedness, response, recovery, coordination and adaptation strategies. On this basis, 45.63% indicated they have knowledge in relation to building resilience to floods, 63.09% indicated they have positive attitude towards flood resilience. However, only 37.81% claimed they do not practice the knowledge they have in the area of ensuring resilience to floods. This thus, shows that the fairly low exposure, high

susceptibility and fairly median resilience accounted for the moderate FVI value for the socio-behavioural component for Ringim LGA.

The politico-administrative FVI value is 100% which shows a very high vulnerability. This is so because it showed a reasonably high exposure vulnerability (80.91%), emanating from poor attention given to river and natural resource features management programmes (77.86%) and poor or inefficient land use management and design structure implementation practices (83.96%). Though, susceptibility, that is, governance was very low (15.49%), resilience effort was also very low (7.78%). The explains the very high FVI value for the component. It is important however, to note that the resilience efforts comprised of four (4) indicators: Post-flood risk assessment and integration (20.75%), sustainable community livelihood welfare programme (4.72%), relocation site projects (1.89%) and disease prevention programmes against malaria and diarrhea (3.77%).

The overall FVI for Ringim LGA is 88.54% which falls within the very high vulnerability range. Worthy of note however is the fact that 22.14% of the community members are actively involved in activities related to river and natural resource management, protection and implementation. This is a major source of concern, given that the flood type experienced in the area is river related (fluvial flooding). Another area of concern is inefficient or low level of implementation of existing land use management and design structure or system (16.04% compliance). There is the need to incorporate both concerns into policies and building standards relating to hazard risk reduction and management. This cannot be possible without sensitizing and educating the communities on the benefits and need to comply with land use policies and standards. Such outreach, combined with enforcement of these policies to ensure compliance will better the community, thereby boosting its resilience against future flood events. In addition, to ensure self-sufficiency and reduce overreliance on government, there is need to invest more in social capital development through ensuring greater skills

acquisition in this community. This will help reduce peoples' vulnerability to hazards and improve the capacity to recover from flood disasters.

There is also the need for authorities to improve on post-flood assessment and integration, considering that its current state is not encouraging. There is also the need to provide sustainable livelihood welfare programmes and establish relocation site projects for affected communities. The study has shown that such programmes and projects are nearly absent in these communities. Furthermore, there is need to invest greatly in the area of evacuation and early warning systems in such communities. The establishment of disaster disease prevention programmes in necessary to prevent risk of disease outbreaks during and after periods of flooding. These must be taken seriously, and the disaster risk and management authorities must change their approach towards disaster response from its current reactive approach to preventive approach. Assisting the vulnerable population with financial and technical support in relation to flood recovery and post-flood reconstruction activities is also necessary. More so, there is a need to improve on the drainage infrastructure in the Ringim LGA. Drainage deficits and quality has been identified as one of the main contributors to flood vulnerability in this community just like others. The construction flood barriers are also needed along river boundaries is also very important boost the water holding capacity of rivers and prevent overflow during periods of heavy rainfall, which usually leads to flooding. This can also be boosted by regular dredging of rivers, dams and ponds.

4.3.3 FVI Results for Hadejia LGA

Table 7 below presents the Flood Vulnerability Index (FVI) for Hadejia LGA. From the results presented in the table, the Hydro-climatic Flood vulnerability index (FVI) is 25.66%, which shows a low vulnerability in terms of this component. The low vulnerability can be attributed to very high exposure in terms the rate of occurrence of flooding as indicated on a yearly basis (85.42%), the very high proportion in terms of the ability of flood water to

penetrate houses in the affected areas (91.67%) and a high exposure arising from a quite high number of affected houses or residents not located in elevated areas (60.42%). However, the proportion of affected households who indicated that the flood water height reached at least, their waist level was quite low (27.27%), implying a very low exposure in relation to this indicator.

Table 7: Flood Vulnerability Index (FVI) for Hadejia LGA

Components	Exposure		Susceptibility		Resilience		FVI
	Indicators	%	Indicators	%	Indicators	%	%
I. Hydro-Climatic	i. RFO ii. FH iii. HPFW iv. HNLEA	85.42 27.27 91.67 60.42	i. ANFY	21.00	i. LUMDS	54.17	25.66
II. Social	i. OAWD ii. RLR	76.93 25.00	i. LEA	52.08	i. WPTP	2.33	100.00
III. Economic	i. HWIS ii. HWWS iii. ARS iv. AWAS	41.67 6.25 87.50 87.50	i. HM	45.83	i. HHI ii. PIS	6.98 0.00	100.00
IV. Socio-Behavioural	i. PHFR	35.76	i. AHFR	59.12	i. KHFR	44.29	47.73
V. Politico-Administrative	i. RNRFMP ii. LUMDS	39.58 45.83	i. G	18.05	i. PFRAIP ii. SCLWP iii. RSP iv. DPP	41.67 10.42 6.25 20.83	38.95
Aggregate Mean FVI							62.47

Similarly, as indicated in the discussion of FVI results for Ringim and Guri LGA, since the average number of flood cases per affected State in 2016 was 3.72, representing approximately 21% flood occurrence per state, we maintained the same valued for Hadejia LGA, as the average number of flood events recorded in Jigawa State in the same year. As part of the effort of authorities to ensure resilience to floods, the implementation and compliance with land use management and structural design (LUMDS) was quite impressive

(that is 54.17%) compared to the other LGAs discussed above. This indicates a moderate or considerable level of implementation of the LUMDS structure, thus, explaining the high resilience and hence, low vulnerability in relation to the hydro-climatic component for Hadejia LGA. The edge in terms of development Hadejia LGA has over other LGAs reinforces this result.

The social FVI component was 100%. Households' practice of open animal waste disposal was 76.93% among those examined. The proportion of households who indicated their willingness to relocate to a new location when advised by authorities was 72.92%. The remaining 25.53% either refused to comment or disagreed to relocate because they were not sure if where they are relocating to will provide them a better alternative. As regards basic educational attainment, about 52.08% of households examined here households had attained secondary and primary school education. This could be attributed as one of the major contributory factors of households' vulnerability to flooding in the area. Water purification and treatment practices (resilience factors) was almost absent (2.33%) among the selected inhabitants of the community. This accounts for the very high flood vulnerability index for the social component. The result also reinforces need to take education of community members in this LGA very seriously to avoid possible outbreak of waterborne diseases during future flood episodes.

The economic FVI is 100% for Hadejia LGA, showing a very high vulnerability. This is simply explained by the very high exposure indicators except for the very low proportion of respondents (6.25%) who don't have access to quality drinking water sources. The results also showed that 41.67% households examined had no access to quality and improved sanitation services, though 87.50% of them indicated the presence of rats in their vicinity, coupled with 87.50% of the affected households who live in waterlogged areas. More so, the findings showed that only about 45.83% of the selected houses in the area can withstand strong winds

and invasion of water during periods of heavy rains and flooding. Furthermore, all selected households here also had insurance cover for their properties and farmlands in addition to just 6.98% of them who receive a monthly non-agricultural income of a least $165. Thus, a moderate exposure and very low resilience indicators explains the very high vulnerability index obtained for the economic component in Hadejia LGA.

For the socio-behavioural component, the FVI was 47.73%, indicating a fairly moderate vulnerability. This is value indicates that the community is likely not to be significantly affected by diseases associated with high risk flood areas, and its attendant effects, particularly during and after such natural calamities. Also worthy of note is that the vulnerability index was calculated in terms of households' knowledge, attitude and practices (KAP) of resilience to flooding (see, appendix section for more on the respective calculations) and this was assessed in relation to hazards, risks, exposure, preparedness, response, recovery, coordination and adaptation strategies. The results show that 44.29% of the flood victims examined here demonstrated some knowledge in relation to building resilience to floods, 59.12% demonstrated positive attitude towards flood resilience, while approximately 35.70% of them indicated that they don't practice the knowledge they have on resilience to floods. Therefore, the results show that the low exposure, moderate susceptibility and fairly moderate resilience accounted for the moderate FVI value for the socio-behavioural component for this community.

The politico-administrative FVI value is 38.95% which indicates a low vulnerability. This is so, since the results show fairly moderate average exposure (42.71%), explained by some considerable level of non-implementation of river and natural resource features management programmes (39.58%) and some level of non-implementation of land use management and design structure (45.83%). Though, susceptibility, that is, governance was much very low (18.05%), resilience effort was nearly the almost the same as the former (19.79%). This

explains the low FVI value for the component. Again, it is of importance however, to note that the average value of four (4) indicators: Post-flood risk assessment and integration (41.67%%), sustainable community livelihood welfare programme (10.42%), relocation site projects (6.25%) and disease prevention programmes against malaria and diarrhea (20.88%) formed the value for resilience.

The overall FVI for Hadejia is 62.47% which falls within the high vulnerability range. Interestingly, around 60.42% of the community members are actively involved in activities related to river and natural resource management, protection and implementation. The level of non-implementation of the existing land use management and design structure or system was 45.83%. This show some level of integration of both indicators into policies and building standards relating to hazard risk reduction and management, though there is still need for more improvement especially in the area of enforcement. In general, Hadejia LGA appears to be more resilient/less vulnerable than other LGAs examined.

There is also the need for authorities to improve more on post-flood assessment and integration efforts. There is also the need to provide sustainable livelihood welfare programmes and establish relocation site projects for affected communities. The study has shown that the coverage of such programmes and projects is very limited in this community. Furthermore, there is need to invest greatly in the area of evacuation and early warning systems in such communities. The establishment of disaster disease prevention programmes in necessary to prevent risk of disease outbreaks during and after periods of flooding. These must be taken seriously, and the disaster risk and management authorities must change their approach towards disaster response from reactive to preventive approach. Assisting the vulnerable population financial and technical support in relation to flood recovery and post-flood reconstruction activities is also necessary. More so, there is a need to invest more in drainage infrastructure in the Hadejia LGA. Households in areas with significant drainage

deficits appears to be more vulnerable in this community. Drainage deficits and quality has been identified as one of the main contributors to flood vulnerability in this community just like others. The construction of flood barriers is also necessary along river boundaries to boost the water holding capacity of rivers and prevent overflow during periods of heavy rainfall, which usually leads to flooding. Regular dredging of rivers channels should be maintained.

4.3.4 FVI Results for Kafin Hausa LGA

Table 8 below shows the results of the Flood Vulnerability Index (FVI) for Kafin Hausa LGA. The Hydro-climatic Flood vulnerability index (FVI) is 78.46%, which implies a high vulnerability in terms of this component.

Table 8: Flood Vulnerability Index (FVI) for Kafin Hausa LGA

Components	Exposure		Susceptibility		Resilience		FVI
	Indicators	%	Indicators	%	Indicators	%	%
I. Hydro-Climatic	i. RFO ii. FH iii. HPFW iv. HNLEA	97.22 29.41 94.44 69.44	i. ANFY	21.00	i. LUMDS	19.44	78.46
II. Social	i. OAWD ii. RLR	92.86 13.89	i. LEA	47.22	i. WPTP	0.00	100.00
III. Economic	i. HWIS ii. HWWS iii. ARS iv. AWAS	80.56 0.00 97.22 83.33	i. HM	91.67	i. HHI ii. PIS	3.33 0.00	100.00
IV. Socio-Behavioural	i. PHFR	37.67	i. AHFR	60.41	i. KHFR	46.18	49.28
V. Politico-Administrative	i. RNRFMP ii. LUMDS	58.33 80.56	i. G	7.41	i. PFRAIP ii. SCLWP iii. RSP iv. DPP	11.11 0.00 0.00 5.56	100.00
Aggregate Mean FVI							85.55

This high vulnerability can be explained or linked to very high exposure in terms the rate of occurrence of flooding on a yearly basis (97.22%), the very high proportion in terms of the

ability of flood water to penetrate houses in the affected areas (94.44%) and a high exposure arising from quite a significant number of affected houses which are not located in elevated areas (69.44%), except for the proportion of affected households who indicated that the flood water height reached at least, their waist level was considerably low (29.41%), implying a low exposure in relation to this indicator.

Again, as explained in the previous discussions of FVI results, the average number of flood cases per affected State in 2016 was 3.72, representing approximately 21% flood occurrence per state. This value was used here for Kafin Hausa LGA, to represent the average number of flood events recorded in Jigawa State in the same year. Resilience efforts to floods on the part of authorities in terms of the implementation and compliance with land use management and structural design (LUMDS) was unimpressive (that is, 19.44% level of compliance). This value suggests the need for agencies in charge of implementation and enforcement land use guidelines to step up their effort in this regard. In summary, the high vulnerability FVI value in terms of the Hydro-climatic components, for Kafin-Hausa LGA can be simply attributed to the high exposure value and low resilience value of the indicators.

The social FVI component is 100%. The study observed a very predominant practice of open animal waste disposal (92.86%) among the examined households. The proportion of households who indicated their willingness to relocate to a new location when advised by authorities was also large (75.00%). Educational attainment among the selected households, that is, for those who had completed primary and secondary education was 47.22%. This could be attributed as one of the major contributory factors to households' vulnerability to flooding in the area. Water purification and treatment practices (resilience factors) was discovered to be completely absent among the selected inhabitants of the community. This accounts for the very high flood vulnerability index for the social component, owing to high exposure indicators and the absence of resilience practices. The result also reinforces need to

take education of community members in this LGA very seriously to avoid possible outbreak of waterborne diseases during future flood episodes. Also, programmes educating inhabitants on sanitation and water purification practices should be organized by authorities, in collaboration with health practitioners to help enlighten community members on such practices and its importance.

The economic FVI is 100% for Kafin Hausa LGA, showing a very high vulnerability. This is simply explained by high exposure indicators, though the results showed that all of the households examined in Kafin Hausa LGA have access to quality drinking water sources. While a high proportion of the households (80.56%) had no access to quality and improved sanitation services, 97.22% of them acknowledged the presence of rats in their vicinity and the results also showed that 83.33% of the affected households reside in waterlogged areas. Another alarming finding from the results is that only 8.33% of the examined households had houses which can withstand strong winds and invasion of water during periods of heavy rains and flooding. This is not surprising considering that only 19.67% of the selected flood victims complied with the existing land use management and design structures. Just as in the case with the other LGAs discussed, none of selected households had insurance cover for their properties and farmlands. Interestingly also, just around 3.33% households receive a monthly non-agricultural income of a least $165. This is also a clear case of very high exposure and low resilience on the average, which explains the very high FVI value obtained for the economic components in Kafin Hausa LGA.

The socio-behavioural FVI component is 49.28%, indicating a fairly moderate vulnerability. This is value indicates that the community is likely not to be significantly affected by diseases associated with high risk flood areas, and its attendant effects, particularly during and after heavy rainfall or flooding. However, this doesn’t exonerate the community from such happenings. It is important also to note that the vulnerability index was calculated in terms of

households' knowledge, attitude and practices (KAP) of resilience to flooding (see, appendix section for more on the respective calculations) and this was assessed in relation to hazards, risks, exposure, preparedness, response, recovery, coordination and adaptation strategies. The results show that 46.18% of the flood victims examined here demonstrated some knowledge in relation to building flood resilience practices, 60.41% indicated they have positive attitude towards flood resilience, while roughly around 37.67% of them showed that they don't practice the knowledge they have on resilience to floods. Hence, the results showed that low exposure combined with high susceptibility and a fairly moderate resilience value explains the moderate FVI value obtained for the socio-behavioural component for this community.

The politico-administrative FVI value here is 100%, which indicates a very high vulnerability. This is be explained again by a high exposure on the average (69.45%) and a low average resilience value (4.17%). The high exposure value comes from a high level, in terms of non-implementation of land use management and design structure (80.56%) and a fairly moderate level of non-participation in river and natural resource features management programmes (58.53). Susceptibility, that is, governance indicator was very low (7.41%) as well as resilience efforts which was nearly almost absent (4.17%). This was obtained from the average value of four (4) indicators: Post-flood risk assessment and integration (11.11%), sustainable community livelihood welfare programme (0.00%), relocation site projects (0.00%) and disease prevention programmes against malaria and diarrhea (5.56%).

The overall FVI for Kafin-Hausa LGA is 85.55% which falls within the very high vulnerability range. This can be generally explained by high exposure values across the five components and low resilience values for most of the resilience indicators. Greater attention must be given to efforts to improve education, improved compliance to land use and management design structures, participation in river and natural resource features management programmes, post-flood risk assessment, community livelihood development

welfare schemes, disease control and prevention programmes and construction of alternative relocation sites for flood victims. This necessitates the need for the integration of some of the key indicators identified, into policies and building standards relating to hazard risk reduction and management.

Furthermore, there is need to invest greatly in the area of evacuation and early warning systems in this community. The establishment of disaster disease prevention programmes in necessary to prevent risk of disease outbreaks during and after periods of flooding. These must be taken seriously, and the disaster risk and management authorities must change their approach towards disaster response from reactive to preventive approach. Assisting the vulnerable population financial and technical support in relation to flood recovery and post-flood reconstruction activities is also necessary. More so, there is a need to invest more in drainage infrastructure in the Kafin Hausa LGA. Drainage deficits and quality has been identified as one of the main contributors to flood vulnerability in this community just like others. The construction flood barriers along river boundaries is also very important boost the water holding capacity of rivers and prevent overflow during periods of heavy rainfall, which usually leads to flooding. Regular dredging of rivers channels should be given serious attention.

4.3.5 FVI Results for the Overall Study Areas Covered

Table 9 below shows the overall Flood Vulnerability Index (FVI) results for the whole study area (that is, combining the whole sample or for the four LGAs combined). The Hydro-climatic Flood vulnerability index (FVI) is 60.46%, which shows a high vulnerability value for the component. This high vulnerability can be accounted for by the high exposure in terms the rate of occurrence of flooding (78.49%), that is based on those who are of the perception that flooding is experienced on a yearly basis. In addition to that, the flood water penetrated a significantly large proportion of houses within the affected area (92.43%), with about 70.52%

of the affected homes located in non-elevated areas. However, only 29.31% of the affected respondents indicated that the flood water height reached at least, their waist level, showing a low value of exposure in terms of the indicator.

Table 9: Flood Vulnerability Index (FVI) of the overall Sample for the Four (4) LGAs

Components	**Exposure**		**Susceptibility**		**Resilience**		**FVI**
	Indicators	%	Indicators	%	Indicators	%	%
I. Hydro-Climatic	i. RFO ii. FH iii. HPFW iv. HNLEA	78.49 29.31 92.43 70.52	i. ANFY	21.00	i. LUMDS	23.51	60.46
II. Social	i. OAWD ii. RLR	88.48 16.73	i. LEA	41.05	i. WPTP	5.25	100.00
III. Economic	i. HWIS ii. HWWS iii. ARS iv. AWAS	72.51 13.55 91.63 74.90	i. HM	62.94	i. HHI ii. PIS	7.76 0.00	100.00
IV. Socio-Behavioural	i. PHFR	37.61	i. AHFR	61.68	i. KHFR	44.08	52.63
V. Politico-Administrative	i. RNRFMP ii. LUMDS	67.73 76.49	i. G	11.55	i. PFRAIP ii. SCLWP iii. RSP iv. DPP	19.92 5.18 1.99 6.77	98.39

Aggregate Mean FVI	82.30

Since the average number of flood cases per affected State in 2016 was 3.72, representing approximately 21% of flood occurrence per state, this figure was applied to the whole sample, just as was done in the case of the respective individual LGAs. This implies that the value represents the average number of flood events recorded in Jigawa State in the same year. The overall resilience efforts to floods on the part of authorities in terms of the implementation and compliance with land use management and structural design (LUMDS) showed an expression of 23.51% level of compliance. This value suggests there is still so much work left to be carried out by institutions in charge of implementation and enforcement of land use guidelines. Also, there is need to consider relocating flood victims from high risk areas to more safer locations.

The social FVI component is 100%, representing a very high vulnerability for the overall sample. In general, the results present an observed widespread practice of open animal waste disposal (88.48%) across the entire households examined. Households who indicated their willingness to relocate to a new location when advised by authorities constituted approximately 81.27%. The results also showed that 41.05% of those examined across the selected LGAs have completed primary and secondary school education. This is generally not encouraging. It is not surprising too that Jigawa State is ranked according to the latest National Bureau of Statistics (NBS, 2018) report as one of the most educationally disadvantage states in Nigeria. Quite a number of households examined had no form of formal education before. Unimpressively, only 5.25% of households indicated they applied any of the water purification and treatment practices. Certainly, this is one of the factors that contributes to vulnerability of households during and after periods of floods, thus, making them less resilient. This accounts for the very high flood vulnerability index for the social

component, owing to high values observed among the exposure indicators and low resilience practices. By implication, education should form part of the top developmental agenda for the state. The result also reinforces need to take education of community members across all LGAs very seriously to avoid possible outbreak of waterborne diseases during future flood episodes. Also, programmes educating inhabitants on sanitation and water purification practices should be organized by authorities, in collaboration with health practitioners to help enlighten community members on such practices and its importance. This must be done across board, or all over the affected LGAs.

The economic FVI for the overall sample is 100%, and this shows a very high vulnerability. This is again explained by high values for the exposure indicators and very low values for the resilience indicators. As can observed from the results, there was a huge indication of the presence or availability of rats in their vicinities (91.63%) among the respondents, in addition 74.90% of the affected households living in waterlogged areas. More so, a high proportion of the households (72.49%) had no access to quality and improved sanitation services. An area of serious concern from the results obtained is the fact that out of all the households examined, around 62.94% of them live in houses which cannot resist strong winds and heavy water flow during rainfall and flooding periods in particular. The fact that only about 23.51% of the households appeared to have complied with the existing land use management and design structure reinforces above findings. It is important to note that this concern does not only pertain to the overall sample, but cuts across each of the LGAs considered. Households adoption of insurance as a cover for properties and farmlands was completely absent across the overall sample and in like manner (as in the case of the individual LGAs), households earning monthly income from non-agricultural sources of not less than $165 were very small (7.76%).

The socio-behavioural FVI component is 52.63%, indicating a moderate vulnerability. This is value indicates that across the entire sample, households are less likely to be significantly affected by diseases associated with high-risk flood areas, and its attendant effects, particularly during and after heavy rainfall or flooding. It is important reemphasize that the vulnerability index was calculated in terms of households' knowledge, attitude and practices (KAP) of resilience to flooding (see, appendix section for more on the respective calculations) and this was assessed in relation to hazards, risks, exposure, preparedness, response, recovery, coordination and adaptation strategies. From the results, 44.08% of the flood victims examined here demonstrated some knowledge in relation to flood resilience practices, 61.98% indicated a positive attitude towards flood resilience, while approximately 37.61% of them showed they don't practice the knowledge they have on resilience to floods. This therefore accounts for the moderate vulnerability value obtained for the socio-behavioural component from the entire sample.

The politico-administrative FVI value here is 98.39%, which indicates a very high vulnerability in terms of the component. This can be again explained by a high average exposure value (72.11%) and a very low average resilience value (8.47%). The high exposure value comes from a high level, in terms of non-implementation of land use management and design structure (76.49%) as well as a high level of non-participation in river and natural resource features management programmes (67.73%). Governance contribution to resilience as indicated by the affected households was just about 11.55%. The value for the resilience indicator was very low (8.47%) and this was obtained from the average value of four (4) indicators: Post-flood risk assessment and integration (19.92%), sustainable community livelihood welfare programme (5.18%), relocation site projects (1.99%) and disease prevention programmes against malaria and diarrhea (6.77%).

The overall FVI value for the entire sample is 82.30%, which falls within the very high vulnerability range. This can be generally explained by high exposure values across the five components and low resilience values for most of the resilience indicators. Greater attention must be given to efforts to improve education, improved compliance to land use and management design structures, participation in river and natural resource features management programmes, post-flood risk assessment, community livelihood development welfare schemes, disease control and prevention programmes and construction of alternative relocation sites for flood victims. This also indicates the need for integration of some of the key indicators identified, into policies and building standards relating to hazard risk reduction and management. This aspect must be given special priority.

Furthermore, there is need to invest greatly in the area of evacuation and early warning systems in such communities. The establishment of disaster disease prevention programmes is necessary to prevent risk of disease outbreaks during and after periods of flooding. These must be taken seriously too, and the disaster risk and management authorities must change their approach towards disaster response from the present reactive approach to a more preventive one. Assisting the vulnerable population with financial and technical support in relation to flood recovery and post-flood reconstruction activities is also critical here. More so, there is a need to invest more in drainage infrastructure across all LGAs. Drainage deficits and quality has been identified as one of the main contributors to flood vulnerability across communities within the study area. There is also the need to construct flood barriers along river boundaries to strengthen the water holding capacity of rivers concerned and prevent overflow during periods of heavy rainfall. Regular dredging of rivers channels should be maintained. For all these to be given proper attention, both State and National Emergency Management Agencies (SEMA) and the National Emergency Management Agency (NEMA), which are institutions responsible for addressing issues related to hazards such as floods, must

change their approach from disaster risk management to focus more on disaster risk reduction approaches.

4.4 Factors Influencing the Adoption of Flood Coping Strategies

Table 10 below presents a description of the variables used to estimate the Multivariate Probit regression model to determine the factors influencing households' choice of coping strategies.

Table 10: List of Variables and Definitions

Variable	Definition and measurement
Origin	Dummy: 1 if household is located in their original home local government area, 0 if not.
Guri	Dummy: 1 if household head is located in Guri local government area, 0 if otherwise.
Hadeja	Dummy: 1 if household head is located in Hadeja local government area, 0 if otherwise.
Kafin Hausa	Dummy: 1 if household head is located in Kafin Hausa local government area, 0 if otherwise.
Sex	Dummy: 1 if household head is a male and 0 if a female
Age	The total number of years from birth of a household head.
Family size	The total number of nuclear household members of a household head
Marital status	Dummy: 1 if household head stays with spouse(s) and 0 if otherwise.
Education	The total number of years of formal education a household head had.
Occupation	Dummy: 1 if the primary occupation of a household head is non-farm and 0 if main occupation is farming.
Agric income	The total amount of income from agricultural activities in a year (Naira)
Non-agric. income	The total amount of income from non-agricultural activities in a year (Naira)
House status	Dummy: 1 if household heads lives in own residence and 0 if otherwise.
OSC	Dummy: 1 if there is located in an area with Open Sewage or Canal
SEA	Dummy: 1 if household is Situated in an Elevated Area (HSEA), and 0 if otherwise.
ALFHA	Dummy: 1 if household head is Aware of Location in Flood Hazard Area (ALFHA) hence at high flood risk, and 0 if otherwise.
LERG	Dummy: 1 if there is a Local Emergency Response Group (LERG) in the community of the household head and 0 if otherwise.
AFRP	Dummy: 1 if household head is aware of flood related program (AFRP) in the local government area and 0 if otherwise.
EFWSC	Dummy: 1 if household head is located in a community where there is an early flood warning system in the community (EFWSC) and 0 if otherwise.

4.4.1 Model Diagnosis

The Wald chi square of the model is 289.72 and this is significant at 1%. This implies that the model has significantly explained the variations in the adoption of flood coping strategies. Similarly, the joint correlation of the seven models show a chi square value of 28.02 and this was also significant at 5%. This implies that the error terms in the seven models are correlated, hence, the estimation of a multivariate probit is justified. While the paired correlation among the models shows both positive and negative correlations, some shows a significant correlation while others do not. However, only three of the paired correlations were statistically significant.

Table 11: Correlation Matrix

X	assistance_govt	c_safety_nets	relocation	assistance_fr	Distilling
	-0.159				
c_safety_nets	(0.120)				
	-0.167	-0.205			
relocation	(0.139)	(0.130)			
	-0.162	-0.113	0.057		
assistance_fr	(0.111)	(0.112)	(0.107)		
	0.240**	0.131	-0.220**	0.051	
distiling	(0.109)	(0.115)	(0.112)	(0.106)	
	-0.038	0.172	0.076	-0.398***	0.155
Credit_b	(0.175)	(0.157)	(0.149)	(0.152)	(0.152)

Note: *, **, * represents 10%, 5% and 1% significance level respectively**

4.4.2 Determinants of Households' Adoption of Flood Coping Strategies

This section discusses the results from the multivariate probit model. A number of factors had significant effects on specific coping strategies as shown in Table 12 and 13, and these variables are discussed below.

The effect of sex is positive and significant in explaining the decision to relocate from the current residential area to another area. The positive effect means that the male heads have a higher probability of relocating to different areas as a flood adaptation measure than the females. This is consistent with arguments that males often migrate during climate shock

periods and leave their families behind, primarily to obtain income in these new areas to cushion the families left behind. Although insignificant, female heads have a higher probability of seeking assistance from govern and friends as well as obtaining credit from banks for adapting to floods. These collaborate with the positive effect of sex on relocation.

Table 12: Summary of the Determinants of Households' Choice of Flood Coping Strategies

Variable	Assistance from Govt	Communal safety nets	Relocation	Assistance from friends	Distilling	Credit from Banks
	Coef.	Coef.	Coef.	Coef.	Coef.	Coef.
Origin	0.225	0.411	0.732**	-0.04	-0.446	0.333
Guri	-0.543*	-1.131***	-0.850**	-0.05	-0.515**	0.306
Hadeja	1.694***	-0.042	-1.200***	-0.86***	-1.183***	-0.800**
K/Hausa	0.880**	-1.198***	-1.384***	-0.64**	-0.741	-0.020
Sex	-0.433	0.152	0.797**	-0.18	-0.037	-0.020
Age	-0.007	0.025*	-0.006	0.032**	0.020	0.032
Family size	0.063	-0.036	0.024**	-0.08*	-0.067	-0.045
Marital status	-0.078	0.062	0.365**	-0.06	0.066	0.031
Education	-0.020	-.0.084**	0.055	-0.09***	-0.035	0.114***
Occupation	0.182	0.029	-0.094	0.389*	0.307	1.130***
Agric Inc.	0.0001*	0.000	0.000	0.000	0.000	0.000
Non Agric Inc.	0.001	0.000*	0.000	0.000	0.000	0.000
Housing status	-0.013	0.049	-0.012	-0.17**	0.153*	-0.126
OSC	0.267	0.294	0.201	0.493**	0.322	-0.012
SEA	-0.207	0.411**	-0.504**	0.216	0.111	0.048
ALFHA	0.225	-0.256	0.055	-0.370	0.669**	1.021*
LERG	-0.003	-0.589*	-0.745*	0.400	-0.072	0.341
AFRP	0.805***	0.385	0.037	-0.28	-0.042	0.757**
EFWSC	0.052	-0.080	0.247	0.608	0.213	-1.415**
Constant	-0.958	-1.121	-2.793***	0.955	-0.228	-5.231***

Note: *, **, * represents 10%, 5% and 1% significance level respectively.**

Age had positive effect on all flood adaptation decisions except the decision to seek assistance from government and relocation. However, the effects are only statistically significant for the decisions to seek assistance from friends and communal safety nets as flood adaptation measures. This implies that the probability of seeking assistance from friends or accessing

communal safety nets is higher for the elderly than the younger household heads. This is conceivable considering that the older household heads may have colleagues who are capable of providing financial assistance to them. Also, the elderly has high influence in the communities, therefore, it is possible they would use this influence in accessing community safety nets.

The total number of nuclear family members had a negative effect on all flood adaptation strategies except assistance from government and relocation. However, the effect is only statistically significant for the decision to seek assistance from friends. Thus, the higher the number of family members, the lesser the probabilities of access to assistance from friends. Although the family size is not a criterion for access to assistance from friends, it is possible that households with larger members may be sceptical on their ability to use financial assistances from friends for the adoption flood resilience and coping strategies. Also, it is difficult for people to provide assistance to people with larger household sizes since they are more likely to use the assistances provided for direct consumption.

The effect of marital status on relocation is positive and statistically significant at 5%. For all other flood adaptation strategies, the effect was insignificant. The positive significance effect means that household heads who stays with their spouses at the same household have a higher probability of relocating than those who currently do not stay with their spouses or are single. This can be due to the possibility that household heads who stay with their spouses may take collective decision that would allow the household head or a member of the family to relocate to other areas, especially with high economic returns while they can still be another responsible person to ensure the home upkeep. On the other hand, one would argue that the single should have a higher probability of relocating since their decision making can be fast and may have low limitations for relocating.

Education had positive significant effect on access to credit from banks and a negative significant effect on seeking assistance from friends and community safety nets. Thus, while respondents who had higher years of formal education have a higher probability of accessing credit from banks, the less educated on the other hand have higher probabilities of adopting seeking assistance from friends or accessing communal safety nets as flood coping strategies. The positive effect of education of credit access was expected since all processes to access credit are formal and require that anyone applying for same have some level of formal education to be able to read, write and understand the terms and conditions of the credit facility. Also, education generally drives people from searching for informal coping strategies such as assistance from friends that may have no terms of reference. Also, communal safety nets are usually a reserved strategy for people with low education and who may be incapable of adopting personal flood coping strategies.

The occupational status of a respondent had significant effect on access to credit and assistance from friends as flood coping strategies. In this instance, occupation had a positive significant effect on adoption of flood coping strategy. This implies that household heads whose current occupation is non-farming have a higher probability of accessing credit from the banks as well as obtaining assistance from friends. This is conceivable as credit disbursement and access by farmers in Nigeria is generally low, relative to other non-farm activities. However, one would expect that farmers would have a higher probability of seeking assistance from their friends due to the high cohesion among farmers than other workers.

Two income sources were considered, income agriculture and income from non-agricultural activities. From the result, while income from agriculture had positive effect on seeking assistance from government, income from non-agricultural activities had positive significant effect on communal safety nets. Income is an important tool for enhancing the adaptation to climate shocks such as floods. In most agrarian communities, the high-income earners are

often given or obtain higher authorities in various leadership positions. Therefore, considering that government assistance is provided through the community elders while communal safety nets are determined by the community elders, it is highly plausible that the high-income earners may use their influence to obtain assistance from government and communal safety nets.

The housing status of the household head had a negative significant effect on accessing financial assistance from friends and relatives but a positive significant effect on distilling. This implies that while household heads residing in personal apartments have a lower probability of accessing financial assistance from friends and relatives while they have higher probability of distilling in order to avert flooding. The fact that household heads living in their own accommodation have higher probability of distilling is plausible since they often see the accommodations as their properties which can be affected by floods, hence, engage in frequent distilling of open and close gutters in their vicinity. On the other hand, household heads who resides in rented accommodations may feel that they can easily move into a different house or a different direction, hence, there is no need to engage in communal activities such as distilling.

The result shows that locating in an elevated area have significant effect on accessing communal safety nets and relocation. However, while the effect on communal safety nets is positive, the effect on relocation is negative. Thus, household heads whose houses are located in elevated areas have higher probability of accessing communal safety nets while they have a lower probability of relocating to other areas. These observations are consistent with the researcher's expectation. It is expected that households located in low-lying areas would be more willing to relocate to high lying areas since flooding is likely to have high impacts on the former areas than the latter areas.

ALFHA had positive significant effect on the decision to adopt distilling and accessing credit from banks and flood coping strategies. This implies that household heads that are aware that they are located in flood hazard areas have higher probabilities engaging in distilling and accessing credit from banks. Thus, been aware of the potential of flood occurrence, households may engage in coping strategies such as distilling that can either reduce the potential impacts of floods or engage in strategies such as access to credit that can be used to recover quickly from flood events. This justified the need to enhance the understanding of households on the nature of the geographical locations to enhance their decision making.

LERG had a negative significant effect on the decision to relocate and the access communal safety nets. Thus, household heads who have local emergency groups in their communities have lower probability of accessing communal safety nets and also relocating. This is consistent with the expectations of the researcher since the households would become complacent that the emergency groups can come to their aids during any flood or climate shock events. Thus, with the presence of local emergency response groups, the level of impact of floods would be reduce, hence, households may feel slightly secure in the presence of such groups. Since the local government response teams are far from the communities or households, the local community response teams become a first-hand source of response team to the households. This result also implies that households have high confidence on local emergence response teams and must therefore be strengthened to ensure that they deliver high standard services to their community members during flood periods.

Expectedly, AFRP had a positive significant effect on the decision to seek assistance from the government and/or access credit from the banks. This implies that households who are aware of flood related programs in their local government areas have a higher probability of adopting these flood coping strategies. These flood related programmes usually expose households to the government opportunities available to flood victims and the potential role of

accessing credit in coping with flood events. Thus, these programmes enhance the households understanding of and expose them to taking flood coping strategies.

EFWSC had positive effects on the adoption of all flood coping strategies except communal safety nets and access to credit from the banks. However, the effect is significant for only access to credit from the banks. This result implies that household heads that are located in communities with early flood warning systems in their various communities have lesser probability of accessing credit from banks as a coping strategy. This is plausible since the presence of these early warning systems means that the households would be aware of the floods before they occur. In this case, the households can take some precautionary and temporal measures to avert the impacts. Hence, there would be a lower motivation for accessing credits as a way of coping with floods.

Origin had a positive effect on the decision to relocate as a flood coping strategy. Thus, household heads who are located in their home local government area had a higher probability of relocating to other areas in order to cope with floods. This is contrary to the researcher's expectations since it is expected that these households would be determined to stay in their home local government areas irrespective of climate shocks. In other words, the migrating households are expected to have high probability of migrating to other areas, perhaps, their home local government areas, in the periods of floods.

The local government area variables also had significant effect on various flood coping strategies relative to households in Ringim (the reference group). For instance, households located in Guri local government area have lesser probabilities of seeking assistance from government, distilling, accessing communal safety nets and relocating, relative to the households in Ringim local government area. Also, while households located in Hadeja local government area have lower probabilities of relocating, accessing assistance from friends and distilling, these households also have higher probability of accessing assistance from the

government, relative to those in Ringim. Locating in Kafin Hausa local government area have significant effect on all coping strategies. However, while the effect on assistance from government and accessing credit from banks are positive, communal safety nets, distilling and assistance from friends are negative.

Table 13: Determinants of Households' Choice of Flood Coping Strategies

Variable	assistance_govt		c_safety_nets		relocation		assistance_fr		distiling		credit from banks	
	Coef. (Std. Err)	Z-Value [P-Value]	Coef. (Std. Err)	Z-Value [P-Value]	Coef. (Std. Err)	Z-Value [P-Value]	Coef. (Std. Err)	Z-Value [P-Value]	Coef. (Std. Err)	Z-Value [P-Value]	Coef. (Std. Err)	Z-Value [P-Value]
Origin	0.225 (0.322)	0.700 [0.484]	0.411 (0.300)	1.370 [0.171]	0.732** (0.372)	1.970 [0.049]	-0.04 (0.271)	-0.14 [0.892]	-0.446 (0.278)	-1.61 [0.108]	0.333 (0.529)	0.630 [0.529]
Guri	-0.543* (0.289)	-1.880 [0.060]	-1.131*** (0.296)	-3.810 [0.000]	-0.850** (0.282)	-3.020 [0.003]	-0.05 (0.252)	-0.19 [0.846]	-0.515** (0.259)	-1.99 [0.047]	0.306 (0.337)	0.91 [0.365]
Hadejia	1.694*** (0.292)	5.810 [0.000]	-0.042 (0.261)	-0.160 [0.871]	-1.200*** (0.336)	-3.570 [0.000]	-0.86*** (0.261)	-3.32 [0.001]	-1.183*** (0.267)	-4.44 [0.000]	-0.800** (0.390)	-2.05 [0.040]
Kafin Hausa	0.880** (0.294)	3.000 [0.003]	-1.198*** (0.340)	-3.530 [0.000]	-1.384*** (0.385)	-3.590 [0.000]	-0.64** (0.273)	-2.35 [0.019]	-0.741 (0.283)	-2.62 [0.009]	-0.927 (0.508)	-1.82 [0.068]
Sex	-0.433 (0.284)	-1.530 [0.127]	0.152 (0.292)	0.520 [0.603]	0.797** (0.405)	1.970 [0.049]	-0.18 (0.253)	-0.70 [0.484]	-0.037 (0.257)	-0.14 [0.885]	-0.020 (0.461)	-0.04 [0.965]
Age	-0.007 (0.016)	-0.420 [0.671]	0.025* (0.015)	1.680 [0.092]	-0.006 (0.016)	-0.360 [0.719]	0.032** (0.015)	2.20 [0.028]	0.020 (0.015)	1.33 [0.185]	0.032 (0.022)	1.46 [0.145]
Family size	0.063 (0.053)	1.210 [0.228]	-0.036 (0.048)	-0.760 [0.446]	0.024** (0.051)	0.480 [0.634]	-0.08* (0.047)	-1.720 [0.085]	-0.067 (0.049)	-1.37 [0.170]	-0.045 (0.073)	-0.61 [0.540]
Marital status	-0.078 (0.130)	-0.600 [0.550]	0.062 (0.133)	0.470 [0.638]	0.365** (0.155)	2.350 [0.019]	-0.06 (0.117)	-0.530 [0.594]	0.066 (0.123)	0.54 [0.592]	0.031 (0.199)	0.16 [0.876]
Education	-0.020 (0.035)	-0.570 [0.568]	-0.084** (0.034)	-2.480 [0.013]	0.055 (0.036)	1.530 [0.125]	-0.09*** (0.034)	-2.690 [0.007]	-0.035 (0.032)	-1.07 [0.285]	0.114 (0.042)	2.71*** [0.007]
Occupation	0.182 (0.244)	0.750 [0.456]	0.029 (0.237)	0.120 [0.903]	-0.094 (0.261)	-0.360 [0.720]	0.389* (0.220)	1.770 [0.078]	0.307 (0.221)	1.39 [0.165]	1.130 (0.343)	3.29*** [0.001]
Agric income	0.0001* (0.0003)	1.770 [0.076]	0.000 (0.000)	1.390 [0.165]	0.000 (0.000)	1.530 [0.125]	0.000 (0.000)	-0.810 [0.417]	0.000 (0.000)	-0.44 [0.659]	0.000 (0.000)	-0.26 [0.794]
Non-agric.	0.001	-0.640	0.000*	1.890	0.000	-0.310	0.000	0.770	0.000	0.42	0.000	1.38

income	(0.005)	[0.524]	(0.000)	[0.058]	(0.000)	[0.755]	(0.000)	[0.439]	(0.000)	[0.677]	(0.000)	[0.167]
House status	-0.013 (0.085)	-0.160 [0.875]	0.049 (0.083)	0.590 [0.554]	-0.012 (0.088)	-0.140 [0.890]	-0.17** (0.078)	-2.130 [0.034]	0.153* (0.081)	1.89 [0.058]	-0.126 (0.117)	-1.07 [0.282]
OSC	0.267 (0.206)	1.300 [0.195]	0.294 (0.214)	1.380 [0.168]	0.201 (0.228)	0.880 [0.379]	0.493** (0.196)	2.510 [0.012]	0.322 (0.196)	1.64 [0.100]	-0.012 (0.282)	-0.04 [0.965]
SEA	-0.207 (0.222)	-0.930 [0.351]	0.411** (0.205)	2.010 [0.045]	-0.504** (0.245)	-2.060 [0.039]	0.216 (0.199)	1.080 [0.278]	0.111 (0.202)	0.55 [0.584]	0.048 (0.289)	0.16 [0.869]
ALFHA	0.225 (0.352)	0.640 [0.523]	-0.256 (0.316)	-0.810 [0.417]	0.055 (0.356)	0.150 [0.877]	-0.370 (0.312)	-1.190 [0.235]	0.669** (0.299)	2.24 [0.025]	1.021* (0.531)	1.92 [0.054]
LERG	-0.003 (0.308)	-0.010 [0.992]	-0.589* (0.314)	-1.880 [0.061]	-0.745* (0.405)	-1.840 [0.066]	0.400 (0.296)	1.350 [0.176]	-0.072 (0.287)	-0.25 [0.801]	0.341 (0.406)	0.84 [0.400]
AFRP	0.805*** (0.293)	2.750 [0.006]	0.385 (0.264)	1.460 [0.145]	0.037 (0.307)	0.120 [0.905]	-0.28 (0.261)	-1.090 [0.275]	-0.042 (0.264)	-0.16 [0.874]	0.757** (0.355)	2.13 [0.033]
EFWSC	0.052 (0.394)	0.130 [0.894]	-0.080 (0.383)	-0.210 [0.835]	0.247 (0.412)	0.600 [0.549]	0.608 (0.403)	1.510 [0.131]	0.213 (0.393)	0.54 [0.589]	-1.415** (0.702)	-2.02 [0.044]
Constant	-0.958 (0.788)	-1.220 [0.224]	-1.121 (0.807)	-1.390 [0.165]	- 2.793*** (0.978)	-2.860 [0.004]	0.955 (0.720)	1.330 [0.185]	-0.228 (0.716)	-0.32 [0.750]	-5.231*** (1.325)	-3.95 [0.000]

Note: *, **, * represents 10%, 5% and 1% significance level respectively.**

4.4.3 Probability of Adoption of Coping Strategies

As shown in table 14 below, the probability of adopting all of the coping strategies by households (0.0017) is less than the probability of households not adopting (0.042) any of the coping strategies. This is not surprising because most of the signs in the correlation matrix were negative (though not significant), indicating that most of the coping strategies are substitutes to each other. Hence, the likelihood of households not being able to adopt all of the coping strategies at the same time.

Table 14: Probability of Adoption

Probability	Mean	Std. Dev.	Min	Max
Pr(Adopting all the Strategies)	0.001741	0.006003	9.04E-13	0.059249
Pr(Not adopting any of the strategies)	0.042444	0.049468	6.22E-06	0.263505

4.4.4 Factors influencing the choice of flood coping strategies under Random Forest Model

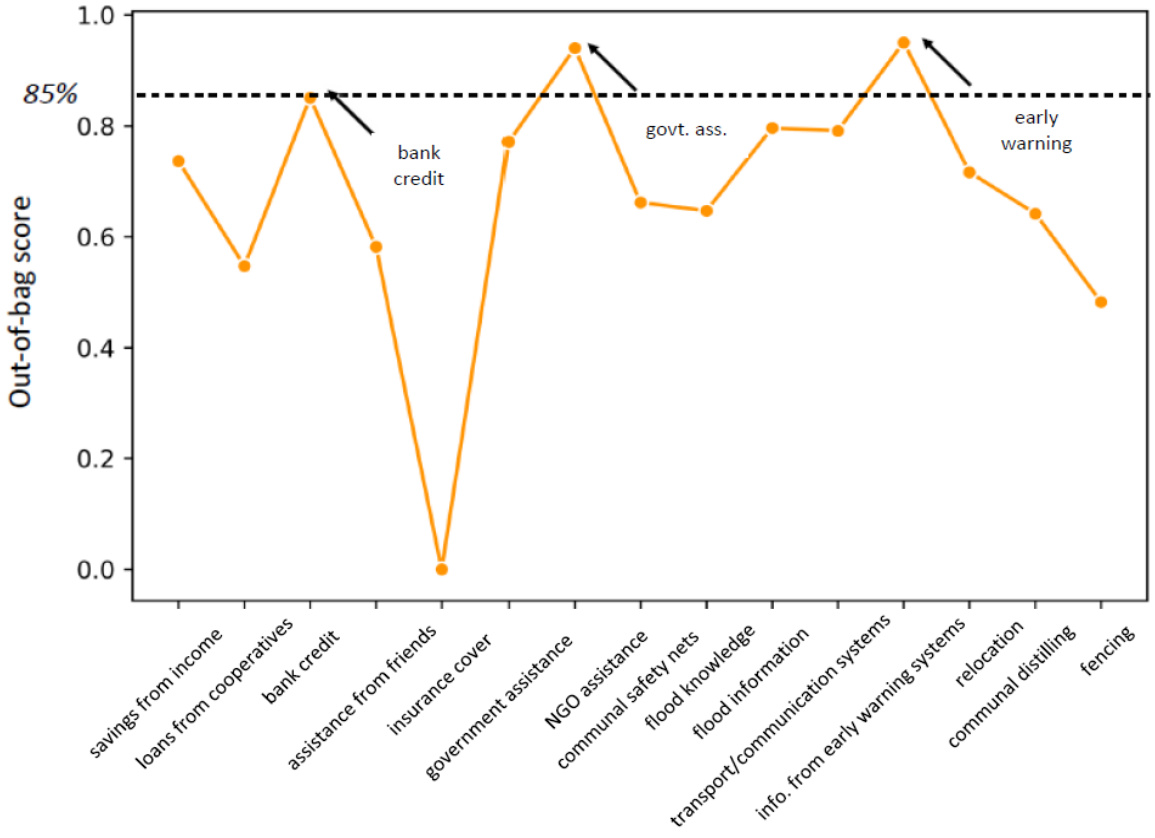

Figure 16: Out-of-bag Error Plot

The figure above (Figure 16) shows the results of the out-of-bag error estimation. Normally, the first step involves the re-training of the data using the random forest based on the out-of-bag error. Then the partial dependence plot will only be used for targets (variables to be predicted, which are those captured as the flood coping strategies) that have classification rates of at least 85% using the two (2) most predominate features (that is, the two most ranked predictors or socioeconomic variables based on the importance ranking plots). From the out-of-bag error estimation, only three (3) household flood coping strategies have scores of at least 85%. These coping strategies are access to credit from banks, assistance from government and access to information from early warning systems. Thus, the importance ranking of the socioeconomic characteristic (predictors) was done for each of the three coping strategies to identify the two most influential household socioeconomic characteristic, in terms of their ability to influence the adoption of the coping strategies. The results are presented below:

(a) Importance Ranking and Partial Dependence Plot: Bank Credit

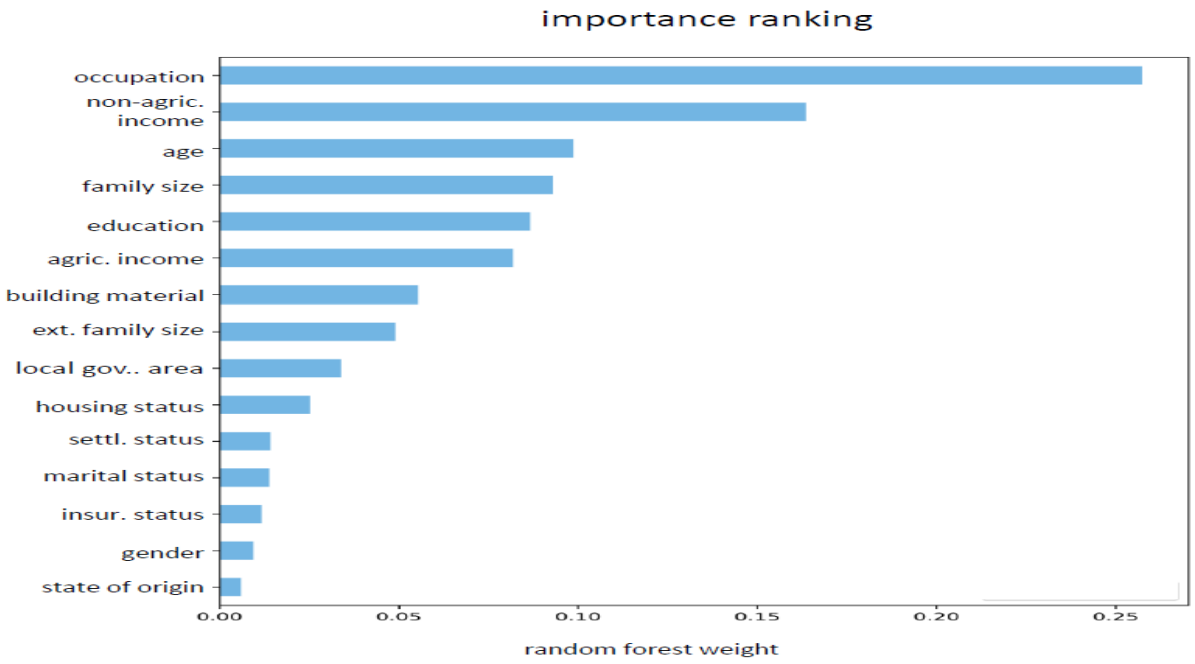

Figure 17: Importance Ranking Plot for Bank Credit

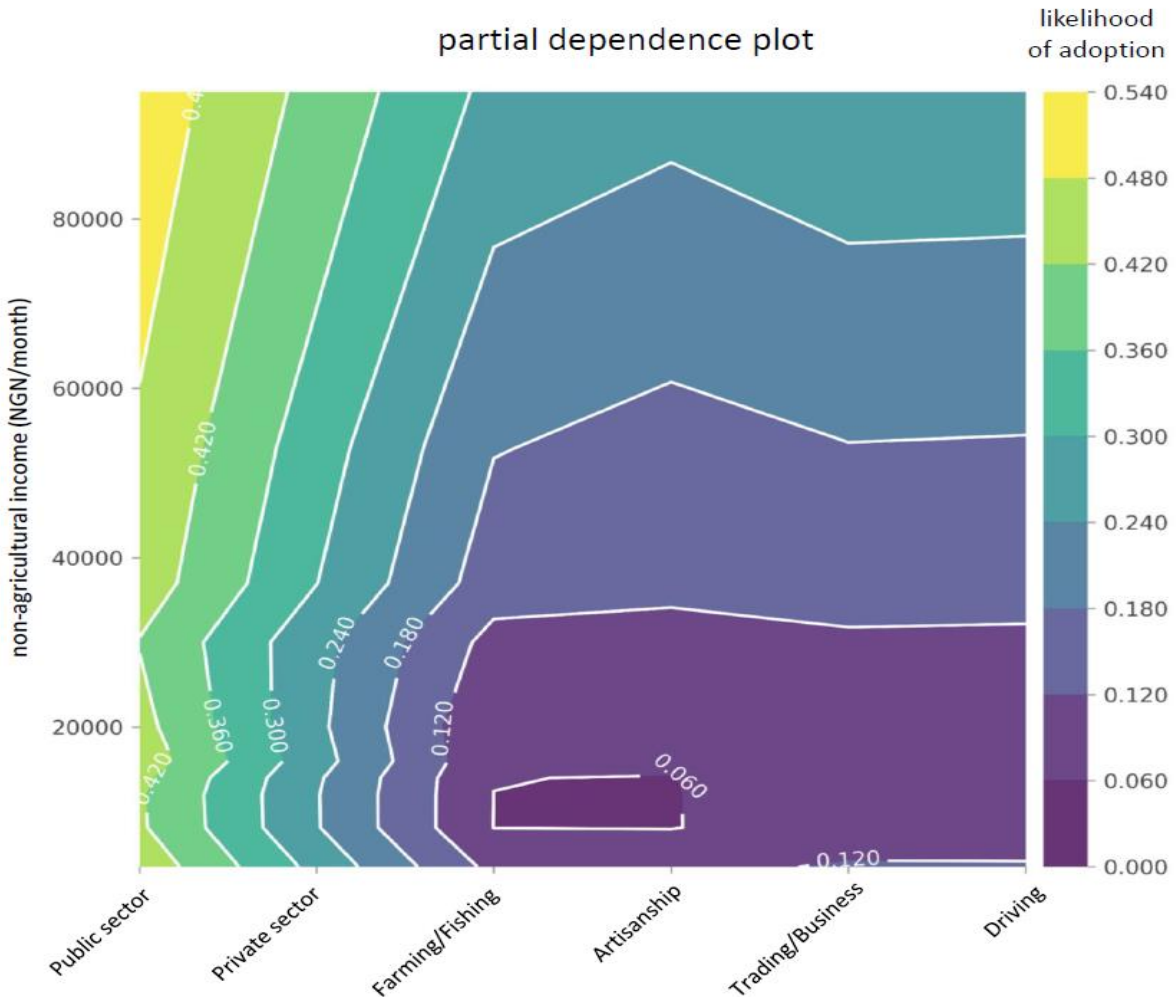

Figure 18: Partial Dependence Plot for Bank Credit

Starting with the Figure 17, that is, the importance ranking plot, it is very clear that the two most influential socioeconomic variables, in terms of adoption of credit from bank as a coping strategy to flooding are occupation and monthly income from non-agricultural sources. This is so because occupation has the highest weight followed by non-agricultural income. Hence, in accordance with the procedure, they are the only two variables used to plot the partial dependence plot (PDP). From the second diagram (Figure 18), a more detailed view of the extent to which both socioeconomic variables simultaneously influence the choice of bank credit as a coping strategy at different level can be seen. For instance, it can be seen from the diagram that though occupation influences the choice of bank credit as a coping strategy, only public sector and private sector employees have the greatest to access credit from banks, and

this is particularly associated with household heads with monthly non-agricultural income of at least ₦40,000 (approximately from $110 and above). This could be explained by the fact that banks may consider people working in the public and private as more credit worthy, in terms of their ability to meet the banks' collateral security requirements, implying their less likelihood to default in repaying the loans when issued, relative to people from the other occupations (farmers/fishermen, artisans, traders/business men and drivers) as shown in the second diagram above.

(b) Importance Ranking and Partial Dependence Plot: Assistance from Government

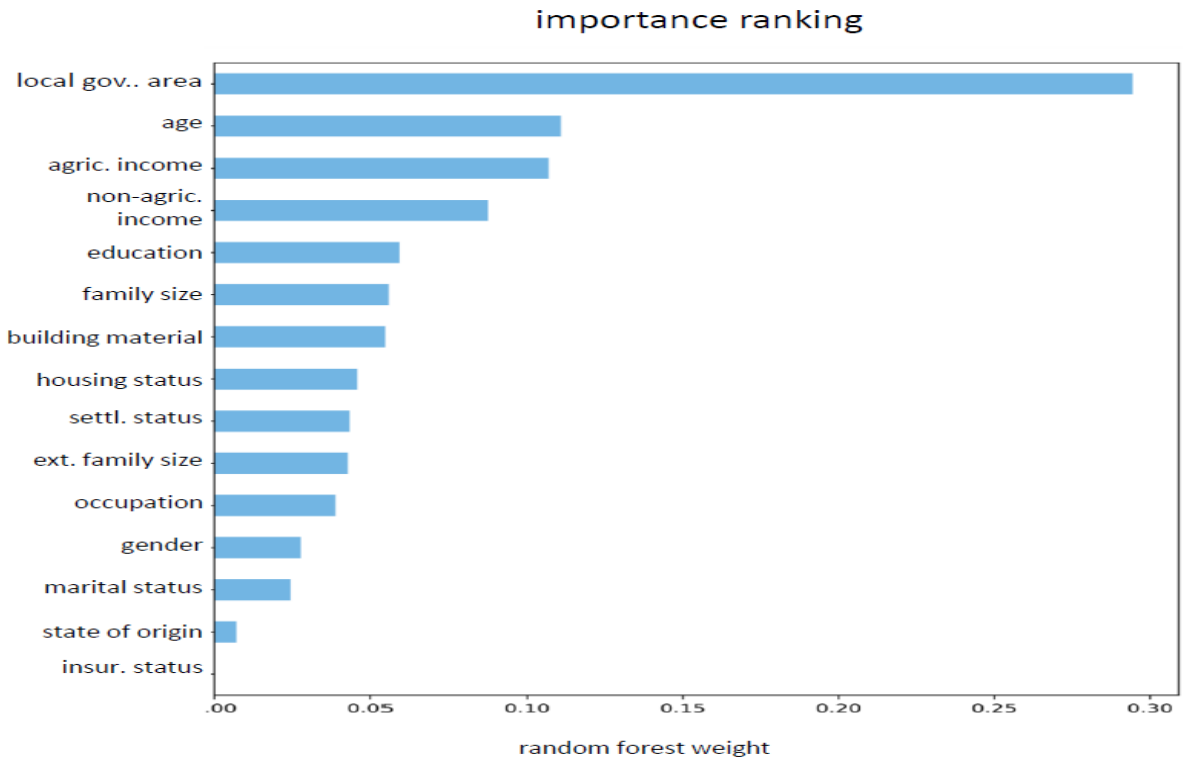

Figure 19: Importance Ranking Plot for Government Assistance

From the importance ranking plot above (Figure 19), the two socioeconomic variables that are most influential in the choice of assistance from government as a coping strategy are location in terms of local government areas (LGAs) and age, because they have the highest random forest weights respectively. That is, LGA is the most influential in the choice of assistance from government as a coping strategy, followed by age. The results from the second diagram

(Figure 20) below (that is, the partial dependence plot) showed that younger households heads (that is, those between the ages of 20 and 32 years), most of which reside in Hadejia and Kafin Hausa LGA have greater access to assistance from government as a flood coping strategy compared to the elderly category. This is more pronounced among household heads between the ages of 35 and 50 years, most of which are located in Ringim and Guri LGAs (that is, the elderly group). This is not surprising because those living in Hadejia and Kafin Hausa LGAs are closer to the government administrative areas, hence, they are easily the first point of contact in the distribution of relief materials after the occurrence of flooding in Jigawa State due to easier access to their locations.

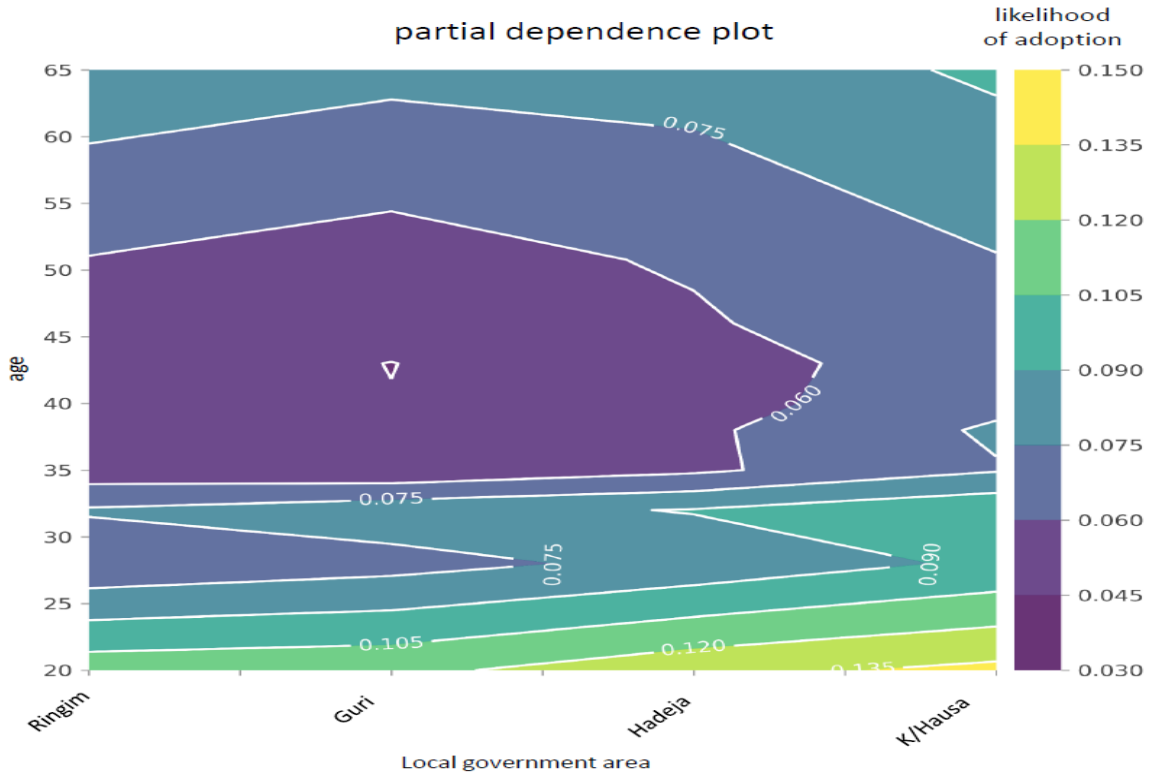

Figure 20: Partial Dependence Plot for Government Assistance

In addition, the younger household are more likely to feel the impact of the flood hazard since they don't have much in terms of assets to rely upon compared to the elderly group.

(c) Importance Ranking and Partial Dependence Plot: Early Warning Information

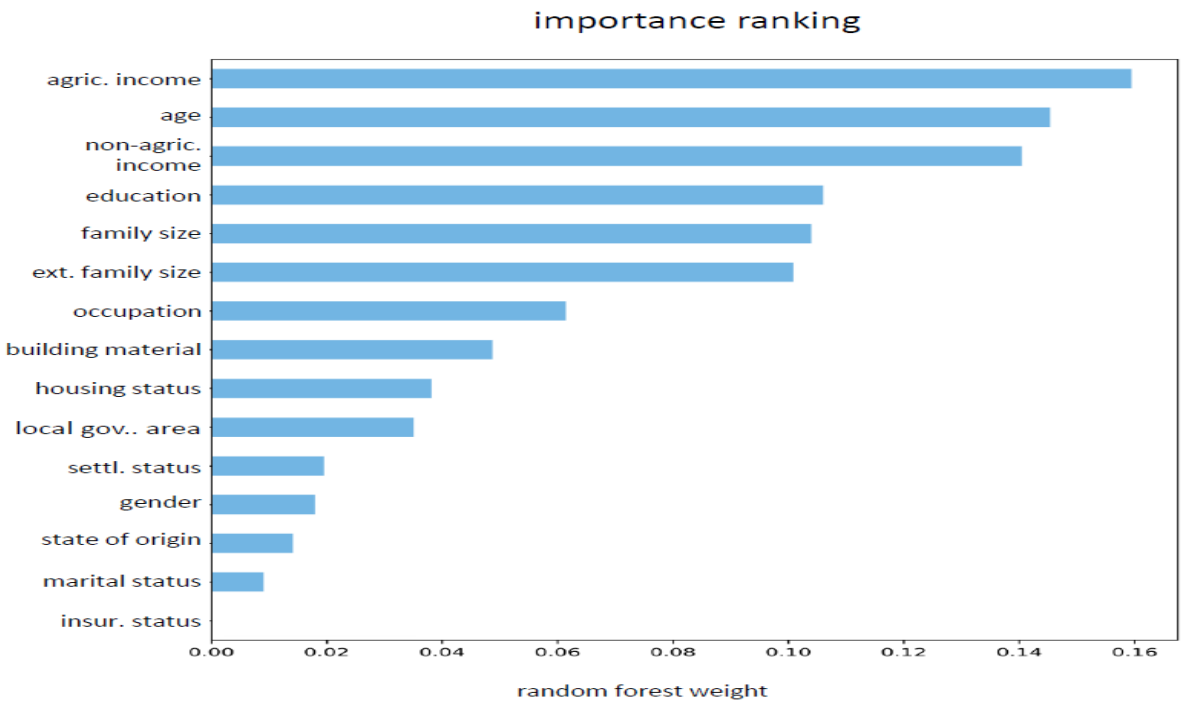

Figure 21: Importance Ranking Plot for Early Warning Information

From the diagram above (Figure 21), the importance ranking plot shows that the two most influential socioeconomic variables associated with the choice of access to information from early warning systems as a coping strategy to flood are age and annual agricultural income. Income from agricultural sources is ranked highest, closely followed by age. Looking at the partial dependence plots below (Figure 22), it can be observed that the elderly household heads (between the ages of 50 and 65 years), and predominantly those with very high income from agricultural sources have greater likelihood of relying on warnings on impending floods from early warning systems in place, relative to the younger household heads and those with lower agricultural income. This is so because the elderly group are naturally more likely to be concerned about loss of lives and properties relative to the younger group, considering their tendency to possess more assets and responsibilities. Hence, they tend to be more worried about possible losses to assets they may face if flooding should occur. Going in search of

information on impending floods is aimed at making them prepared and ensuring they secure their assets and properties beforehand.

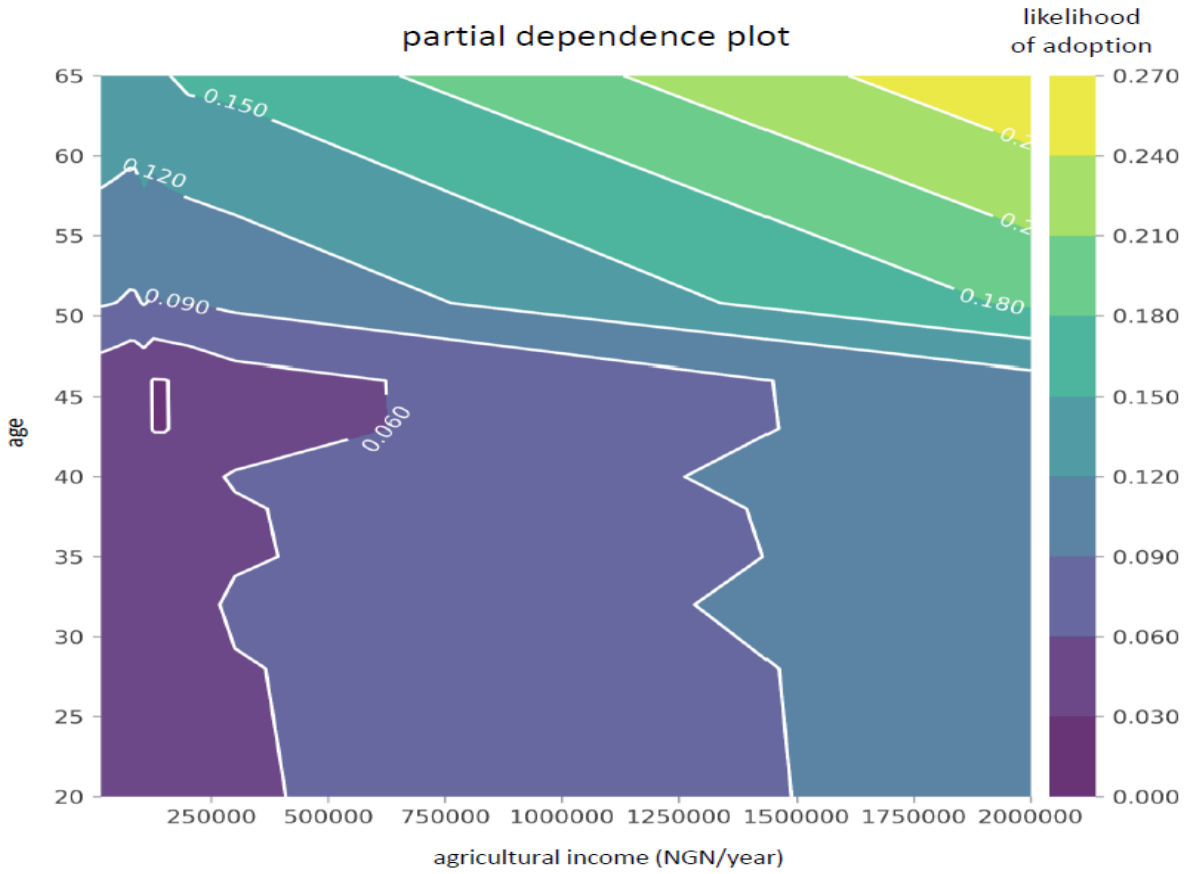

Figure 22: Partial Dependence Plot for Early Warning Information

4.5 Estimating the Costs and Benefits of Improving Households Resilience to Floods

Considering that the kind of flood experienced in Jigawa state is Fluvial (River flooding) as found in the survey, we decided to propose a flood resilient project that will be beneficial to both members of the flood prone communities and the government, which is the financier of the project. Hence, we proposed the construction of dams in strategic locations of the affected flood areas. Each dam will be constructed in such a way that it will help capture or trap excess water flowing from the river channels (Hadejia and Jama'are rivers) during peak periods of rainfall, which is usually responsible for flooding the affected communities. In turn, a publicly operated irrigation scheme or mechanism will be constructed alongside each dam, for use in the production of some agricultural cash crops (rice and wheat) for revenue generation by authorities and employment purposes for the members of the communities to benefit.

Hence, we proposed the construction of an 11m high dam which is associated with a public irrigation system for the benefit of all stakeholders involved. The capacity of the dam (that is, the amount of water that can be stored in the dam) is 280,000m^3 of water. Each dam based on its capacity can provide enough water needed to cultivate an estimated thirty-five hectares (35ha) of wheat or rice. Thus, the following steps were followed to determine the viability of the proposed project:

i. Estimating the costs of the proposed flood resilient project. This can be achieved by also understanding the eligible costs of the project and also, the appropriately required costs in a benefit-cost analysis (BCA).

ii. Pointing out the benefits associated with the resilience project proposed.

iii. Determining the net present value of the proposed resilience project benefits using the benefit computation process. Recognizing and using the BCA terms.

The total estimated cost of the bulk of water infrastructure which includes the dam, irrigation system and the related infrastructure (that is, the provision of access roads, power lines and proper supervision by a qualified engineer is approximately $294,405.00 (₦106,873,000.00). The breakdown of the costs involved is shown in the Table 15 below.

It is important to note that we made of provision for maintenance cost, which constituted 10% of the cost of the project, excluding provision for contingencies that may arise during the construction of the irrigation dam structure. Normally, such projects have a life span or useful life of between 50 to 100 years. However, since this is a small-scale dam project, we used a 50-year useful life for the project. As for the discount rate for calculating the present value, what is recommended is to use either the existing inflation rate or lending rate (interest rate) in the country. Since the dam is sufficient enough to provide irrigation for 35ha of cultivated land, the cost of the in-capital funding per hectare is approximately $8,411.46/ha. Looking at the per hectare cost of the project is a very important way of comparing the dam sites where irrigation activities are involved. Another important comparison that can be made is by looking at the cost of the dam to the capacity of the dam (which determines the area that can be irrigated for wheat or rice cultivation during the dry season). The cost of the dam in relation to the amount of water that can stored is $1.05/$m^3$, that is, taking into account the 10% contingency cost and maintenance cost respectively. This is particular useful for economic comparisons especially where more than one dam is to be constructed.

Estimating the cost and benefits of the proposed irrigation dam agricultural scheme is necessary to determine the economic viability of the project. In this case, the dry season crop (rice and wheat) is expected to be grown each on a 35-hectare irrigation scheme, which is attached to every dam.

Table 15: Cost of Establishing the Flood Resilient Irrigation Dam Project

Item	Activity	Unit Rate	Quantity	Cost (US$)	Amount (US$)
1.	Site Investigation work	Sum	-	-	12,000.00
2.	Engineer's Fees: design and supervision	Sum	-	-	17,000.00
3.	Mobilization Fee	Sum	-	-	7,500.00
4.	Clearing Site:				
	Embankment Area	ha	5	2000	10,000.00
	Reservoir	ha	40	500	20,000.00
5.	Cut-off/Core:				
	Evacuation	m^3	750	5.5	4,125.00
	Backfilling	m^3	750	7.0	5,250.00
6.	Embankment	m^3	22,000	3.5	77,000.00
7.	Training banks	m^3	1400	6.0	8,400.00
8.	Spillway	m^3	770	6.0	4,620.00
9.	Finishing works	hours	240	10	2,400.00
10.	Other dam works including settlement works after construction	Sum	-	-	5,000.00
	Subtotal Dam			**A**	**173,295.00**
11.	Irrigation scheme (one-centre pivot)	ha	35	-	42,000.00
12.	Miscellaneous (access road/power line	Sum	-	-	30,000.00
	Subtotal Irrigation Scheme			**B**	72,000.00
	Subtotal Overall Project			**A+B**	245,295.00
	Contingencies			10%(A+B)	24,560
	Maintenance Cost			10%(A+B)	24,560
	Grand Total			**US$**	**294,415.00**

As shown in the Table 16 below, the current price of rice '(farm gate selling price) in Jigawa State is $291.5/ton and the expected rice yield from irrigation systems in Jigawa State is between 4tonnes/hectare and 5tonnes/hectare with good management practices. In our case however, we targeted a yield of 4t/ha. For wheat, its current price (farm gate selling price) is $360/ton and its expected yield was between 3t/ha to 4.5t/ha. However, we put ours at 3.5t/ha, assuming good farm management practices and taking into account possible risks that may give rise to shortfalls below its maximum yield. Hence, for 35ha, the expected yield for both

rice and wheat will be 140 tonnes and 122.5 tonnes respectively. This will bring an expected return of $40,810 and $44,100 for rice and wheat respectively.

Note: Information on input costs and farm gate prices for rice and wheat respectively were obtained from the National Agricultural Extension and Research Liaison Services (NAERLS), Ahmadu Bello University, Zaria, Nigeria.

Table 16: Expected Returns on the Proposed Farming Activities under the Dam-Irrigation Project

Crop	**Expected Yield (35ha)**	**Area to be cultivated**	**Farm gate price (US$)**	**Expected output**	**Expected revenue (US$)**
Rice	4t/ha	35ha	291.5/t	140t	40,810.00
Wheat	3.5t/ha	35ha	360/t	122.5t	44,100.00
Total					**84,910.00**

As shown in the Table 17 below, the average cost per farming year (dry season) for the cultivation rice and wheat (which includes cost of fertilizer, labour, land preparation, other inputs plus harvesting) is $386/ha and $413/ha. There is an additional cost of $300 for irrigating one hectare of land, each in the cultivation of rice and wheat respectively. When we included the cost of irrigation for each commodity, this brings the overall input cost to $24,010 and $24,955 for 35ha each of rice and wheat production respectively for the farming year. Therefore, even without a comprehensive cost benefit analysis, the construction of the dam and irrigation scheme appears to be economically viable and profitable, yielding a net profit of $16,800 and $19,145 for rice and wheat cultivation, each on a 35-heactare plot of land. Each of amounts (profits) are enough to cover the 10% operation and maintenance cost set aside from the total capital cost of each dam that will be constructed. In fact, it appears that the cost of the dam can be paid off within the first 18 years of initiating the project, that is, assuming only rice is cultivated on the 35ha of land. If wheat was the crop cultivated, the

cost of the irrigation dam project will be paid within the first 16 years of the initiation of the scheme/project.

Table 17: Expected Cost of Production per year (dry season)

Crop	Area to be cultivated	Cost of irrigation (US$)	Cost of production (US$)	Total cost of production (US$)	Total cost for 35ha Cultivation (US$)
Rice	35ha	300/ha	386/ha	686/ha	24,010.00
Wheat	35ha	300/ha	413/ha	713/ha	24,955.00
Total					**48,965.00**

However, we will proceed with the estimation of the benefit-cost analysis for the project. Since the overall cost of the project is known, it is important to proceed with identifying and estimating the possible benefits from the project/scheme. A number of benefits can be identified from the implementation of the proposed project, some of which are quantifiable, while others are unquantifiable due to unavailable information or data. Three benefits which are quantifiable are the cost of damages from floods to households (available from the field survey conducted) which will be averted, profit earned by the government from investment in rice or wheat cultivation and the possible employment gains from the dam and irrigation projects by members of the affected communities. Table 18 below shows the possible gains by members of the community in terms of employment opportunities. Based on information obtained from the NAERLS, an average of 30 and 35 workers is expected to be employed per hectare of rice and wheat cultivated respectively. In addition, the cost of employed labour is estimated at $138/ha and $165/ha of rice and wheat cultivated respectively. Based on the proposed 35-heactare land to be cultivated for both commodities, an estimated number of 1,050 and 1,225 persons will be employed for rice and wheat cultivation respectively. This brings the total cost of paying the hired labour to $4,860/35ha and $5,775/35ha for rice and wheat respectively. These amounts represent benefits accruing from the proposed projects.

Other unquantifiable benefits of the projects include amount saved from cost of emergency response and management, environment clean up, environmental damage, cost of setting up temporary shelters, cost of alternative transits, among others.

Next, we proceed to the determination of the net present value of the resilience project benefits using the benefit computation process. This involves the calculation of the present value coefficient.

Table 18: Expected Cost on Hired Labour/Employees per year (dry season)

Crop	Expected number of labour (35ha)	Area to be cultivated	Overall number of employees(35ha)	Cost of employed individuals (US$)	Total cost on labour hired (US$)
Rice	30 people/ha	35ha	1050 persons	138/ha	4,830.00
Wheat	35 people/ha	35ha	1225 persons	165/ha	5,775.00
Total					**10,605.00**

The present value coefficient (PVC) is the combined effect of the discount rate and the useful time of the flood resilience project. The PVC is used to bring annualized costs and benefits to the net present value (NPV). The formulae for calculating PVC is shown below:

$$PVC = \frac{[1-(1+r)^{-T}]}{r}$$

Where:

r is the discount rate (14% prevailing interest rate in Nigeria) and T is the projects useful life (which is 50 years in our case).

$$PVC = \frac{[1-(1+0.14)^{-50}]}{0.14} = \frac{[1-(1.14)^{-50}]}{0.14} = 7.13$$

Therefore, the total benefits of the project=

PVC × (annual damage averted or annual damage reduction + annual income earned by workers employed + profit earned by the government from the cultivation of rice or wheat)

Total cost of the project = ($294,415 + cost of producing wheat or rice over the project lifetime)

Hence, Benefit-Cost Ratio (BCR) = (Total project benefit of the project ÷ Total project cost of the project). Normally, any viable project worth investing in must have a BCR value of at least one (1) to be considered.

Note: To determine the cost of damage averted, we multiplied the average cost of damage by the total number of households affected by floods covered during the survey (which is 251 households). The details on how the various components for the benefit-cost analysis were computed are shown below:

As shown in table (..), the Total Cost of constructing a dam with an attached irrigation system is $294,415.

In addition, from table (..), the estimated costs of producing either of the commodities every year, is given below as follows:

Rice = $24,010

Wheat = $24,955

Assuming constant input costs, commodity prices and production costs over the useful life of the proposed project, the estimated overall cost of producing both commodities over a 50-year period will be:

Rice = $24,010 × 50 = $1,200,000

Wheat = $24,955 × 50 = $1,247,750

Hence, the estimated overall or total cost of the project, assuming the dam water is used for cultivation of rice through irrigation becomes:

= estimated cost of the irrigation/dam project + the estimated cost of rice production over a 50 years period

= $294,415 + $1,200,000

= $ 1,494,415

Following a similar procedure, the estimated overall or total cost of the project, assuming the dam water is used for cultivation of wheat through irrigation becomes:

= estimated cost of the irrigation/dam project + the estimated cost of wheat production over a 50 years period

= $294,415 + $1,247,750

= $1,542,165

Based on the data obtained from the survey, the average cost of the damages per household dur to the flooding was ₦416,797.012 ($1,148.28). Since 251 households were covered in the survey, the estimated total cost of damage due to floods becomes:

Estimated overall cost of damage = $1,148.28 × 251

= $288,218.28

Assuming that $288,218.28 is the minimum cost of damage from flood that will be averted with the establishment of the irrigation/dam project, this can then be taken as one of the possible benefits from the proposed project.

In addition to the above benefit, the estimated aggregate amount to be to paid hired labour (farm workers) from the communities concerned is $4,830 or $5,775 under the cultivation of

rice or wheat respectively. These are also considered as possible benefits from the cultivation of rice or wheat, which are all associated with the proposed project at hand. Lastly, there are also benefits in the form of profit earned by the government from investment in rice or wheat cultivation. As earlier pointed out, the estimated possible benefits from rice or wheat production will be $16,800 and $19,145 respectively.

Hence, the estimated overall benefit of the proposed project under rice production alone, without taking PVC into account becomes;

= $288,218.28 + $4,830 + $16,800

= $309,848.28

But, PVC = 7.13

Hence, the real estimated overall benefit of the project under rice cultivation is:

= $309,848.28 × 7.13

= $2,209,218.24

Similarly, the estimated overall benefit of the proposed project under wheat production alone, without taking PVC into account becomes;

= $288,218.28 + $5,775 + $19,145

= $313,138.28

Since PVC = 7.13, then the real estimated overall benefit of the project under wheat cultivation becomes:

= $313,138.28 × 7.13

= $2,232,675.94

From the available information, we can then proceed to compute the BCR, under the cultivation of each of the crops (rice or wheat). The results are shown in the tables below:

Table 19: Benefit-Cost Analysis for the Project under Rice Cultivation

Description	**Computation**	**Result**
Total Project Benefits	($309,848.28 × 7.13)	$2,209,218.24
Total Project Cost	($294,415 + $1,200,000)	$ 1,494,415.00
Benefit-Cost Ratio (BCR)	$\frac{\$2,209,218.24}{\$1,494,415.00}$	**1.48**

Table 20: Benefit-Cost Analysis for the Project under Wheat Cultivation

Description	**Computation**	**Result**
Total Project Benefits	($313,138.28 × 7.13)	$2,232,675.94
Total Project Cost	($294,415 + $1,247,750)	$1,542,165
Benefit-Cost Ratio (BCR)	$\frac{\$2,232,675.94}{\$1,542,165.00}$	**1.45**

From the result presented in both tables (Table 19 and Table 20) above, we can see that the BCR is greater than 1, that is, under the cultivation of rice (1.48) or wheat (1.45) with each dam/irrigation project. Hence, the findings show that the proposed project is worth investing in by the government of Jigawa State to help improve the resilience of the affected communities to floods, as the benefits from investing in the project outweighs the cost of the investment.

CHAPTER 5

Summary and Conclusions

5.1 Conclusion

Globally, data has shown that flooding constitutes one of the greatest threats among natural and climate-related disasters. In fact, within the immediate past decade (2000-2010), information from the World Bank has shown that floods occurred more than any other natural/climate-linked disaster. The amount damages due to flooding has been on the increase, especially in developing countries. Coastal flooding due to heavy rainfall and runoff in Nigeria is worsened by the rise is sea level (Adeoti, Olayide & Coster, 2010). In addition to the flood impacts of sea level rise, there is the potential for sea water inflow into the inland waters such as the rivers and mangroves, thereby, affecting the functioning of the inland waters' ecosystem and livelihoods. With more rise in sea level, there is an expectation that more inland flooding, which is associated with the river networks will be experienced. In Nigeria, despite efforts by the government to improve on infrastructure, the incidence of yearly recorded cases of floods have remained unabated. This has become a source of concern to all relevant stakeholders (households, private sector and the government). Although, it is well understood that it is impossible to completely eradicate flood risk in cities and urban areas, all hands must be on deck to ensure resources are channelled in such a way to ensure sustainable flood risk reduction. There is a general consensus that one of the ways to achieve sustainable development is through building resilience of our cities, urban areas and communities to disasters and hazards, of which floods is the most predominant. However, building resilience entails reducing vulnerability of households (flood victims) to floods. Vulnerability can be explained as the degree of damage or destruction which should be anticipated under any given conditions of exposure, susceptibility and resilience. This implies

that building resilience of households to floods entails identifying the underlying factors contributing to vulnerabilities of households to floods, with the aim of coming up with strategies that will help shape human and institutional responses to floods in Nigeria. This can be possible only through integrating the inputs of all relevant stakeholders and by including disaster risk reduction strategies into the developmental agenda of the government. Thus, this study covers Jigawa State, which has been categorized as one of the states with high risk of flooding in Nigeria.

The study relies mainly on survey data collected through questionnaires from 251 households (flood victims) in 2016 and well-structured interviews (involving government institutions and community elders). The study principally examined the causes of persistent flooding in the study area and measures the level and extent of households' vulnerability to flooding (including an assessment households' knowledge, attitude and practices of flood resilience), focusing on the differences in vulnerability among communities. Within the context of the concepts of exposure, susceptibility and resilience, the study relied on the recommendations of the indicators identified World Disaster Risk Index and Balica et al., (2012) to measure the level of households' vulnerability to floods using the Cendrero and Fischer's (1997) community-based flood vulnerability index model. The study further went ahead to identify the coping strategies available to households to cope against floods. Using the Multivariate Probit Regression Model, the study identified the key factors influencing the choice of coping strategies by households.

Empirical results from the findings show that the urban poor are the most affected by flooding in Jigawa State and they fall under the category of people living in informal settlements. The study revealed that the primary factors influencing the vulnerability of households to flooding is physical and socio-economic in nature. In other words, empirical findings from the study revealed significant physical and socio-economic vulnerability, which can be linked to

settlement issues and poverty. Across all the Local Government Areas (LGAs) covered in the study, the results showed very high exposure values and very low resilience values, though, the figures from Hadejia LGA was relatively better compared to the other three LGAs (Ringim, Guri and Kafin Hausa). This implies the need for authorities to give greater attention to the provision of social services and the creation of economic empowerment opportunities to help improve the resilience of households to floods. Though most of the households were of the perception that the main causes of frequent flooding in Jigawa State was heavy and prolonged and inadequate infrastructural facilities, the mapping of the affected areas showed a significant number of households have their settlements located in high-risk areas to flooding and the building materials in most of the cases were not made of materials that could withstand strong flow of water and wind. This suggests the need to consider relocation and resettlement as a long-term alternative. Other revealed influencing factors of persistent flooding as obtained from the interviewed stakeholders include the vegetation and topography (soil type and structure) of the area and mismanagement of dams and river reservoirs, most of which were located outside Jigawa State. Interstate cooperation will be needed among other measures to address the dam and river mismanagement issue. With less vegetation cover and rising temperatures, climate change may likely increase the intensity and frequency of rainfall, which will imply more flooding in the area. Increased greening of spaces within urban areas and cities is another plausible solution. This is one mitigating strategy of bringing down temperatures, which will further help reduce the intensity of rainfall and flooding experienced.

Considering the type of vulnerability revealed and the need to boost economic resilience at the micro level through improving the livelihood alternatives of the poor households affected by the floods, the study proposed cost effective government funded and private sector operated irrigation-dam projects in strategic locations of the affected areas. This was done to

support agricultural production and activities, which is the main occupation of people living in the affected areas. Apart from serving as a source of generating revenue for the government, it will also benefit the private sector as well. The ultimate goal is to boost households' income and improve the available coping strategies, and hence, help boost their adaptive capacities. Results from the benefit-cost analysis revealed that the project is very viable, and the amount invested in the project will be recovered in less than 20 years of its establishment if properly managed and sustained.

The study found that the approach of institutional response to flooding was more reactive and not proactive. It was primarily restricted to the provision of relief materials after a flood had occurred. In some cases, the relief materials are either inadequate or not properly directed to the affected flood victims. In one of the interviews conducted, some elders were of the view that the National Emergency Management Agency, that is NEMA (the body in charge of management of flood disasters in Nigeria usually drop off relief materials with the local government authorities or sometimes, with the district heads of the areas. According to them, most of the relief materials are often diverted by these authorities, with very little left to be distributed to the flood victims after several days of waiting. Though NEMA officials claimed they provide pre-flood disaster education, the members of the communities covered were of the view that they never received any such services. This points out to a possible disconnect between NEMA and the affected communities. Findings also revealed that there were no emergency shelters around the affected areas. Usually, school buildings are utilized as temporary shelters for flood victims. This normally disrupts schooling activities for a number of days. In addition, the study revealed considerable noncompliance with land use management guidelines. Community livelihood development welfare schemes, disease control and prevention programmes were observed to be nearly absent across the communities. The same situation was observed for post-flood risk assessment and early flood

warning systems. Generally, most of the affected people were poor and low-income earners. Hence, a combination of adaptation and mitigation measures is required in this case. Most of the adaptation strategies can fit well into the developmental plans of Jigawa State. Successful adaptation strategies will require the advancement of knowledge among the affected community members as well as the development of capacities and confidence within local government authorities. It will also require the right political will from government and its representative institutions.

5.2 Recommendations and Policy Implications

The study revealed significant vulnerability of households across the study area in different facets: social, economic, politico-administrative (governance) physical, socio-behavioural and hydro-physical. There exist no global solutions to climate-induced disasters. Hence, whatever ^policies and strategies developed for implementation must take into cognisance, the need to uplift the most vulnerable groups (women and the poor) and systems. In other words, flood control and flood risk reduction policies must be designed in such a way that it addresses the realities of the most vulnerable group of individuals locally. The first step to address flooding in Jigawa State is to embark on a holistic reform of institutions. Policies and programmes designed to manage and reduce flood risk must take into account the interests of all relevant stakeholders, particularly the poor and most affected groups. These poor and most vulnerable must be consulted to understand their challenges and needs, after which their inputs (that is, their views, knowledge, priorities and capacities) will be included in the development, formulation and implementation of such policies and programmes. This will help in expanding the range of adaptive strategies available to the target groups. There is need to transform institutional response to flooding from its present reactive approach to a more proactive one. Flood risk reduction and management has now advanced beyond the traditional approach of providing humanitarian relief materials as is the case in Nigeria. In other the

mitigate the effects of flood disasters, the best approach is to address the causes of vulnerability of households to flooding. Authorities should start by creating sustainable livelihood alternatives through the provision of empowerment (like education) and job creation opportunities, as well as social services provision and social investment programmes.

Relocation of households from high-risk to low-risk flood areas is another possible alternative, notwithstanding the reluctance of the affected people to move out. To ensure the success of these alternative, government should purchase the lands from owners living in such areas. It can then proceed to construct low-income resilient homes with storm-water drainages and sewage treatment installations. Law should be made and implemented to prevent further resettlement on previously unoccupied high-risk areas. Flood water retention pond and dams can be established, maintained and used to promote agricultural activities during dry seasons. NEMA should partner with sister agencies such SEMA, LEMA, NIHSA and NGOs as well as donor agencies to educate people in affected communities on the negative consequences of flooding and lessons from the past flooding. This can be achieved through establishing capacity building programmes (involving organized workshop, provision of flood risk education, etc.), collecting information and dissemination of the information via the most accessible media sources to help boost the adaptive capacities of the most vulnerable groups. Mapping of flood risk areas, building emergency shelters and the formation of flood emergency response plans is also necessary. State governments should ensure regular dredging and maintenance of rivers and dams to reduce the risk of flooding during periods of heavy rainfall. To address physical vulnerability, there is need for authorities to tackle the infrastructural deficits in urban area and cities. Flood resilient drainages, bridges and flood barriers should be constructed in high risk areas. In other to mitigate flood impacts induced by climate change, investment in low cost green infrastructure is a possible alternative, considering other multiple benefits (ecological and economic) that can be obtained from

investing in it. Greening urban spaces has the major advantage of reducing temperature and the damaging impacts from heavy rainfall. Green technology includes flood gardens, green roofs and permeable roads. These technologies can go a long way to reduce flood impacts and environmental pollution. Increasing the tree covers (afforestation and agroforestry), especially around open spaces in urban areas and cities will also serve as a preventive measure against flooding. Regular weather forecasts by NIMET and timely dissemination of information to inhabitants of flood risk areas could also be useful in the sense that people will have enough time to seek temporary settlement areas, hence, reducing possible damages to properties and lives.

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APPENDIX

Appendix A1

Introduction

Looking at Nigeria in the last ten years, we can observe that the rate and frequency of floods has been on the increase. Consequently, the effect arising from the frequent flood disasters are huge and affects a wide range of socio-economic activities, specifically in areas surrounding building and housing, assets, means of livelihood, health, education and economic activities in general, which relates to production, consumption and income earnings. This is a pressing problem which requires immediate attention of the relevant stakeholders (Household, Government Agencies and Private Sector Actors, such as NGOs) for policy response purposes. It is in line with this urgency, that I am undertaking my PhD work on **'Climate Vulnerability and Building Flood Resilience in Jigawa State, Nigeria'**. All information provided will solely be used for the study and will be treated with strict confidentiality. I will greatly appreciate your cooperation. Thank you for the time taken to answer the questions contained in the questionnaire.

SECTION A: Demographic Characteristics of the Respondents' Area (to be filled by the Interviewer- for robustness checks)

Respondent Number_____

Are the following services present in your area? Tick as many as applicable. ____Electricity ____Pipe borne water system, ____Sewage system ____Health care service/Clinic close to the area, ____Police Station

Is the road leading to your home accessible by car? ____Yes ____No

What is the nature of the road leading to the respondents' area? _____Paved/_____Concrete?

It is important to note what infrastructural facilities are available to the respondents, from the point of view of the interviewer.

SECTION B: Household Characteristic (if respondent is different from the Household Head in Section C Below)

What is your status in the house? ____ Head ____ Spouse ____ Child to head ____ Others (specify) _____

Household's Head's Sex? ____Female/____Male

Household's Head's Educational Attainment? ___No Formal Education ___Primary School Not Completed ___Primary School Completed ___Secondary School not completed ___Secondary School Completed ___Post-Secondary Education ___Koranic/non-Formal Education, Others (specify) _____

Household's Head's Estimated Average Monthly Income (in Naira)? ___Less than ₦10,000 ___₦10,001- ₦ 20,000 ___₦ 20,001- ₦ 40,000 ___₦ 40,001- ₦ 80,000 ___₦ 80,001- ₦ 120,000 ___Above ₦ 120,000

SECTION C: Socio-Demographic, Physical and Environmental Profile of the Respondent Households

1. Is this your native State of Origin? ___ Yes ___ No

2. If No, what is your reason for moving into this State? ___Employment___ Education___ Marriage___ Climate Shocks, Others (specify) _____

3. Local Government Area (LGA) _____

4. Name of Community/Town/City _____

5. Status of settlement? ___Rural ___Urban

6. Respondent's/ Household Head's Sex? ___Male ___Female

7. What is your Age at last Birthday _____ years

8. Numbers of immediate family members _____

9. Numbers of extended family members _____

10. Number of female and male in your household? ____Female/Male____

11. What is your current Marital Status? ___Single/Never Married ___Married ___Separated ___Divorced ___Widowed

12. What is your Highest Educational Attainment? ___No Formal Education ___Primary School Not Completed ___Primary School Completed ___Secondary School not completed ___Secondary School Completed ___Post-Secondary Education ___Koranic/non-Formal Education, Others (specify) _____

13. What is your current Occupation? ___Unemployed ___Public Sector Employee ___Private Sector Employee ___Farming/Fishing ___Artisan ___Trading/Business ___Driver, Others (specify) _____

14. Respondent's Estimated Monthly Income (Naira) from non-agricultural sources? ___Less than ₦10,000 ___₦10,001- ₦ 20,000 ___₦ 20,001- ₦ 40,000 ___₦ 40,001- ₦ 80,000 ___₦ 80,001- ₦ 120,000 ___Above ₦ 120,000

15. Respondent's Estimated Income (Naira) from agricultural sources? _____

16. Housing Tenure Status? ___Self Apartment (single family) ___Tenant ___Squatter ___ Compound House (multiple family), Others (Specify) _____

17. Is your housing property insured? _____Yes/_____No

18. What material is your constructed house made of? ___ Wood ___ Concrete___ Steel ___ Galvanized Iron ___Cartoon ___ Bricks ___ Coconut leaves ___ Tiles ___ Nipa material ___ Plastic ___ Clay Bricks, Others: please. specify _____

19. For how long have you lived in this community? _____ years

20. Were you victims of the last flooding (year 2016) in this community? ____Yes/____No

21. If 'Yes' in (20) above, what exactly was the effect on your household? _____

22. Have any member of your family had **Malaria/Fever** especially during raining or flooding periods? ____Yes/____No

23. If Yes, specify the number of people affected? _____

24. Have any member of your family had **Diarrhea** especially during raining or flooding periods? ____Yes/____No

25. If Yes, specify the number of people affected? _____

26. Have any member of your family had **Leptospirosis** especially during raining or flooding periods? ____Yes/____No

27. Do you think these ailments were caused by the floods? ___ Yes ___ No

28. How frequent is your community flooded from heavy rains? ___ Every month ___ Every 4 months ___ Every year ___ Every 6 months ___ Sometimes ___ Rarely ___ Never

29. Did the flood water penetrate your home? ___Yes ___ No

30. If 'Yes', what height did the water reach? ___ Ankle level ___ Knee level ___Waist level ___ Shoulder level ___ Above the head ___ Roof level ___ Beyond the roof, Others, please specify _____

31. Do you think the immediate surroundings of your home is clean? ___ Yes ___ No

32. Do you think your house is located in a waterlogged area? ___ Yes ___ No

33. Do you have open sewage or canals in your surroundings? ___ Yes ___ No

34. Is your house located near a river, creek or pond? ____Yes ____No

35. Is your house situated in an elevated area? ___ Yes ___ No

36. Where do adults/children in your household usually go to defecate? ___ Public latrine ___ In your own latrine ___ In a neighbour's latrine _ __ In a water body ___ On the ground ___ Anywhere, Others, pls. specify _____

37. What type of latrine do you have access to at home? ___ Pour flush ___ Water-sealed ___ Antipolo type ___ We don't have a latrine, Others, pls. specify_____

38. Where do you normally dispose liquid waste from your household? ___ Into a drainage ___Into the pit ___ Into the septic tank ___ Anywhere, Others, please specify_____

39. Where do you normally dispose solid wastes from your household? ___ Burning ___ Garbage collected by LGA ___ Burying under the ground ___ Throwing into the river ___Composting___ In a water body or river, Others, please specify_____

40. Do you practice waste segregation in your household or community? ___Yes ___ No

41. During ordinary days (i.e. days or periods without flooding), what is your main source of drinking water at home? ___ Well ___ River ___ Pipe borne water ___ Communal Borehole water___ Spring ___ Commercial water seller dispensers___ Bottled water from industries ___ Others please specify _____

42. During flooding or heavy rains days, what is your main source of drinking water? ___ Well ___ River ___ Pipe borne water ___ Communal Borehole water___ Spring ___ Commercial water seller dispensers___ Bottled water from industries ___ Others please specify_____

43. In your opinion, is your source of drinking water clean during flooding? ___Yes ___No

44. How do you treat or sterilize your drinking water? ___ Settling ___ Filtering ___ Boiling in less than 10 minutes ___ Boiling in 10 minutes ___ Chlorination ___ Nothing, Others, please specify _____

45. Are you permitted to rear/keep domestic animals in your vicinity? ___ Yes ___ No

46. Which of the following domestic animals do you own at home? (Tick as many as applicable) ___ Cow ___ Chicken ___ Goats ___ Birds ___ Donkeys___ Cats ___ Dogs___ Pig ___ Horse, Others, please specify _____

47. Give the number of the domestic animals you own at home? _____

48. How do you dispose the faecal materials from the domestic animals you own? ___ Public latrine___ In your own latrine ___ On the ground ___ In a neighbour's latrine ___ In a water body or river ___ Into the pit ___ Anywhere, Others, pls. specify _____

49. What type of domestic animals have you observed in neighbour's vicinity? ___ Cow ___ Chicken ___ Goats ___ Birds ___ Donkeys___ Cats ___ Dogs___ Pig ___ Horse, Others, please specify _____

50. Have you noticed rats roaming around your vicinity? ___ Yes ___ No

51. Have you noticed rats roaming around your neighbour's vicinity? ___ Yes ___ No

52. Have you noticed domestic animals roaming around your vicinity without its owner? ___ Yes ___ No

53. Which of the following sanitation and hygiene programmes have you had before? ___ Garbage Segregation ___ About water safety ___ Disease outbreaks during flooding ___ Environmental sanitation ___ The right way of washing of hands with soap and water ___ Owning a latrine, Others_____

54. From which source did you hear or learn about the sanitation and hygiene programmes? ___ LGAs ___ TV ___ Radio___ Own family ___ From neighbours ___ NGO worker ___ Health Centres ___ Health workers ___ School/Teachers ___ Workers ___ Billboard ____ Others, please specify _____

55. Do you have a good relationship with your neighbours? ___ Yes ___ No

56. Will you help your neighbours when required during or after flooding or heavy rains? ___Yes ___ No

57. Are there health and hygiene related meetings held in your community at regular intervals? ___ Yes ___ No

58. If 'Yes' in (57) above, do you participate regularly in it? ___ Yes ___ No

59. Have you seen your neighbours helping each other in whichever way possible during flooding events or period heavy rains? ___ Yes ___ No

60. If your house is very near to a river or pond, do you know that you can be at risk of flooding? ___ Yes ___ No

61. Are you willing to vacate your place if you are advised by the Government that your community or area is no longer safe due to flooding? ___Yes ___ No

62. If Yes in (61) above, give reasons why? _____ _____ _____ _____ _____

63. If No, in (61) above, give reasons why? _____ _____ _____ ___ _____

SECTION D: Respondent Household Knowledge and Practices on Flood Resilience

64. Do you know that the community/area you live in is a flood hazard area and you are at high risk? ___ Yes ___ No

65. Do you understand the nature and destructive capability of floods? ___ Yes ___ No

66. Are you still living in this area/community despite experiencing flooding before?

___ Yes ___ No

67. Have you seen drainage infrastructures overloaded during heavy rains___ Yes ___ No

68. If 'Yes' in (67) above, do you think this constitutes a potential risk to flooding?

___ Yes ___ No

69. Have you sighted all kinds of debris in drainage during and after flooding?

___ Yes ___ No

70. Are you aware of the existence and availability of flood hazard maps for your area/community? ___ Yes ___ No

71. Do you know that flooding can happen during and after heavy rainfalls? ___ Yes ___ No

72. Do you know the level of defence and limitations of the flood control barriers?

___ Yes ___ No

73. Are you aware of the period in the year that flooding usually occur? ___ Yes ___ No

74. Do you consider flooding as something that can happen anytime, hence the need for one to be ready always? ___ Yes ___ No

75. Do you know very well the negative impacts of flooding (property loss, injury, disease infection and death)? ___ Yes ___ No

76. Have you or any member of your household been exposed to flooding before? ___ Yes ___ No

77. Have you or any member of your household sustained injuries from flooding in the past?

___ Yes ___ No

78. Have you or any member of your household taken ill during and after flooding? ___ Yes ___ No

79. Have your household lost loved ones because of flood impacts, as well as injuries and infections? ___ Yes ___ No

80. Have you experienced any loss of property from past flooding? ___ Yes ___ No

81. Do you know about the existence of flood early warning systems in your community?

___ Yes ___ No

82. If 'Yes' in (81) above, do you know how it can be interpreted? ___ Yes ___ No

83. Do you know about the existence of seminars and practical trainings on the use of Early Warning Systems in your community? ___ Yes ___ No

84. Are you aware of the medium through which information on flood prevention is disseminated around your community? ___ Yes ___ No

85. Which of the following media sources do you get such information from? ___ LGAs ___ Radio ___ TV ___Newspapers/Magazines ___ Billboard ___ Family members ___Other villagers ___ Religious Groups ___ NGO worker ___ Health Centres ___ Health Workers ___ School/Teachers, Others, pls. specify _____

86. Do you know about the existence of any local emergency response group in your community? ___ Yes ___ No

87. Do you know where the evacuation centres are located? ___ Yes ___ No

88. Do you abide by the instructions (especially in relation to hygiene and sanitation) governing your stay at the evacuation centres? ___ Yes ___ No

89. Do you know about the different programmes organized by local government authorities (LGAs) during and after the occurrence of calamities? ___ Yes ___ No

90. Do you know that the emergency response teams and other units work together in a coordinated manner? ___ Yes ___ No

91. Do you know the laid down procedures governing the conduct and coordination of emergency response and evacuation? ___ Yes ___ No

92. Are you aware of any flood adaptation strategies used in your community?

___Yes ___ No

93. If 'Yes' in (92) above, give a list of some? _____ _____ _____ _____ ___

_____

94. How much importance do you give the following below? Use the following ranking order: 1. Seriously; 2. Very seriously; 3. Lightly; 4. Very lightly

List of Issues	**Rankings based on Household's Attitude Towards the Listed Issues**
HAZARDS (e.g. areas prone to flooding)	
RISKS (poor or overloaded drainage systems, inefficient or absence of bridges, dikes, etc.)	
EXPOSURE (relocating from flood areas, drinking unclean water, watching flood waters)	
PREPAREDNESS (knowledge and awareness of the existence of flood early warning systems)	
RESPONSE (cooperation, readiness, constant dissemination of flood information via media)	
RECOVERY (staying at flood emergency camps, quick repairs of damaged homes, etc)	
COORDINATION (Cooperation with LGAs on related programmes, knowledge sharing, etc.)	
ADAPTATION STARTEGIES (supporting and	

applying strategies by LGAs, attending lectures)	

95. Will you continue to live in your house knowing fully well that it is in a flood prone area? ___ Yes ___ No

96. If 'Yes' in (95) above, please explain why? _____ _____ _____ __ _____

97. Do you put on raincoat, rainboots and other protective wears during flooding? ___ Yes ___ No

98. If you receive flood warning announcements from authorities regarding your area, will you quickly evacuate from your area? ___ Yes ___ No

99. During a flooding event, would you stay near the flowing flood water and watch it flow? ___ Yes ___ No

100. Do you try to pick up debris and materials flowing or stocked in the water during flooding? ___ Yes ___ No

101. Before heavy rains, do you keep matches, lamps and other related items safe and ready? ___ Yes ___ No

102. In anticipation of the likelihood of heavy rains ahead, do you unplug electrical appliances beforehand? ___ Yes ___ No

103. Do you normally secure your doors and windows, food items, clothing, drums, harmful wind-movable materials and other relevant materials before heavy rains? ___ Yes ___ No

104. Did you attend emergency response and Early Warning System training in your community? ___ Yes ___ No

105. If you lack a means of transportation, do you make alternative arrangements with neighbours and local authorities just in case flooding could occur? ___ Yes ___ No

106. Before a flood or heavy rain, do you ensure your automobile vehicles are fuelled beforehand? ___ Yes ___ No

107. During periods it rains for many hours, are you always alert for possible flooding? ___ Yes ___ No

108. In search for further information and warning during heavy rains, do you make effort to listen to radio and television related programmes? ___ Yes ___ No

109. In times of need during flooding, do you receive assistance from your neighbourhood/local associations? ___ Yes ___ No

110. If 'Yes' in (109) above, what kind of assistance do you receive? _____ _____ ___ _____

111. Do you regularly check the water levels of the river around you? ___ Yes ___ No

112. Do you normally remain in evacuation centres until local authorities inform you that it is safe to leave? ___ Yes ___ No

113. Do you avoid contaminated food and check that the water you drink during and after flooding is safe for consumption? ___ Yes ___ No

114. Do you as much as possible avoid staying near river banks until all potential flooding periods has passed? ___ Yes ___ No

115. Do you attend and participate in lessons learned from and trainings on past flood events? ___ Yes ___ No

116. Do you immediately take members of you household who fell sick during flood for medical check-ups? ___ Yes ___ No

117. Do you promptly repair damaged properties/items after flooding? ___ Yes ___ No

118. After a flooding event, do you quickly clean up your house? ___ Yes ___ No

119. Are you aware of any flood adaptation project put in place by authorities?
___ Yes ___ No

120. If 'Yes', are you in support of adaptation strategies put in place by authorities?
___ Yes ___ No

121. Are you willing to pay for any flood adaptation project? ___ Yes ___ No

122. If 'Yes', how much will you be willing to pay as a monthly premium? _____

123. Do you think this amount can help you build resilience to floods? ___ Yes ___ No

124. What exact benefits do you expect from the insurance during flood? _____ _____
_____

125. If 'No' in (121) above (i.e. you are not willing to pay), why? _____
_____

126. Have you migrated from this area and returned after the flooding? ___ Yes ___ No

127. Are you willing to insure your house/properties against flood? ___ Yes ___ No

128. If 'Yes' how much will you be willing to pay each month? _____

129. Are you aware of the existence of any River and Natural Resource Management Programme in your community? ___ Yes ___ No

130. Are you aware of the existence of any Land Use Management and Structural Design System? ___ Yes ___ No

131. If Yes, is it properly implemented and enforced in your community? ___ Yes ___ No

132. Are you aware of any damage and loss assessment to lives, properties and infrastructure made by local government authorities in your community after flood has occurred? ___ Yes ___ No

133. Is there any welfare programme established by authorities in your community to help flood victims recover from flood losses? ___ Yes ___ No

134. Are you aware of the construction of any relocation site for flood victims in your community? ___ Yes ___ No

135. Is there any health prevention programme against malaria, diarrhea and leptospirosis taking place at regular interval in your community? ___ Yes ___ No

SECTION E: General Information on the Causes, Frequency and Effects of Flood Disaster

136. What do you see as the cause of the flooding in your community? ____Heavy rainfall ___Lack of or poor drainage systems ___Building on water ways ___Poor solid waste disposal systems (dumping wastes in gutters) ___Poor building materials, Others (specify) _____

137. Assess the severity of the flood disaster in your locality by selecting any of the options provided. ___Not severe (not destructive) ___Severe (destructive) ___Very severe (very destructive)

138. How long did it take you or your household to recover from the flood incidence? ___ 1 month ___ 3 Months ___ 6 Months ___ 1 year ___ More than one year

139. Using these codes: 1. Strongly agree 2. Agree 3. Somewhat agree 4. Disagree, do you think that the effect of flooding in your community has made you worse off in terms of the following options below?

Socio-economic aspects	**Effects**
a. Livelihoods	
b. Housing	
c. Assets (Land, Animals, Crops, etc.)	
d. Education	
e. Health	
f. Income earnings/Profits	
g. Production/Productivity	
h. Water facilities	
g. Electricity	
h. Others (specify)	

140. Please, describe how the occurrence of flood disaster has affected you and your household by ticking the respective options below: (respondents may suffer from inertia and begin to be inconsistent in their responses

Socio-economic aspects	Worse off	Better off	No difference	Can't say
a. Access to means of livelihood				
b. Ownership of economic assets				
c. Housing affordability				
d. Maintenance of housing quality				
e. Occurrence of sanitation related diseases				
f. Access to health facilities				
g. Affordability of medical services				
h. Access to educational facilities				
i. Quality of educational facilities				
j. Productivity at work				
k. Income earning/profit making				
l. State of electricity supply				
m. Access to improved water facility				
n. Quality of water				
o. Social interaction				

141. What is the monetary value of losses from the last flood disaster (in Naira) on assets and livelihood as stated below?

a. Cost of damage to building	
b. Cost of damage to other properties (farmland, etc)	
c. Income and profit shortfall	
d. Cost of medical care associated with the effect of the flood disaster	
e. Cost of damage to assets (Crops, Animals, etc.)	
f. Cost of damage to facilities/utilities (repairs on damages to electricity, water, sanitation and waste disposal facilities)	
g. Cost of other losses	

142. Please, indicate the differential effect of floods on the following categories of people using the codes provided below:

1. More affected; 2. Less affected; 3. Same effect; 4. Don't know

Category of People	Effect Status
a. Female Adult	
b. Male Adult	
c. Female Child	
d. Male Child	
e. The Elderly	
f. The Disabled	
g. Low income earners	
h. Middle income earners	
i. High income earners	
k. Non-indigenes	

SECTION F: Coping Strategies Adopted Against the Effects of Floods

143. Do you find ways of coping with the past flooding event? ___ Yes ___ No

144. If 'Yes', what are the coping strategies adopted by you and your household to mitigate the effect of floods?

List of Coping Strategies	Options adopted by Households
a. Use of Household Savings from income	
b. Loans from cooperatives	
c. Access to credits from Banks	
d. Financial assistance from friends and relatives	
e. Flood insurance/Insurance contribution (both for household and business)	
f. Assistance from government	
g. Assistance from private organizations such as NGOs	
h. Communal safety nets	
i. Non-erosive flood recovery knowledge	
k. Access to flood emergency infrastructure	
l. Access to transport and communication services	
m. Information from Early Warning Systems	
n. Relocation of Household	
o. Communal desilting of chocked gutters	
p. Fencing household's land/resilience	
m. Others (specify) …… ____	

145. Please, how can you describe the level of effectiveness of the coping strategy/strategies adopted by you and your households as stated above, in relation to the socio-economic aspect(s) it was applied to, using the following codes: 1. Extremely effective; 2. Very effective; 3. Effective; 4. Not effective

Socio-economic aspects	**Level of Effectiveness**
a. Access to means of livelihood	
b. Ownership of economic assets	
c. Housing affordability	
d. Maintenance of housing quality	
e. Occurrence of sanitation related diseases	
f. Access to health facilities	
g. Affordability of medical services	
h. Access to educational facilities	
i. Quality of educational facilities	
j. Productivity at work	
k. Income earning/profit making	
l. State of electricity supply	
m. Access to improved water facility	
n. Quality of water	

146. Among the options provided below, which of them are major constraints militating against the effectiveness of the adopted strategies?

___Lack of/inadequate funds ___Lack of/inadequate Government support ___Lack of technical know-how___ Lack of cooperation from community members, Others (specify) _____

147. In your monthly household spending, do you set aside some amount specifically to help cope with flood event when they eventually occur? ___Yes ___No

148. Aside your main occupation, do you engage in any other economic activity?

___Yes ___No

149. If Yes in (142) above, give the other economic activities? _____
_____

150. Do you have any investment in financial assets (shares, bonds, treasury bills, etc.) which you could easily liquidate in times of need, like in flood situations?

___Yes ___No

151. Do you have any technical knowledge to reduce flood vulnerability and enhance flood recovery? ___Yes ___No

152. If 'Yes' in (145) above, please specify by ticking the area you have knowledge in below:

(a) Flood water control knowledge	
(b) Flood water and sanitation knowledge	
(c) First aid knowledge	

(d) Flood vulnerability management knowledge	
(e) Strategy to maintain or quickly resume schooling when interrupted by flooding	
(f) Strategy to maintain or quickly resume local energy supply in the event of a flood	
(g) Strategy to maintain or quickly resume provision of local food supplies in the event of a flood	
(h) Strategy to maintain or quickly resume healthcare services when interrupted by flooding	
(i) Strategies for rapid delivery of actionable information for flood management	
(j) Strategy to maintain or quickly resume mobility services (transport and communication) in the event of a flood	
(k) Strategy to maintain or quickly resume local waste collection & disposal services in the event of a flood	
(m) Strategy to maintain or quickly resume the provision local safe water in the event of a flood	
(n) Knowledge on personal safety	
(o) Others (specify) ……	

153. Kindly state your perception about your community's exposure to floods.

___Very exposed ___Exposed ___Not exposed ___Don't know

154. What is the level of vulnerability of your household to flood incidence?

___Very vulnerable ___Vulnerable ___Not vulnerable ___Don't know

155. Are you aware of the existence of any flood emergency infrastructure in your community?

___Yes ___No

156. If 'Yes' in (149) above, is it accessible in the event of the occurrence of a flood?

___Yes ___No

SECTION G: Recommendations on Measures for Preventing Floods and Mitigating its Effects

157. What role do you think the following stakeholders can play with respect to minimizing the occurrence and effect of floods on your community? (mitigation strategies)

a. Households	

b. Community	
c. Government	
d. NGOs	
e. Donors/Development Partners	

Appendix A2

INTERVIEW GUIDE (Relevant Institutions- NIMET and Ministry of Environment)

Questions for interviewees

1 How does climate change and variability in climatic conditions influence flood occurrence in Jigawa State, particularly in Dutse and Hadeja LGA/communities (severity, frequency and impact)?

What other factors are responsible for the occurrence of flood the State?

Do you receive early warning information from relevant government agencies in relation to floods?

What early warning flood-related information and flood emergency services do you provide to communities at risk of flooding in the State?

2. What government social safety net schemes are in place to equip/protect communities against the effect of floods?

Comment the financial provision in the budget for flood mitigation financing, conservation of ecosystem services and habitats, and sustainable resources management for resilience?

What flood infrastructure/lifelines infrastructure (transport and communication) are in place? Comment on their accessibility during floods?

3. What provisions made for flood insurance or insuring assets/properties to cover for their damage or loss when flood occurs?

What legislation is in place at the national level that recognizes the restoration of habitats?

Any conservation management plan in place by your agency?

What river basin level flood controls measures or watershed management plan in place?

What government policy plans are in place for mainstreaming flood risk?

What national policy plan is in place for improving forecasting ability?

4. Any flood regulation and environmental conservation legislation are place at the national level? Comment on their enforceability?

What are legal or regulatory constraint to the implementation of these regulations?

What is the nature of your flood disaster response plan (pre-flood or post-flood)?
Comment on the source (local/external sources), adequacy and timeliness of financing for the flood response plan?
What financial commitment will be required to make communities at risk flood resilient?

5. What strategies have you put in place to ensure the maintenance and quick resumption of supply of utility services, as well as educational, infrastructural and information and communication services in the event of floods?

Appendix A3

INTERVIEW GUIDE (For Community Heads and Leaders/Elders)

Questions for interviewees

1. How does climate change and variability in climatic conditions influence flood occurrence in your community (severity, frequency and impact)?

What other factors are responsible for the occurrence of flood in your community?

Do you receive early warning information from relevant government agencies in relation to floods?

2. What social safety net schemes and mutual assistance systems in place to equip your community against the effect of floods?

What community development investment vehicles are existing in this community?

What communal flood protection measures are in place?

What sustainable natural resource management scheme and preservation measures of ecosystem services are in place to maintain natural habitats for flood resilience services?

What flood emergency infrastructure/lifelines infrastructure (transport and communication) are in place and how effective are these strategies? How accessible are the services?

3. What community representative bodies in place for flood management coordination and decision making (social inclusiveness and leadership)?

What intercommunity coordination mechanism in place?

What flood recovery knowledge is your community endowed with?
Comment on the culture of sharing information within you community or communities? Comment also on the culture of insuring assets/properties?

4. What flood regulation is in place within communities (Comment on its enforcement)?

What formal community emergency services are in place that integrates flood advice and management?

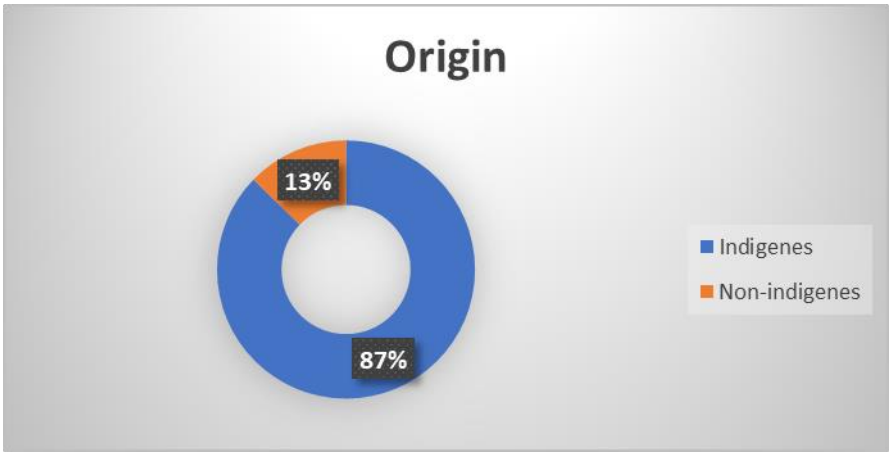
Comment on the level of social participation in flood management related activities as well as their level of compliance with social norms to ensure safety of lives and assets??

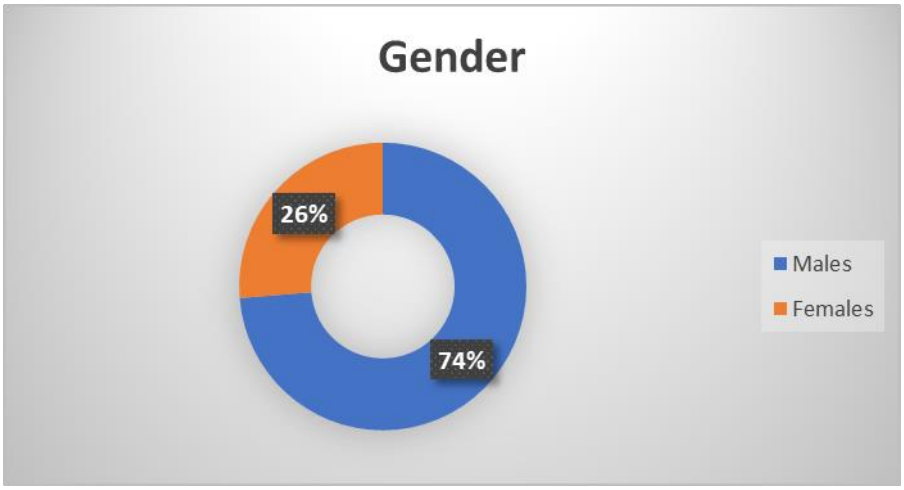
5. What form of external flood assistance and formal flood related services exist during floods?
Comment level of functioning of utility services, as well as educational, infrastructural and information and communication services during and after floods?

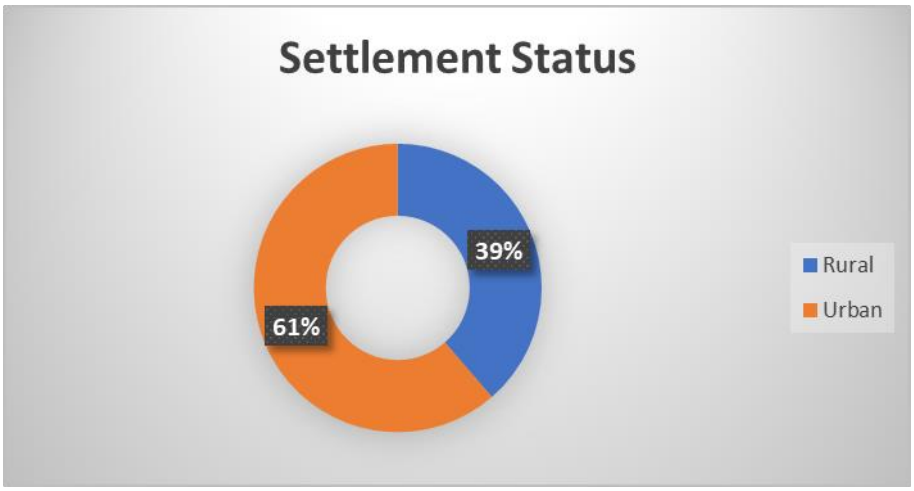
What strategies are in place to ensure the maintenance and quick resumption of supply of the above-mentioned services after flood occurrence?
Comment on the effect of floods on income loss, business activities, health (flood related diseases), lives, properties and assets in your community?

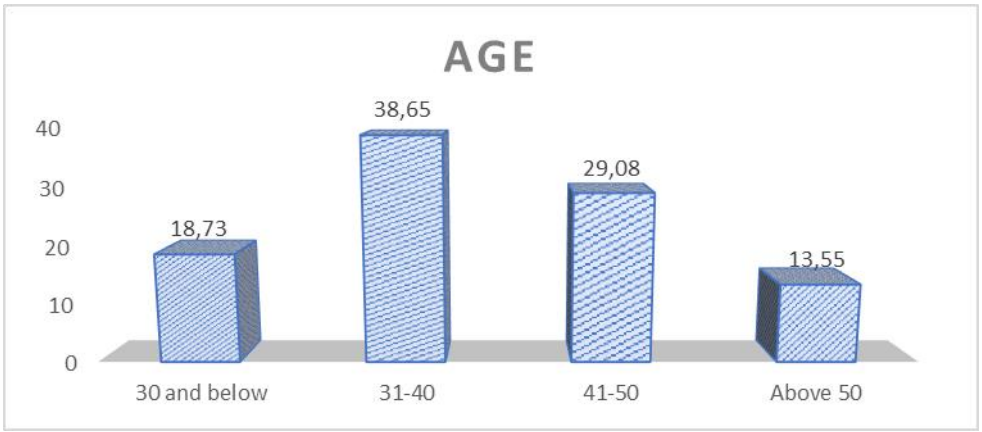
6. Comment on your community's flood exposure and vulnerability perception?
Comment on your community's value for education

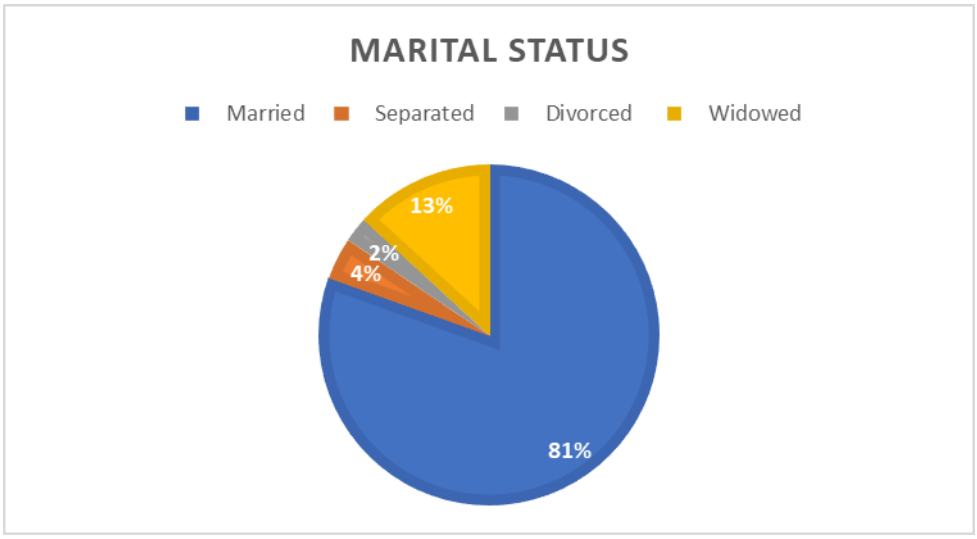
Appendix A4: Graphs and Diagram Showing Households Socioeconomic Characteristics

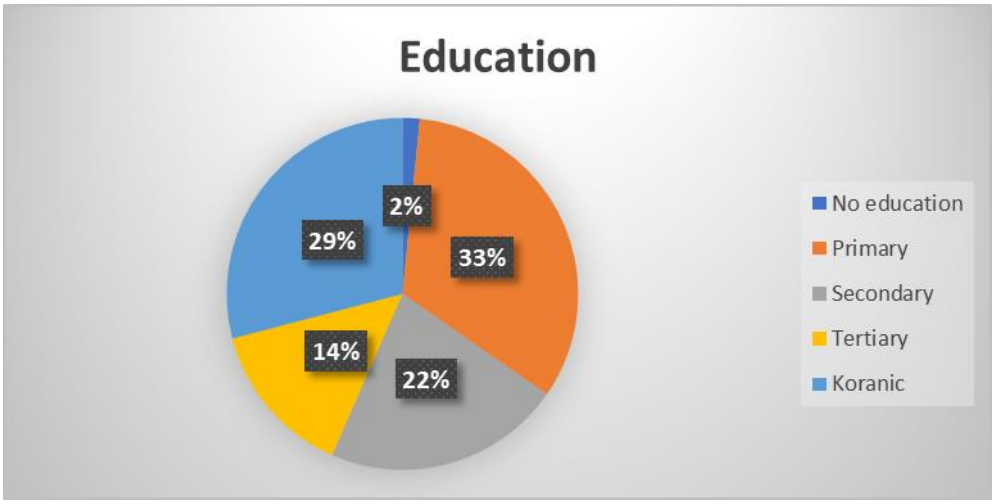


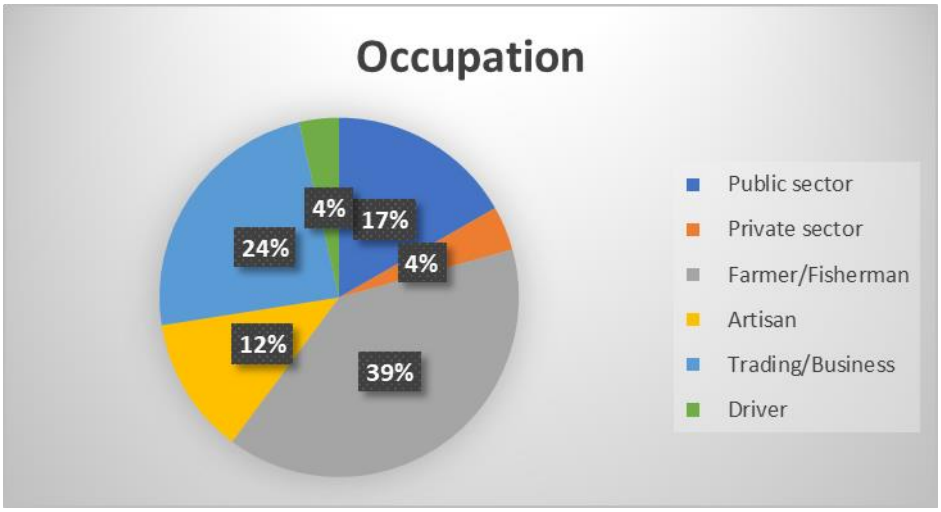

Gender
26%
74%
Males
Females

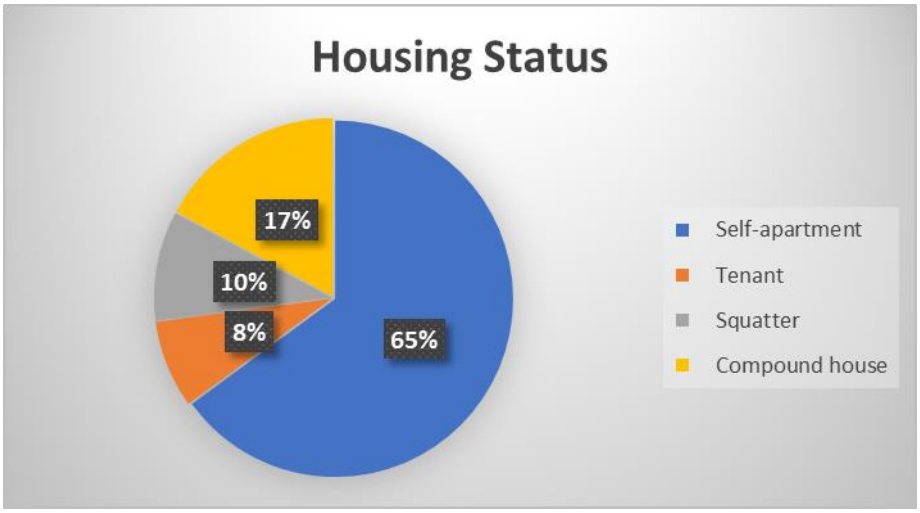

Settlement Status
39%
61%
Rural
Urban

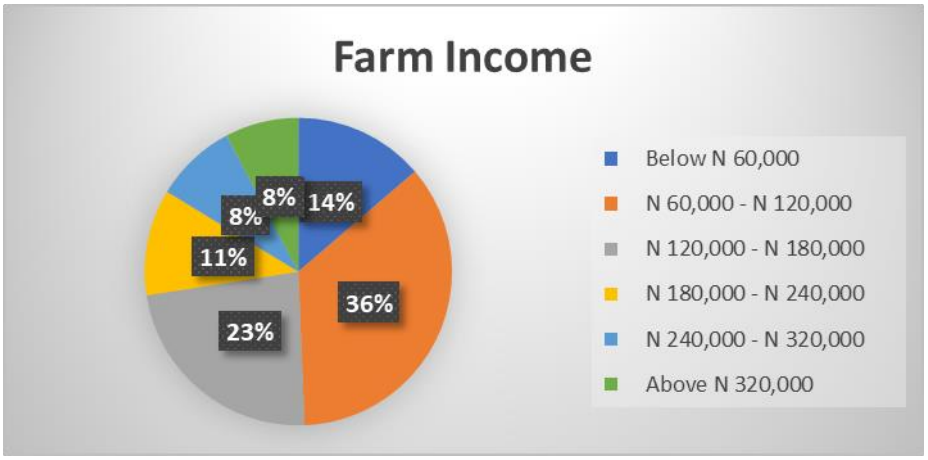

AGE
40
30
20
10
0
18,73
38,65
29,08
13,55
30 and below
31-40
41-50
Above 50

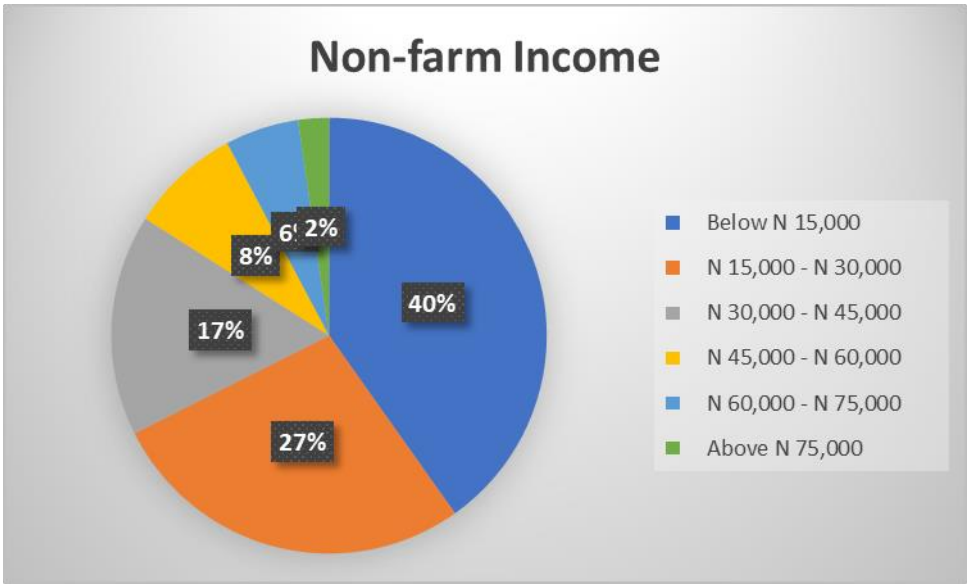

MARITAL STATUS
Married
Separated
Divorced
Widowed
13%
2%
4%
81%


Education
2%
33%
29%
14%
22%
No education
Primary
Secondary
Tertiary
Koranic


Occupation
4%
17%
24%
4%
12%
39%
Public sector
Private sector
Farmer/Fisherman
Artisan
Trading/Business
Driver


Housing Status
17%
10%
8%
65%
Self-apartment
Tenant
Squatter
Compound house


Farm Income
8%
14%
8%
11%
36%
23%
Below N 60,000
N 60,000 - N 120,000
N 120,000 - N 180,000
N 180,000 - N 240,000
N 240,000 - N 320,000
Above N 320,000


Non-farm Income
2%
8%
40%
17%
27%
Below N 15,000
N 15,000 - N 30,000
N 30,000 - N 45,000
N 45,000 - N 60,000
N 60,000 - N 75,000
Above N 75,000

Appendix A5: Determinants of Adoption of Coping Starategies/Household Socio-Economic and Socio-Demographic Characteristics

Are you an indigene of Jigawa State?

Origin	Ringim		Guri		Hadejia		Kafin-Hausa		Overall	
	Number	%	Number	%	Number	%	Number	%	Number	%
Yes	93	87.74	55	90.16	41	83.33	30	87.25	219	87.25
No	13	12.26	6	9.84	7	16.67	6	12.75	32	12.75
Total	106	100.00	61	100.00	48	100.00	36	100.00	251	100.00

Respondents Local Government (LGA) of Origin

LGA of Origin	Number	Percentage (%)
Ringim	106	42.23
Guri	61	24.31
Hadejia	48	19.12
Kafin-Hausa	36	14.34
Total	251	100.00

Reasons for Migration of Non-indigenes to Jigawa State

Reasons for migration	Number	Percentage(%)
Employment	8	25.00
Education	1	3.13
Marriage	12	37.50
Climate Shocks	11	34.37
Total	32	100.00

Respondents' Settlement Status	Ringim		Guri		Hadejia		Kafin-Hausa		Overall	
	Number	%	Number	%	Number	%	Number	%	Number	%

Reason for migration	Ringim		Guri		Hadejia		Kafin-Hausa		Overall	
	Number	%	Number	%	Number	%	Number	%	Number	%
Employment	4	30.77	1	16.67	2	28.57	1	16.67	8	25.00
Education	0	0.00	0	0.00	1	14.29	0	0.00	1	3.13

Respondents' Communities	Ringim		Guri		Hadejia		Kafin-Hausa		Overall	
	Number	%	Number	%	Number	%	Number	%	Number	%
Majiya Gari	72	67.92	0	0.00	0	0.00	0	0.00	72	28.69
Auramo Sabuwa	34	32.08	0	0.00	0	0.00	0	0.00	34	13.55
GRA	0	0.00	61	100.00	0	0.00	0	0.00	61	24.30
Gudiccin	0	0.00	0	0.00	48	100.00	0	0.00	48	19.12
Tage	0	0.00	0	0.00	0	0.00	36	100.00	36	14.34
Total	106	100.00	61	100.00	48	100.00	36	100.00	251	100.00
Marriage	3	23.08	3	50.00	2	28.57	4	66.67	12	37.50
Climate Shocks	6	46.15	2	33.33	2	28.57	1	16.67	11	34.37
Total	13	100.00	6	100.00	7	100.00	6	100.00	32	100.00

Rural	0	0.00	61	100.00	0	0.00	36	100.00	97	38.65
Urban	106	100.00	0	0.00	48	100.00	0	0.00	154	61.35
Total	106	100.00	61	100.00	48	100.00	36	100.00	251	100.00

Respondents' Sex	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
Male	77	72.64	45	73.77	36	75.00	27	75.00	185	73.71
Female	29	27.36	16	26.23	12	25.00	9	25.00	66	26.29
Total	106	100.00	61	100.00	48	100.00	36	100.00	251	100.00

Respondents' Age	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
< 20 Years	0	0.00	1	1.64	0	0.00	0	0.00	1	0.40
21-30 Years	19	17.92	15	24.59	9	18.75	3	8.33	46	18.33
31-40 Years	31	29.25	24	39.34	23	47.92	19	52.78	97	38.65
41-50 Years	38	35.85	15	24.59	10	20.83	10	27.78	73	29.08
51-60 Years	18	16.98	6	9.84	5	10.42	3	8.33	32	12.75
> 60 Years	0	0.00	0	0.00	1	2.08	1	2.78	2	0.80
Total	106	100.00	61	100.00	48	100.00	36	100.00	251	100.00
Average		41.82		37.36		39.06		40.17		40.00

Households' Family Size	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
1-5 persons	20	18.87	23	37.70	23	47.92	12	33.33	78	31.08
6-10 persons	58	54.72	34	55.74	22	45.83	21	58.33	135	53.78
11-15 persons	27	26.47	4	6.56	3	6.26	3	8.33	37	14.74
16 and above	1	0.94	3	0.00	0	0.00	0	0.00	1	0.40
Total	106	100.00	61	100.00	48	100.00	36	100.00	251	100.00
Average		8.26		6.30		6.33		6.58		7.18

Households Marital Status	Ringim		Guri		Hadejia		Kafin-Hausa		Overall	
	Number	%	Number	%	Number	%	Number	%	Number	%
Married	77	72.64	51	83.61	41	85.42	33	91.67	202	80.48
Separated	5	4.72	3	4.92	2	4.17	0	0.00	10	3.98
Divorced	4	3.77	0	0.00	2	4.17	0	0.00	6	2.39
Widowed	20	18.87	7	11.48	3	6.25	3	8.33	33	13.15
Total	106	100.00	61	100.00	48	100.00	36	100.00	251	100.00

Households Education	Ringim		Guri		Hadejia		Kafin-Hausa		Overall	
	Number	%	Number	%	Number	%	Number	%	Number	%
No formal Education	4	3.77	0	0.00	0	0.00	0	0.00	4	1.59
Primary School (not completed)	12	11.32	10	16.39	8	16.67	5	13.89	35	13.94
Primary School (completed)	16	15.09	10	16.39	12	25.00	10	27.78	48	19.12
Secondary School (not completed)	12	11.32	7	11.48	6	12.50	3	8.33	28	11.16
Secondary School (completed)	11	10.38	5	8.20	7	14.58	4	11.11	27	10.76
Post-secondary Education	18	16.98	8	13.11	7	14.58	3	8.33	36	14.34
Koranic Education	33	31.13	21	34.43	8	16.67	11	30.56	73	29.08
Total	106	100.00	61	100.00	48	100.00	36	100.00	251	100.00

Households Occupation	Ringim		Guri		Hadejia		Kafin-Hausa		Overall	
	Number	%	Number	%	Number	%	Number	%	Number	%
Public sector employee	19	17.92	10	16.39	8	16.67	5	13.89	42	16.73
Private sector employee	4	3.77	0	0.00	4	8.33	2	5.56	10	3.98
Farming/ Fishing	53	50.00	25	40.98	9	18.75	12	33.33	99	39.44
Artisan	10	9.43	6	9.84	11	22.92	4	11.11	31	12.35
Trading/ Business	18	16.98	16	26.23	14	29.17	12	33.33	60	23.90
Driver	2	1.89	4	6.26	2	4.17	1	2.78	9	3.59
Total	106	100.00	61	100.00	48	100.00	36	100.00	251	100.00

Households Non-farm Income	Ringim		Guri		Hadejia		Kafin-Hausa		Overall	
	Number	%	Number	%	Number	%	Number	%	Number	%
₦1 to ₦15,000	33	35.87	26	48.15	16	37.21	13	43.33	88	40.18
₦15,001 to ₦30,000	28	30.43	13	24.07	9	20.93	10	33.33	60	27.40
₦30,001 to ₦45,000	10	10.87	10	18.52	11	25.58	5	16.67	36	16.44
₦45,001 to ₦60,000	10	10.87	3	5.56	4	9.30	1	3.33	18	8.22
₦60,001 to ₦75,000	7	7.61	2	3.70	2	4.65	1	3.33	12	5.48
Above N75,000	4	4.35	0	0.00	1	2.33	0	0.00	5	2.28
Total	92	100.00	54	100.00	43	100.00	30	100.00	219	100.00
Average	₦28,902.17		₦22,407.41		₦29,220.93		₦21,950		₦26,410.96	

Households Farm Income	Ringim		Guri		Hadejia		Kafin-Hausa		Overall	
	Number	%	Number	%	Number	%	Number	%	Number	%
₦1 to ₦60,000	14	13.73	6	10.53	3	7.32	9	27.27	32	13.73

₦60,001 to ₦120,000	35	34.31	18	31.58	16	39.02	14	42.42	83	35.62
₦120,001 to ₦180,000	26	25.49	11	19.30	11	26.83	6	18.18	54	23.18
11₦180,001 to ₦240,000	12	11.76	8	14.04	5	12.20	1	3.03	24	11.16
₦240,001 to ₦320,000	8	7.84	6	10.53	4	9.76	2	6.06	20	8.58
Above N320,000	7	6.86	8	14.04	2	4.88	1	3.03	18	7.73
Total	102	100.00	57	100.00	41	100.00	33	100.00	233	100.00
Average	₦158,539.22		₦190,175.44		₦151,121.95		₦121,242.42		₦159,690.99	

Repondents Housing Tenure Status	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
Self-apartment	68	64.15	35	57.38	35	72.92	25	69.44	163	64.94
Tenant	7	6.60	4	6.56	6	12.50	3	8.33	20	7.97
Squatter	12	11.32	13	21.31	0	0.00	0	0.00	25	9.96
Compound House	19	17.92	9	14.75	7	14.58	8	22.22	43	17.13
Total	106	100.00	61	100.00	48	100.00	36	100.00	251	100.00

Households Property Insurance Status	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
Yes	1	0.94	0	0.00	0	0.00	0	0.00	1	0.40
No	105	99.06	61	100.00	48	100.00	36	100.00	250	99.60
Total	106	100.00	61	100.00	48	100.00	36	100.00	251	100.00

House Construction Material	Ringim		Guri		Hadejia		Kafin-Hausa		Overall	
	Number	%	Number	%	Number	%	Number	%	Number	%
Wood	5	4.72	0	0.00	2	4.17	0	0.00	7	2.79
Concrete	7	6.60	2	3.28	0	0.00	0	0.00	9	3.59
Bricks	41	38.68	14	22.95	26	54.17	3	8.33	84	33.47
Coconut Leaves	1	0.94	0	0.00	0	0.00	0	0.00	1	0.40
Clay Bricks	27	25.47	10	16.39	6	12.50	22	61.11	65	25.90
Bricks and Clay Bricks	25	23.58	35	57.38	14	29.17	11	30.56	85	33.86
Total	106	100.00	61	100.00	48	100.00		100.00	251	100.00

Length of stay in the Community?	Ringim		Guri		Hadejia		Kafin-Hausa		Overall	
	Number	%	Number	%	Number	%	Number	%	Number	%
1-10 Years	5	4.72	14	22.95	1	2.08	0	0.00	20	7.97
11-20 Years	12	11.32	12	19.67	4	8.33	7	19.44	35	13.94
21-30 Years	33	31.13	17	27.87	12	25.00	8	22.22	70	27.89
31-40 Years	25	23.58	11	18.03	20	41.67	11	30.56	67	26.69
41-50 Years	19	17.92	4	6.56	8	16.67	9	25.00	40	15.94
51-60 Years	12	11.32	3	4.92	3	6.25	1	2.78	19	7.57
Total	106	100.00	61	100.00	48	100.00	36	100.00	251	100.00
Average		34.10		23.69		33.67		32.50		31.26

Extended Family Members	Ringim		Guri		Hadejia		Kafin-Hausa		Overall	
	Number	%	Number	%	Number	%	Number	%	Number	%
1-2 persons	62	35.16	21	43.75	27	65.85	14	46.67	94	44.76
3-4 persons	32	35.16	24	50.00	13	31.71	13	43.33	82	39.05

5-6 persons	21	23.08	1	2.08	0	0.00	2	6.67	24	11.43
7-8 persons	3	3.30	1	2.08	1	2.44	1	3.33	6	2.86
9-10 persons	3	3.30	1	2.08	0	0.00	0	0.00	4	1.90
Total	91	100.00	48	100.00	41	100.00	30	100.00	210	100.00
Average		3.08		2.31		2.02		2.31		2.58

Female Family Members (including extended)	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
1-2 persons	13	12.26	12	19.67	6	12.50	8	22.22	39	15.54
3-4 persons	30	28.30	27	44.26	26	54.17	13	36.11	96	38.25
5-6 persons	29	27.36	13	21.31	14	29.17	9	25.00	65	25.90
7-8 persons	17	16.04	8	13.11	2	4.17	6	16.67	33	13.15
9-10 persons	17	16.04	1	1.64	0	0.00	0	0.00	18	7.17
Total	106	100.00	61	100.00	48	100.00	36	100.00	251	100.00
Average		5.46		4.15		4.04		4.28		4.70

Male Family Members (including extended)	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
1-2 persons	10	9.43	12	19.67	8	16.67	5	13.89	35	13.94

3-4 persons	19	17.92	20	32.79	22	45.83	14	38.89	75	29.88
5-6 persons	36	33.96	20	32.79	10	20.83	10	27.27	76	30.28
7-8 persons	24	22.64	7	11.48	6	12.50	6	16.67	43	17.13
9-10 persons	14	13.21	1	1.64	2	4.17	1	2.78	18	7.17
11-12 persons	2	1.89	1	1.64	0	0.00	0	0.00	3	1.20
13-14 persons	1	0.94	0	0.00	0	0.00	0	0.00	1	0.40
Total	106	100.00	61	100.00	48	100.00	36	100.00	251	100.00
Average		5.89		4.46		4.29		4.64		5.06

Are you Victims of 2016 flooding?	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
Yes	106	100.00	61	100.00	48	100.00	36	100.00	251	100.00
No	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Total	106	100.00	61	100.00	48	100.00	36	100.00	251	100.00

Do you have open sewage canals in yoyr surroundings?	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
Yes	79	74.53	57	93.44	21	43.75	25	69.44	182	72.51
No	27	25.47	4	6.56	27	56.25	11	30.56	69	27.49
Total	106	100.00	61	100.00	48	100.00	36	100.00	251	100.00

Are you Victims of 2016 flooding?	Ringim		Guri		Hadejia		Kafin-Hausa		Overall	
	Number	%	Number	%	Number	%	Number	%	Number	%
Yes	37	34.91	7	11.48	19	39.58	11	30.56	74	29.48
No	69	65.09	54	88.52	29	60.42	25	69.44	177	70.52
Total	106	100.00	61	100.00	48	100.00	36	100.00	251	100.00

Aware you are living in a flood hazard and high-risk area?	Ringim		Guri		Hadejia		Kafin-Hausa		Overall	
	Number	%	Number	%	Number	%	Number	%	Number	%
Yes	89	83.96	59	96.72	45	93.75	33	91.67	226	90.04
No	17	16.04	2	3.28	3	6.25	3	8.33	25	9.96
Total	106	100.00	61	100.00	48	100.00	36	100.00	251	100.00

Aware of the existence of flood early warning systems in your community?	Ringim		Guri		Hadejia		Kafin-Hausa		Overall	
	Number	%	Number	%	Number	%	Number	%	Number	%
Yes	12	11.32	0	0.00	4	8.33	1	2.78	17	6.77
No	94	88.68	61	100.00	44	91.67	35	97.22	234	93.23
Total	106	100.00	61	100.00	48	100.00	36	100.00	251	100.00

Aware of the existence of local emergency response group?	Ringim		Guri		Hadejia		Kafin-Hausa		Overall	
	Number	%	Number	%	Number	%	Number	%	Number	%
Yes	16	15.09	0	0.00	12	25.00	3	8.33	31	12.35
No	90	84.91	61	100.00	36	75.00	33	91.67	220	87.65
Total	106	100.00	61	100.00	48	100.00	36	100.00	251	100.00

Any family member infected with Malaria?	Ringim		Guri		Hadejia		Kafin-Hausa		Overall	
	Number	%	Number	%	Number	%	Number	%	Number	%
Yes	68	64.15	41	67.21	34	70.83	26	72.22	169	67.33
No	38	35.85	20	32.79	14	29.17	10	27.78	82	32.67
Total	106	100.00	61	100.00	48	100.00	36	100.00	251	100.00

Any family member infected with Diarrhea?	Ringim		Guri		Hadejia		Kafin-Hausa		Overall	
	Number	%	Number	%	Number	%	Number	%	Number	%
Yes	38	35.85	19	31.15	15	31.25	10	27.78	82	32.67
No	68	64.15	42	68.85	33	68.75	26	72.22	169	67.33
Total	106	100.00	61	100.00	48	100.00		100.00	251	100.00

Any family member infected with Leptospirosis?	Ringim		Guri		Hadejia		Kafin-Hausa		Overall	
	Number	%	Number	%	Number	%	Number	%	Number	%
Yes	0	0.00	60	98.36	0	0.00	0	0.00	1	0.40
No	106	100.00	1	1.64	48	100.00	36	100.00	250	99.60
Total	106	100.00	61	100.00	48	100.00	36	100.00	251	100.00

Number of those infected with Malaria?	Ringim		Guri		Hadejia		Kafin-Hausa		Overall	
	Number	%	Number	%	Number	%	Number	%	Number	%
1-2 persons	19	27.94	21	51.22	16	47.06	7	25.93	63	37.06
3-4 persons	24	35.29	16	39.02	13	38.24	12	44.44	65	38.24
5-6 persons	21	30.88	4	9.76	3	8.82	6	22.22	34	20.00
7-8 persons	2	2.94	0	0.00	1	2.94	2	7.41	5	2.94
9-10 persons	1	1.47	0	0.00	1	2.94	0	0.00	2	1.18

11-12 persons	1	1.47	0	0.00	0	0.00	0	0.00	1	0.59
Total	68	100.00	41	100.00	34	100.00	27	100.00	170	100.00
Average		3.78		2.66		3.03		3.69		3.34

Number of those infected with Diarrhea?	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
1-2 persons	17	43.59	14	73.68	4	26.67	3	30.00	38	45.78
3-4 persons	14	35.90	3	15.79	7	46.67	4	40.00	28	33.73
5-6 persons	5	12.82	2	10.53	3	20.00	2	20.00	12	14.46
7-8 persons	2	5.12	0	0.00	1	6.67	1	10.00	4	4.82
11-12 persons	1	2.56	0	0.00	0	0.00	0	0.00	1	1.20
Total	39	100.00	19	100.00	15	100.00	10	100.00	83	100.00
Average		3.29		2.37		3.60		3.70		3.18

Effect of Flood on Household	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
Building destroyed	27	25.47	1	1.64	4		8	22.22	40	15.94
Farmland destroyed	7	6.60	0	0.00	0		0	0.00	7	2.79
Building and properties lost	2	1.89	16	26.23	4		8	22.22	30	11.95
Building and farmland affected	30	28.30	6	9.84	16		6	16.67	58	23.11
Farm produce and farmland destroyed	1	0.94	2	3.28	3		2	5.56	8	3.19

Building, properties, farmland and farm produce destroyed	39	36.79	36	59.02	21		12	33.33	108	43.03
Total	106	100.00	61	100.00	48	100.00	36	100.00		100.00

Where the ailments caused by flood?	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
Yes	66	62.26	46	75.41	35	72.92	32	88.89	179	71.31
No	40	37.74	15	24.59	13	27.08	4	11.11	72	28.69
Total	106	100.00	61	100.00	48	100.00	36	100.00	251	100.00

Frequency at which community is flooded?	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
Every 3 months	1	0.94	0	0.00	0	0.00	0	0.00	1	0.40
Every 6 months	0	0.00	1	1.64	0	0.00	0	0.00	1	0.40
Every year	89	83.96	32	52.46	41	85.42	35	97.22	197	78.49
Every 2 years	11	10.38	12	19.67	5	10.42	0	0.00	28	11.16
Every three years	2	1.89	0	0.00	.0	0.00	0	0.00	2	0.80
Sometimes	3	2.83	16	26.23	2	4.17	1	2.78	22	8.76
Total	106	100.00	61	100.00	48	100.00	36	100.00	251	100.00

Did the flood water penetrate your home?	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**

Yes	98	92.45	56	91.80	44	91.67	34	94.44	232	92.43
No	8	7.55	5	8.20	4	8.33	2	5.56	19	7.57
Total	106	100.00	61	100.00	48	100.00	36	100.00	251	100.00

What height did the flood water reach?	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
Ankle level	16	16.33	9	16.07	13	29.55	10	29.41	48	20.69
Knee level	48	48.98	35	62.50	19	43.18	14	41.18	116	50.00
Waist level	32	32.65	12	21.43	12	27.27	10	29.41	66	28.45
Shoulder level	1	1.02	0	0.00	0	0.00	0	0.00	1	0.43
Roof level	1	1.02	0	0.00	0	0.00	0	0.00	1	0.43
Total	98	100.00	56	100.00	44	100.00	34	100.00	232	100.00

Is your immediate surrounding clean?	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
Yes	43	40.57	28	45.90	36	75.00	19	52.78	126	50.20
No	63	59.43	33	54.10	12	25.00	17	47.22	125	49.80
Total	106	100.00	61	100.00	48	100.00	36	100.00		100.00

Is your house located in a waterlogged area?	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
Yes	66	62.26	50	81.97	42	87.50	30	83.33	188	74.90
No	40	37.74	11	18.03	6	12.50	6	16.67	63	25.10
Total	106	100.00	61	100.00	48	100.00	36	100.00	251	100.00

Do open sewage canals exist in your area?	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**

Yes	79	74.53	57	93.44	21	43.75	25	69.44	182	72.51
No	27	25.47	4	6.56	27	56.25	11	30.56	69	27.49
Total	106	100.00	61	100.00	48	100.00	36	100.00	251	100.00

Is your house located near a pond, river or creek?	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
Yes	46	43.40	50	81.97	33	68.75	20	55.56	149	59.36
No	60	56.60	11	18.03	15	31.25	16	44.44	102	40.64
Total	106	100.00	61	100.00	48	100.00	36	100.00	251	100.00

Is your house located in an elevated area?	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
Yes	37	34.91	7	11.84	19	39.58	11	30.56	74	29.48
No	69	65.09	54	88.52	29	60.42	25	69.44	177	70.52
Total	106	100.00	61	100.00	48	100.00	36	100.00	251	100.00

Where do members of your household defecate?	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
Public latrine	1	0.94	0	0.00	4	8.33	4	11.11	9	3.59
Own latrine	91	85.85	46	75.41	35	72.92	26	72.22	198	78.88
Neighbour's latrine	2	1.89	0	0.00	0	0.00	0	0.00	2	0.80
Water body	0	0.00	0	0.00	0	0.00	1	2.78	1	0.40
On the ground	5	4.72	10	16.39	3	6.25	2	5.56	20	7.37

Anywhere	7	6.60	5	8.20	6	12.50	3	8.33	21	8.37
Total	106	100.00	61	100.00	48	100.00	36	100.00	251	100.00

What type of latrine do you have at home?	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
Pour flush	25	23.58	7	11.48	23	47.92	1	2.78	56	22.31
Water-sealed	4	3.77	1	1.64	7	14.58	0	0.00	12	4.78
Antipolo type	5	4.72	1	1.64	2	4.17	0	0.00	8	3.19
Pit latrine	66	62.26	52	85.25	16	33.33	35	97.22	169	67.33
Don't have	6	5.66	0	0.00	0	0.00	0	0.00	6	2.39
Total	106	100.00	61	100.00	48	100.00	36	100.00	251	100.00

Where do you dispose liquid wastes?	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
Into drainage	60	56.60	21	34.43	27	56.25	16	44.44	124	49.40
Into a pit	10	9.43	4	6.56	13	27.08	12	33.33	39	15.54
Into a Septic Tank	4	3.77	0	0.00	0	0.00	0	0.00	4	1.59
Anywhere	32	30.19	36	59.02	8	16.67	8	22.22	84	33.47
Total	106	100.00	61	100.00	48	100.00	36	100.00	251	100.00

Where do you dispose solid wastes?	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
Burning	82	77.36	49	80.33	28	58.33	26	72.22	185	73.71
Garbage collected by LGAs	3	2.83	0	0.00	3	6.25	0	0.00	6	2.39
Burying under the ground	8	7.55	3	4.92	4	8.33	0	0.00	15	5.98
Composting	4	3.77	5	8.20	2	4.17	1	2.78	12	4.78

As manure in the farm	0	0.00	0	0.00	1	2.08	0	0.00	1	0.40
Refuse dumping sites	9	8.49	4	6.56	10	20.83	9	25.00	32	12.75
Total	106	100.00	61	100.00	48	100.00	36	100.00	251	100.00

Do you practice waste segregation in your community?	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
Yes	75	70.75	34	55.74	28	58.33	8	22.22	145	57.77
No	31	29.25	27	44.26	20	41.67	28	77.78	106	42.23
Total	106	100.00	61	100.00	48	100.00	36	100.00		100.00

Your source of drinking water during normal days?	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
Well	12	11.32	11	18.03	2	4.17	0	0.00	25	9.96
River	5	4.72	3	4.92	1	2.08	0	0.00	9	3.59
Pipe borne water	15	14.15	0	0.00	27	56.25	0	0.00	42	16.73
Communal Borehole water	74	69.81	47	77.05	18	37.50	36	100.00	175	69.72
Total	106	100.00	61	100.00	48	100.00	36	100.00		100.00

Your source of drinking water during floods?	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
Well	7	6.60	1	1.64	0	0.00	0	0.00	8	3.19
River	3	2.83	0	0.00	4	8.33	0	0.00	7	2.79
Pipe borne	14	13.21	1	1.64	24	50.00	0	0.00	39	15.54

water										
Communal Borehole water	82	77.36	54	88.52	20	41.67	36	100.00	192	76.49
Spring	0	0.00	5	8.20	0	0.00	0	0.00	5	1.99
Total	106	100.00	61	100.00	48	100.00	36	100.00	251	100.00

Do you think your source of drinking water clean?	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
Yes	82	77.36	43	70.49	36	75.00	31	86.11	192	76.49
No	24	22.64	18	29.51	12	25.00	5	13.89	59	23.51
Total	106	100.00	61	100.00	48	100.00	36	100.00	251	100.00

How do you clean or sterilize your drinking water?	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
Settling	17	17.71	11	18.64	4	9.30	1	3.23	33	14.41
Filtering	11	11.46	8	13.56	2	4.65	2	6.45	23	10.04
Boiling for less than 10 minutes	7	7.29	2	3.39	1	2.33	0	0.00	10	4.37
Boiling for 10 minutes	1	1.04	0	0.00	0	0.00	0	0.00	1	0.44
Chlorination	1	1.04	0	0.00	0	0.00	0	0.00	1	0.44
Nothing	59	61.46	38	64.41	36	83.72	28	90.32	161	70.31
Total	96	100.00	59	100.00	43	100.00	31	100.00	229	100.00

Are you allowed to keep domesticated animals?	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
Yes	106	100.00	61	100.00	48	100.00	36	100.00	251	100.00

No	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Total	106	100.00	61	100.00	48	100.00	36	100.00	251	100.00

Type of domesticated animals you own?	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
Cow	12	11.65	4	7.14	3	6.67	6	16.67	27	11.16
Chicken	29	28.16	20	35.71	13	28.89	11	30.56	73	30.17
Goat	32	31.07	14	25.00	14	31.11	6	16.67	66	27.27
Sheep	21	20.39	10	17.86	8	17.78	4	11.11	43	17.77
Birds	2	1.94	0	0.00	0	0.00	1	2.78	3	1.24
Donkey	3	2.91	1	1.79	1	2.22	0	0.00	5	2.07
Don’t have	4	3.88	7	12.50	6	13.33	8	22.22	25	10.33
Total	103	100.00	56	100.00	45	100.00	36	100.00	242	100.00

Specify the number of domesticated animals you own?	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
1-2 units	12	12.37	14	27.45	3	7.69	3	10.71	32	14.88
3-4 units	23	23.71	14	27.45	15	38.46	8	28.57	60	27.91
5-6 units	22	22.68	6	11.76	12	30.77	7	25.00	47	21.86
7-8 units	18	18.56	11	21.57	5	12.82	5	17.86	39	18.14
9-10 units	12	12.37	3	5.88	3	7.69	2	7.14	20	9.30
11-12 units	7	7.22	3	5.88	1	2.56	2	7.14	13	6.05
13-14 units	3	3.09	0	0.00	0	0.00	1	3.57	4	1.86
Total	97	100.00	51	100.00	39	100.00	28	100.00	215	100.00
Average		6.35		4.92		5.26		5.86		5.76

Ways you dispose faecal wastes from animals?	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
Burying under the ground	10	10.10	3	5.88	9	23.08	0	0.00	22	10.14
Composting	1	1.01	0	0.00	0	0.00	2	7.14	3	1.38

As manure in the farm	87	87.88	44	86.27	19	48.72	25	89.29	175	80.65
Anywhere	1	1.01	4	7.84	11	28.21	1	3.57	17	7.83
Total	99	100.00	51	100.00	39	100.00	28	100.00	217	100.00

Types of domesticated animals observed in your community?	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
All the listed animals except pigs	106	100.00	61	100.00	48	100.00	32	100.00	247	100.00
Total		100.00		100.00		100.00		100.00		100.00

Have you noticed rats roaming around your vicinity?	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
Yes	96	90.57	57	93.44	42	87.50	35	97.22	230	91.63
No	10	9.43	4	6.56	6	12.50	1	2.78	21	8.37
Total	106	100.00	61	100.00	48	100.00	36	100.00	251	100.00

Have you noticed rats roaming around your neighbour's vicinity?	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
Yes	101	95.28	53	86.89	43	89.58	33	91.67	230	91.63
No	5	4.72	8	13.11	5	10.42	3	8.33	21	8.37
Total	106	100.00	61	100.00	48	100.00	36	100.00	251	100.00

Have you noticed animals roaming around	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**

your vicinity without their owners?										
Yes	87	82.08	51	83.61	39	81.25	33	91.67	210	83.67
No	19	17.92	10	16.39	9	18.75	3	8.33	41	16.33
Total	106	100.00	61	100.00	48	100.00	36	100.00	251	100.00

What sanitation and hygiene programmes have you attended before?	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
Garbage segregation	4	3.77	0	0.00	0	0.00	0	0.00	4	1.59
About water safety	6	5.66	0	0.00	1	2.08	1	2.78	8	3.19
Disease outbreaks during floods	11	10.38	9	14.75	4	8.33	0	0.00	24	9.56
Environmental sanitation	56	52.83	27	44.26	35	72.92	35	97.22	153	60.96
Proper Washing of hands with soap	7	6.60	1	1.64	0	0.00	0	0.00	8	3.19
Water safety and environmental sanitation	1	0.94	2	3.28	0	0.00	0	0.00	3	1.20
Water safety and disease outbreak	2	1.89	1	1.64	0	0.00	0	0.00	3	1.20
Disease outbreak and environmental sanitation	11	10.38	1	1.64	4	8.33	0	0.00	16	6.37
None	8	7.55	20	32.79	4	8.33	0	0.00	32	12.75
Total	106	100.00	61	100.00	48	100.00	36	100.00	251	100.00

What are your other source(s) of information about sanitation and hygiene programmes?	Ringim		Guri		Hadejia		Kafin-Hausa		Overall	
	Number	%	Number	%	Number	%	Number	%	Number	%
LGAs	0	0.00	0	0.00	8	18.18	3	10.71	11	6.18
Television	0	0.00	0	0.00	4	9.09	0		4	2.25
Radio	56	81.16	35	94.59	32	72.73	22	78.58	145	81.46
Own Family	2	2.90	0		0	0.00	0	0.00	2	1.12
Neighbours	5	7.25	2	5.41	0	0.00	0	0.00	7	3.93
NGOs workers	2	2.90	0	0.00	0	0.00	0	0.00	2	1.12
Health workers	2	2.90	0	0.00	0	0.00	3	10.71	5	2.81
Health Centres	2	2.90	0	0.00	0	0.00	0	0.00	2	1.12
Total	69	100.00	37	100.00	44	100.00	28	100.00	178	100.00

Are you in good relationship with your neighbours?	Ringim		Guri		Hadejia		Kafin-Hausa		Overall	
	Number	%	Number	%	Number	%	Number	%	Number	%
Yes	106	100.00	61	100.00	48	100.00	36	100.00	251	100.00
No	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Total	106	100.00	61	100.00	48	100.00	36	100.00	251	100.00

Will you assist your neighbour during floods when sought from you?	Ringim		Guri		Hadejia		Kafin-Hausa		Overall	
	Number	%	Number	%	Number	%	Number	%	Number	%
Yes	106	100.00	61	100.00	48	100.00	34	100.00	249	100.00
No	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Total	106	100.00	61	100.00	48	100.00	34	100.00	249	100.00

Are health and hygiene meetings held in your community?	Ringim		Guri		Hadejia		Kafin-Hausa		Overall	
	Number	%	Number	%	Number	%	Number	%	Number	%
Yes	34	32.08	0	0.00	26	56.52	3	9.38	63	25.71
No	72	67.92	61	100.00	20	43.48	29	90.62	182	74.29
Total	106	100.00	61	100.00	46	100.00	32	100.00	245	100.00

If Yes above, do you regularly attend these meetings?	Ringim		Guri		Hadejia		Kafin-Hausa		Overall	
	Number	%	Number	%	Number	%	Number	%	Number	%
Yes	32	86.49	0	0.00	19	82.61	3	100.00	54	85.71
No	5	13.51	0	0.00	4	17.39	0	0.00	9	14.29
Total	37	100.00	0	0.00	23	100.00	3	100.00	63	100.00

Do you observe neighbours helping each other during floods?	Ringim		Guri		Hadejia		Kafin-Hausa		Overall	
	Number	%	Number	%	Number	%	Number	%	Number	%
Yes	106	100.00	59	96.72	48	0.00	33	100.00	246	99.19
No	0	0.00	2	3.28	0	0.00	0	0.00	2	0.81

Total	106	100.00	61	100.00	48	100.00	33	100.00	248	100.00

By living near a river or pond, do you know you are at risk of flooding?	Ringim		Guri		Hadejia		Kafin-Hausa		Overall	
	Number	%	Number	%	Number	%	Number	%	Number	%
Yes	90	88.24	54	88.52	41	91.11	31	93.94	216	89.63
No	12	11.76	7	11.48	4	8.89	2	6.06	25	10.37
Total	102	100.00	61	100.00	45	100.00	33	100.00	241	100.00

Are you willing to relocate from your community if advised by government?	Ringim		Guri		Hadejia		Kafin-Hausa		Overall	
	Number	%	Number	%	Number	%	Number	%	Number	%
Yes	91	85.85	51	83.61	35	74.47	27	84.38	204	82.93
No	15	14.15	10	16.39	12	25.53	5	15.62	42	17.07
Total	106	100.00	61	100.00	47	100.00	32	100.00	246	100.00

If 'Yes' above, give your reasons?	Ringim		Guri		Hadejia		Kafin-Hausa		Overall	
	Number	%	Number	%	Number	%	Number	%	Number	%
To avoid loss of lives and properties	78	85.71	43	84.31	14	40.00	17	62.96	152	74.51
To avoid having problems with authorities	11	12.09	7	13.73	6	17.14	7	25.92	31	15.20
Because the is no other	0	0.00	1	1.96	4	11.43	0	0.00	5	2.45

alternative										
Just like that	1	1.10	0	0.00	0	0.00	0	0.00	1	0.49
If provided with an alternative	1	1.10	0	0.00	11	31.43	3	11.11	15	7.35
Total	91	100.00	51	100.00	35	100.00	27	100.00	204	100.00

If 'No' above, give your reasons?	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
Nowhere else to go	12	80.00	5	50.00	5	41.67	2	40.00	24	57.14
It's my inheritance	1	6.67	2	20.00	1	8.33	1	20.00	5	11.90
Just like that	0	0.00	1	10.00	1	8.33	0	0.00	2	4.76
No financial means to relocate	2	13.33	2	20.00	5	41.67	2	40.00	11	26.19
Total	15	100.00	10	100.00	12	100.00	5	100.00	42	100.00

Your source of drinking water during floods?	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
Well	7	6.60	1	1.64	0	0.00	0	0.00	8	3.19
River	3	2.83	0	0.00	4	8.33	0	0.00	7	2.79
Pipe borne water	14	13.21	1	1.64	24	50.00	0	0.00	39	15.54
Communal	82	77.36	54	88.52	20	41.67	36	100.00	192	76.49

Borehole water										
Spring	0	0.00	5	8.20	0	0.00	0	0.00	5	1.99
Total	106	100.00	61	100.00	48	100.00	36	100.00	251	100.00

Appendix A6: Household's Knowledge, Attitude and Practices on Resilience to Floods

This appendix presents the results on the knowledge, attitude and practices of Household on resilience to floods, as drawn from questions contained in the survey questionnaires administered to them. Resilience to flood can be gauged under eight (8) sub-categories, that is to say it has eight (8) components, as shown below:

A. Flood Resilience:

(i) Hazards (ii) Risks (iii) Exposure (iv) Preparedness (v) Response (vi) Recovery (vii) Coordination and (viii) Adaptation Strategies

Resilience to Floods: KNOWLEDGE

Item: HAZARDS	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
Questions	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**
1. Do you know you live in a flood hazard area and you are at high risk to floods?	89	83.96	59	96.72	45	93.75	33	91.67	226	90.04
2. Do you understand the nature and destructive capability of floods in your area?	103	97.17	59	96.72	43	89.58	34	94.44	239	95.22
3. Are you still living in your area despite experiencing flood?	103	97.17	58	95.08	46	95.83	34	94.44	241	96.02

4. Have you seen drainage infrastructure overloaded during heavy rains?	97	91.51	56	91.80	45	93.75	33	91.67	231	92.03
5. Have you seen debris of all kinds during and after flood	95	89.62	58	95.08	45	93.75	32	88.89	230	91.63
6. Are you aware of any flood map(s) in your community?	3	2.83	0	0.00	2	4.17	0	0.00	5	1.99
Average (%) Score		77.04		79.23		62.50		76.85		77.82

* F represents figures on frequencies for only 'yes' answers

Resilience to Floods: KNOWLEDGE……. continued

Item: RISKS	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
Questions	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**
1. Do you know that floods can occur during and after heavy rains?	105	99.06	61	100.00	45	93.75	35	97.22	246	98.01
2. Do you know the defence level and limitations of flood control barriers?	37	34.91	39	63.93	29	60.42	22	61.11	127	50.60
3. Are you aware the period in the year that flooding usually occur?	97	91.51	58	95.08	44	91.67	33	91.67	232	92.43
4. Do you consider flooding as something that can occur anytime, hence the need to be always prepared?	99	93.40	59	96.72	46	95.83	32	88.89	236	94.02
Average (%) Score		79.72		88.93		85.42		84.72		83.77

* F represents figures on frequencies for only 'yes' answers

Resilience to Floods: KNOWLEDGE……. continued

Item: EXPOSURE	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
Questions	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**
1. Do you know well the negative impacts of floods?	105	99.06	61	100.00	47	97.92	35	97.22	248	98.80
2. Have you or any member of your household been exposed to flood before?	82	77.36	49	80.33	41	85.42	33	91.67	205	81.67
3.Have any of your household members sustained injuries from flood?	28	26.42	8	13.11	17	35.42	0	0.00	53	21.12
4. Have any you or any member taken ill during flood or period heavy rains?	82	77.36	49	80.33	39	81.25	32	88.89	202	80.48
5. Have you lost anyone in your household due to flooding?	4	3.77	0	0.00	6	12.50	0	0.00	10	3.98

6. Have you experienced property losses from past floods?	104	98.11	57	93.44	44	91.67	34	94.44	239	95.22
Average (%) Score		63.68		61.20		67.36		62.04		63.55

* F represents figures on frequencies for only 'yes' answers

Resilience to Floods: KNOWLEDGE……. continued

Item: PREPAREDNESS	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
Questions	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**
1. Do flood early warning systems exist in your community?	12	11.32	0	0.00	4	8.33	1	2.78	17	6.77
2. If 'Yes', do know how it is interpreted?	2	1.89	0	0.00	2	4.17	1	2.78	5	1.99
3. Do practical trainings on early warning systems exist in your community?	7	6.60	0	0.00	1	2.08	0	0.00	8	3.19
4. Do you know how information on flood prevention is disseminated in your community?	52	49.06	46	75.41	42	87.50	32	88.89	172	68.53
Average (%) Score		17.22		18.85		25.52		23.61		20.12

* F represents figures on frequencies for only 'yes' answers

Resilience to Floods: KNOWLEDGE……. continued

Source of Preparedness	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	

Information	F	%	F	%	F	%	F	%	F	%
LGAs	1	0.94	0	0.00	15	31.25	3	8.33	19	7.57
Television	1	0.94	0	0.00	6	12.50	0	0.00	7	2.79
Radio	64	60.38	34	55.74	26	54.17	21	58.33	154	57.77
Family members	4	3.77	1	1.64	0	0.00	0	0.00	5	1.99
Neighbours	2	1.89	2	3.28	0	0.00	0	0.00	4	1.59
NGO workers	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Health workers	0	0.00	0	0.00	0	0.00	3	8.33	3	1.20
Health Centres	1	0.94	0	0.00	0	0.00	0	0.00	1	0.40
Schools/teachers	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Workers	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Billboards	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Radio and Television	9	8.94	1	1.64	0	0.00	1	2.78	11	4.38
Radio and Health Workers	15	14.15	6	9.84	0	0.00	0	0.00	21	8.37
Radio and School Teachers	9	8.49	4	6.56	0	0.00	0	0.00	13	5.18

Resilience to Floods: KNOWLEDGE……. continued

Item: RESPONSE	Ringim		Guri		Hadejia		Kafin-Hausa		Overall	
Questions	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**
1. Do any local emergency response group exist in your community?	16	15.09	0	0.00	12	25.00	3	8.33	31	12.36
2. Do you know here evacuation centres are located?	88	83.02	14	22.95	45	93.75	8	22.22	155	61.75
Average (%) Score		49.06		11.48		59.38		15.28		37.06

* F represents figures on frequencies for only ‘yes’ answers

Resilience to Floods: KNOWLEDGE……. Continued

Item: RECOVERY	Ringim		Guri		Hadejia		Kafin-Hausa		Overall	
Questions	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**
1. Do you know the rules governing your conduct in evacuation centres?	43	40.57	3	4.92	19	39.58	6	16.67	71	28.29

2. Do you know about different flood related programmes organized by LGAs?	21	19.81	4	6.56	10	20.83	4	11.11	39	15.54
Average (%) Score		30.19		5.74		30.21		13.89		21.92

* F represents figures on frequencies for only 'yes' answers

Resilience to Floods: KNOWLEDGE……. Continued

Item: COORDINATION	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
Questions	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**
1. Do you know that emergency response teams and other units work in a coordinated manner?	20	18.87	0	0.00	6	12.50	3	8.33	29	11.55
2. Do you know the rules governing coordination and conduct emergency response and evacuation?	18	16.98	1	1.64	1	2.08	2	5.56	22	8.76
Average (%) Score		17.93		0.82		7.29		6.95		10.16

* F represents figures on frequencies for only 'yes' answers

Resilience to Floods: SUMMARY OF KNOWLEDGE PERCENTAGE SCORE

Items	**Ringim**	**Guri**	**Hadejia**	**Kafin-Hausa**	**Overall**

	Mean	Mean	Mean	Mean	Mean
Hazard	77.04	79.23	62.50	76.85	77.82
Risk	79.72	88.93	85.42	84.72	83.77
Exposure	63.68	61.20	67.36	62.04	63.55
Preparedness	17.22	18.85	25.52	23.61	20.12
Response	49.06	11.48	59.38	15.28	37.06
Recovery	30.19	5.74	30.21	13.89	21.92
Coordination	17.93	0.82	7.29	6.95	10.16
Adaptation Strategies	30.19	40.98	16.67	86.11	38.25
Overall Average	45.63	38.40	44.29	46.18	44.08

Resilience to Floods: SUMMARY OF ATTITUDE PERCENTAGE SCORE

Items	Ringim	Guri	Hadejia	Kafin-Hausa	Overall
	%	%	%	%	%
Hazard	93.40	96.72	89.58	94.44	93.62
Risk	90.57	96.72	93.75	91.66	95.83
Exposure	81.13	75.41	79.16	80.55	79.28
Preparedness	69.81	77.05	56.25	50.00	66.14
Response	59.43	49.18	50.00	52.78	54.18
Recovery	43.39	29.51	52.09	38.89	41.04
Coordination	31.13	37.70	18.75	38.88	31.48
Adaptation Strategies	35.85	21.31	33.34	36.11	31.88
Overall Average	63.09	60.45	59.12	60.41	61.68

Note: The figures here represent the percentage of households who take these resilience indicators seriously and very seriously (that is, the sum of the two)

List the flood adaptation strategies available in your community?	Ringim		Guri		Hadejia		Kafin-Hausa		Overall	
	Number	%	Number	%	Number	%	Number	%	Number	%

Creating artificial drainage channels	11	10.38	10	16.39	1	2.08	2	5.56	24	9.56
Use of sand bags to form flood barriers	8	7.55	12	19.67	3	6.25	21	58.33	44	17.53
Construction of concrete drainage infrastructure	1	0.94	0	0.00	0	0.00	0	0.00	1	0.40
Creating artificial drainages and the use of sand bags as flood barriers	5	4.72	6	9.84	1	2.08	4	11.11	16	6.37
Clearing/ cleaning drainage channels	4	3.77	0	0.00	0	0.00	0	0.00	4	1.59

Resilience to Floods: PRACTICES

Item: HAZARD	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
Questions	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**
1. Will you still continue to live in your house knowing fully well that your community is a flood prone area?	11	10.38	0	0.00	7	14.58	0	0.00	18	7.17
Average (%) Score		10.38		0.00		14.58		0.00		7.17

* F represents figures on frequencies for only 'No' answers

If Yes, give reasons why you will continue to live in the flood prone	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**

area?										
Nowhere else to go/ no alternative provided	71	66.98	45	73.77	22	46.81	23	63.89	161	64.40
It is our inherited ancestral land	11	10.38	6	9.84	8	17.02	5	13.89	30	12.00
Just like that	1	0.94	3	4.92	0	0.00	0	0.00	4	1.60
Don't have the financial means to relocate	12	11.32	7	11.48	10	21.28	7	19.44	36	14.40

Resilience to Floods: PRACTICES…… continued

Item: RISK	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
Questions	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**
1. Do you give importance to the hazards associated with flooding?	103	97.17	58	95.08	46	95.83	34	94.44	241	96.02
2. Do you give importance to the risks associated with flooding?	1	0.94	1	1.64	1	2.08	0	0.00	3	1.20
Average (%) Score		49.06		48.36		48.96		47.22		48.61

* F represents figures on frequencies for only 'No' answers

Resilience to Floods: PRACTICES…… continued

Item: EXPOSURE	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
Questions	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**
1. Do you put on raincoat, rainboots and other protective wears during flooding?	80	75.47	54	88.52	33	68.75	29	80.56	196	78.09

2. If you receive flood warning announcements from authorities regarding your area, will you quickly evacuate from your area?	25	23.58	60	98.36	36	75.00	33	91.67	154	61.35
3. During a flooding event, would you stay near the flowing flood water and watch it flow?	94	88.68	56	91.80	34	70.83	28	77.78	212	84.46
4. Do you try to pick up debris and materials flowing or stocked in the water during flooding?	68	64.15	30	49.18	34	70.83	23	63.89	155	61.75
Average (%) Score		62.97		81.97		71.35		78.48		71.41

* F represents figures on frequencies for only 'No' answers

Resilience to Floods: PRACTICES…… continued

Item: PREPAREDNESS	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
Questions	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**
1. Before heavy rains, do you keep matches, lamps and other related items safe and ready?	18	16.98	3	4.92	3	6.25	8	22.22	32	12.75
2. In anticipation of the likelihood of heavy rains ahead, do you unplug electrical appliances beforehand?	25	23.58	18	29.51	39.937	14.58	10	27.78	60	23.90
3. Do you normally secure your doors and windows, food items, clothing, drums, harmful wind-movable materials and other relevant materials before heavy rains?	2	1.89	3	4.92	1	2.08	3	8.33	9	3.59

4. Did you attend emergency response and Early Warning System training in your community?	86	81.13	55	90.16	40	83.33	34	94.44	215	85.66
5.. If you lack a means of transportation, do you make alternative arrangements with neighbours and local authorities just in case flooding could occur?	74	69.81	37	60.66	31	64.58	31	86.11	173	68.92
6. Before a flood or heavy rain, do you ensure your automobile vehicles are fuelled beforehand?	77	72.64	47	77.05	33	68.75	16	44.44	173	68.92
Average (%) Score		44.34		44.54		39.93		47.22		43.96

* F represents figures on frequencies for only 'No' answers

Resilience to Floods: PRACTICES…… continued

Item: RESPONSE	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
Questions	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**
1. During periods it rains for many hours, are you always alert for possible flooding?	5	4.72	8	13.11	4	8.33	0	0.00	17	6.77
2. In search for further information and warning during heavy rains, do you make effort to listen to radio and television related programmes?	25	23.58	14	22.95	7	14.58	2	5.56	48	19.12
3. In times of need during flooding, do you receive assistance from your neighbourhood/local associations?	80	75.47	35	57.38	23	47.92	28	77.78	166	66.14
4. Do you regularly check the water levels of the river around	73	68.87	32	52.46	27	56.25	13	36.11	145	57.77

you?										
Average (%) Score		43.16		36.48		31.77		29.86		37.45

* F represents figures on frequencies for only 'No' answers

State the kind of assistance received from neighbourhood associations?	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
Food and clothing materials	12	11.32	3	4.92	15	31.25	5	13.89	35	13.94
Financial assistance	0	0.00	1	1.64	0	0.00	0	0.00	1	0.40
Technical assistance	1	0.94	4	6.56	0	0.00	0	0.00	5	1.99
Awareness on flood information	8	7.55	0	0.00	0	0.00	0	0.00	8	3.19
Evacuation of people affected	7	6.60	5	8.20	4	8.33	0	0.00	16	6.37
Provision of machines for draining flood water	0	0.00	12	19.67	0	0.00	0	0.00	12	4.78

Resilience to Floods: PRACTICES…… continued

Item: RECOVERY	Ringim		Guri		Hadejia		Kafin-Hausa		Overall	
Questions	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**
1. Do you remain in evacuation centres until local authorities inform you that it is safe to leave?	40	37.74	10	16.39	17	35.42	14	38.89	81	32.27
2. Do you avoid contaminated food and check that the water you drink during and after flooding is safe for consumption?	21	19.81	10	16.39	2	4.17	2	5.56	35	13.94
3. Do you as much as possible avoid staying near river banks until all potential flooding periods has passed?	7	6.60	8	13.11	7	14.58	1	2.78	23	9.16
4. Do you attend and participate in lessons learned from and trainings on past flood events?	91	85.85	58	95.08	43	89.58	33	91.67	225	89.64

5. Do you immediately take members of you household who fell sick during flood for medical check-ups?	5	4.72	4	6.56	9	18.75	8	22.22	26	10.36
6. Do you promptly repair damaged properties/items after flooding?	16	15.09	23	37.70	0	0.00	26	72.22	65	25.90
7. After a flooding event, do you quickly clean up your house?	6	5.66	2	3.28	0	0.00	0	0.00	8	3.19
Average (%) Score		25.07		26.93		23.21		33.33		26.35

* F represents figures on frequencies for only 'No' answers

Resilience to Floods: PRACTICES…… continued

Item: COORDINATION	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
Questions	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**
1. Do you support and contribute to flood adaptation and resilience programmes put in place by the authorities?	9	8.49	2	3.28	3	6.25	0	0.00	14	5.58
Average (%) Score		8.49		3.28		6.25		0.00		5.58

* F represents figures on frequencies for only 'No' answers

Resilience to Floods: PRACTICES…… continued

Item: ADAPTATION STRATEGIES	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
Questions	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**
1. Are you aware of any flood adaptation project put in place by	90	84.91	55	90.16	34	70.83	32	88.89	211	84.06

authorities?										
2. Are you willing to pay for any flood adaptation project?	35	33.02	28	45.90	14	29.17	15	41.67	92	36.65
Average (%) Score		58.97		68.03		50.00		65.28		60.36

* F represents figures on frequencies for only 'No' answers

Resilience to Floods: SUMMARY OF PRACTICES PERCENTAGE SCORE

Items	Ringim	Guri	Hadejia	Kafin-Hausa	Overall
	Mean	Mean	Mean	Mean	Mean
Hazard	10.38	0.00	14.58	0.00	7.17
Risk	49.06	48.36	48.96	47.22	48.61
Exposure	62.97	81.97	71.35	78.48	71.41
Preparedness	44.34	44.54	39.93	47.22	43.96
Response	43.16	36.48	31.77	29.86	37.45
Recovery	25.07	26.93	23.21	33.33	26.35
Coordination	8.49	3.28	6.25	0.00	5.58
Adaptation Strategies	58.97	68.03	50.00	65.28	60.36
Overall Average	37.81	38.70	35.76	37.67	37.61

Governance indicators under Susceptibility indicators/Politico-administrative components

Item: RISKS	Ringim		Guri		Hadejia		Kafin-Hausa		Overall	
Questions	F	%	F	%	F	%	F	%	F	%
1. Do you know about the existence of flood early warning systems in your community?	12	11.32	0	0.00	4	8.33	1	2.78	17	6.77
2. Do you know about the existence of any local emergency response group in your community?	16	15.09	0	0.00	12	25.00	3	8.33	31	12.35
3. Do you know about the different programmes organized by local government authorities (LGAs) during and after the occurrence of calamities?	21	19.81	4	6.56	10	20.83	4	11.11	39	15.54
Average (%) Score		15.41		2.19		18.05		7.41		11.55

* F represents figures on frequencies for only 'yes' answers

Socio-Demographic, Physical and Environmental Profile of the Respondent Households (continued…….)

Your source of drinking water normally?	Ringim		Guri		Hadejia		Kafin-Hausa		Overall	
	Number	%	Number	%	Number	%	Number	%	Number	%
Well	12	11.32	11	18.03	2	4.17	0	0.00	25	9.96
River	5	4.72	3	4.92	1	2.08	0	0.00	9	3.59
Pipe borne water	15	14.15	0	0.00	27	56.25	0	0.00	42	16.73
Communal Borehole water	74	69.81	47	77.06	18	37.50	36	100.00	175	69.72
Spring	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Total	106	100.00	61	100.00	48	100.00	36	100.00	251	100.00

Is your source of drinking water clean?	Ringim		Guri		Hadejia		Kafin-Hausa		Overall	
	Number	%	Number	%	Number	%	Number	%	Number	%
Yes	82	77.36	43	70.49	36	75.00	31	86.11	192	76.49
No	24	22.64	18	29.51	12	25.00	3	8.33	57	22.71
Total	106	100.00	61	100.00	48	100.00	34	94.44	249	99.20

How do you treat or sterilize your drinking water?	Ringim		Guri		Hadejia		Kafin-Hausa		Overall	
	Number	%	Number	%	Number	%	Number	%	Number	%
Settling	17	16.04	11	18.03	4	8.33	1	2.78	33	13.15
Filtering	11	10.38	8	13.11	2	4.17	2		23	9.16
Boiling less than 10 minutes	7	6.60	2	3.28	1	2.08	0	5.56	10	3.98
Boiling for	1	0.94	0	0.00	0	0.00	0	0.00	1	0.40

10 minutes										
Chlorination	1	0.94	0	0.00	0	0.00	0	0.00	1	0.40
Do nothing	59	55.66	38	62.30	36	75.00	28	77.78	161	64.14
Total	96	90.57	59	96.72	43	89.58	31	86.11	229	91.24

How do you dispose faecal materials from domestic animals?	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
Burying	10	10.10	3	5.88	9	23.08	0	0.00	22	10.14
Composting	1	1.01	0	0.00	0	0.00	2	7.14	3	1.38
As Manure	87	87.88	44	86.27	19	48.72	25	89.29	175	80.65
Anywhere	1	1.01	4	7.84	11	28.21	1	3.57	17	7.83
Total	99	100.00	51	100.00	39	100.00	28	100.00	249	100.00

Have you noticed rats roaming around your vicinity?	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
Yes	96	90.57	57	93.44	42	87.50	35	97.22	230	91.63
No	10	9.43	4	6.56	6	12.50	1	2.78	21	8.37
Total	106	100.00	61	100.00	48	100.00	36	94.44	251	100.00

Have you noticed any domestic animal roaming around your vicinity?	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
Yes	87	82.08	51	83.61	39	81.25	33	91.67	230	83.67
No	19	17.92	10	16.39	9	18.75	3	8.33	21	16.33
Total	106	100.00	61	100.00	48	100.00	36	100.00	251	100.00

Which sanitation or hygiene programme have you had before?	Ringim		Guri		Hadejia		Kafin-Hausa		Overall	
	Number	%	Number	%	Number	%	Number	%	Number	%
Garbage segregation	4	3.77	0	0.00	0	0.00	0	0.00	4	1.59
Water safety	6	5.66	0	0.00	1	2.08	1	2.78	8	3.19
Disease outbreak	11	10.39	9	14.75	4	8.33	0	0.00	24	9.56
Environmental sanitation	56	52.83	27	44.26	35	72.92	35	97.22	153	60.96
Cleaning hands	7	6.60	1	1.64	0	0.00	0	0.00	8	3.19
Water Safety and Environmental Sanitation	1	0.94	2	3.28	0	0.00	0	0.00	3	1.20
Water Safety and disease outbreak	2	1.89	1	1.64	0	0.00	0	0.00	3	1.20
Environmental sanitation and disease outbreak	11	10.38	1	1.64	4	8.33	0	0.00	16	6.37
None	8	7.88	20	32.79	0	0.00	0	0.00	28	11.16
Total	106	100.00	61	100.00	44	91.67	36	100.00	247	98.41

Are health and hygiene meetings held at regular interval in your community?	Ringim		Guri		Hadejia		Kafin-Hausa		Overall	
	Number	%	Number	%	Number	%	Number	%	Number	%
Yes	34	32.08	0	0.00	26	54.17	3	8.33	63	25.10
No	72	67.92	61	100.00	20	41.67	29	80.56	182	72.51
Total	106	100.00	61	100.00	46	95.83	32	88.89	245	97.61

Do you know you are at high risk	Ringim	Guri	Hadejia	Kafin-Hausa	Overall

of flood if your house is located near a pond or river?	Number	%	Number	%	Number	%	Number	%	Number	%
Yes	90	84.91	54	88.52	41	85.42	31	86.11	216	86.06
No	12	11.32	7	11.48	4	8.33	2	5.56	25	9.96
Total	102	96.23	61	100.00	45	93.75	33	91.67	241	96.02

Are you willing to vacate your area if advised by the government to relocate?	Ringim		Guri		Hadejia		Kafin-Hausa		Overall	
	Number	%	Number	%	Number	%	Number	%	Number	%
Yes	91	85.85	51	83.61	35	72.92	27	75.00	204	81.27
No	15	14.15	10	16.39	12	25.00	5	13.89	42	16.73
Total	106	100.00	61	100.00	47	97.92	32	88.89	246	98.00

If yes, give reasons why you will relocate?	Ringim		Guri		Hadejia		Kafin-Hausa		Overall	
	Number	%	Number	%	Number	%	Number	%	Number	%
To avoid loss of lives and properties	78	73.58	43	70.49	14	29.17	17	47.22	152	60.56
To avoid	11	10.98	7	11.48	6	12.50	7	12.35	31	12.35

future problems with authorities										
Lack of options or alternatives	0	0.00	1	1.64	4	8.33	0	0.00	5	1.99
Just like that	1	0.94	0	0.00	0	0.00	0	0.00	1	0.40
If provided with better alternatives	1	0.94	0	0.00	11	22.92	3	8.33	15	5.98
Total	91	85.85	51	83.61	35	72.92	27	75.00	204	81.28

If No, give reasons why you will not relocate?	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
Lack of options or alternatives	12	11.32	5	8.20	5	10.64	2	5.56	24	9.60
Inheritance	1	0.94	2	3.28	1	2.13	1	2.78	5	2.00
Just like that	0	0.00	1	1.64	1	2.13	0	0.00	2	0.80
No finacial abiity to relocate	2	1.89	2	3.28	5	10.64	2	5.56	11	4.40
Total	15	14.15	10	16.39	12	25.53	5	13.89	42	16.80

Will you quickly evacuate your area when you receive flood warning announcements from authorities?	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
Yes	81	76.42	1	1.64	12	25.00	1	2.78	95	37.85
No	25	23.58	60	98.36	36	75.00	33	91.67	154	61.35

Total	106	100.00	61	100.00	48	100.00	34	94.44	149	99.20

Are you willing to pay for any flood adaptation project?	Ringim		Guri		Hadejia		Kafin-Hausa		Overall	
	Number	%	Number	%	Number	%	Number	%	Number	%
Yes	67	63.21	33	54.10	32	66.67	21	58.33	153	60.96
No	35	33.02	28	45.90	14	29.17	15	41.67	92	36.65
Total	102	96.23	61	100.00	46	95.84	36	100.00	245	97.61

Are you willing to insure your house and/or properties against floods?	Ringim		Guri		Hadejia		Kafin-Hausa		Overall	
	Number	%	Number	%	Number	%	Number	%	Number	%
Yes	59	55.66	26	42.62	16	33.33	12	33.33	113	45.02
No	47	44.34	35	57.38	32	66.67	23	63.89	137	54.58
Total	106	100.00	61	100.00	48	100.00	35	97.22	250	99.60

Are you aware of the existence of River and Natural Resource management programme in your community?	Ringim		Guri		Hadejia		Kafin-Hausa		Overall	
	Number	%	Number	%	Number	%	Number	%	Number	%
Yes	11	10.38	7	11.48	27	56.25	8	22.22	53	21.12
No	82	77.36	48	78.69	19	39.58	21	58.33	170	67.73
Total	93	87.74	55	90.16	46	95.83	29	80.55	223	88.85

Are you aware of the existence of Land Use Management	Ringim		Guri		Hadejia		Kafin-Hausa		Overall	
	Number	%	Number	%	Number	%	Number	%	Number	%

and Structural Design System in your community?										
Yes	17	16.04	9	14.75	26	54.17	7	19.44	59	23.51
No	75	70.76	45	73.77	18	37.50	25	69.44	163	64.94
Total	92	86.79	54	88.52	44	91.67	32	88.89	222	88.45

If Yes, is it properly implemented in your community?	Ringim		Guri		Hadejia		Kafin-Hausa		Overall	
	Number	%	Number	%	Number	%	Number	%	Number	%
Yes	3	2.83	1	1.64	19	39.58	0	0.00	23	9.16
No	14	13.21	8	13.11	7	14.58	6	16.67	35	13.94
Total	17	16.04	9	14.75	26	54.17	6	97.22	58	23.10

Are you aware of any assessment of damages to lives, properties and infrastructure in your communitya after flood events?	Ringim		Guri		Hadejia		Kafin-Hausa		Overall	
	Number	%	Number	%	Number	%	Number	%	Number	%
Yes	22	20.75	4	6.56	20	41.67	4	11.11	50	19.92
No	75	70.75	52	85.25	26	54.17	26	72.22	179	71.31
Total	97	91.50	56	91.81	46	95.84	30	83.33	229	91.23

Are you aware of the any welfare programe set up by	Ringim		Guri		Hadejia		Kafin-Hausa		Overall	
	Number	%	Number	%	Number	%	Number	%	Number	%

authorities for flood victims in your community?										
Yes	5	4.72	3	4.92	5	10.42	0	0.00	13	5.18
No	94	88.68	45	73.77	41	85.42	33	91.67	213	84.86
Total	99	93.40	48	78.69	46	95.84	33	91.67	226	90.04

Are you aware of the construction of any relocation site project in your community?	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
Yes	2	1.89	0	0.00	3	6.25	0	0.00	5	1.99
No	98	92.46	56	91.80	43	89.58	30	83.33	227	90.44
Total	100	94.35	56	91.80	46	95.83	30	83.33	232	92.43

Are you aware of any disease prevention programmes held in your community against floods?	**Ringim**		**Guri**		**Hadejia**		**Kafin-Hausa**		**Overall**	
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
Yes	4	3.77	1	1.64	10	20.83	2	5.56	17	6.77
No	93	87.74	53	86.89	36	75.00	31	86.11	213	84.86
Total	97	91.51	54	88.53	46	95.83	33	91.67	230	91.63