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Measuring Resilience to Natural Disaster in a Data-Sparse Developing Country Context: A Case Study of a Nigerian Community after The Great Flood of 2012.

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ABSTRACT

Disasters have become an issue of concern that they now shape policies on a global scale. This is because what people do, whether in the normal course of their lives or response to disasters, could amplify their vulnerability or the vulnerability of the communities in which they live. Globally, there has been an upsurge in vulnerability to hazards in recent times, and the accompanying disasters have led to increasing losses and a substantial shift in focus in hazard research from vulnerability to an emphasis on how communities can become more resilient to disasters. We may also ask, what qualities do people or communities possess that enable them to survive and even thrive in a stressful situation, shock, or disturbance? In 2012, a Nigerian community was devastated by a flood event such that, several years later, it is not known how much it has recovered from the devastation, if indeed it has, the mechanism of this recovery, and whether it has developed the resilience to resist a future re-occurrence. That is the thrust of this dissertation. A survey using variables adapted to the local context was conducted in the affected community to define social, economic, institutional, infrastructural, and community capital indicators. Although the variables to define these indicators had proven to be reliable in the two previous studies upon which this research is based, there was still a need to conduct a reliability analysis to ascertain how well the variables captured in the survey had measured the underlying indicators. IBM SPSS software was used in the reliability analysis, and it was found that while several variables were reliable and captured the indicators of interest, some other variables, like age which is a natural attribute of the respondents and considered reliable and suitable in the previous work were just inappropriate using the methodology adopted in this research. It was also found that using only the dichotomous coding scheme for the study was not enough to determine a full suite of reliable indicators and had to be complemented with the Likert coding convention

as some variables that did not perform very well using the dichotomous scale did much better when the Likert convention was employed and vice versa. Following this procedure, some indicators to measure or determine community resilience were chosen, which could form the nucleus of variables to be deployed to determine community resilience anywhere else in any other region of the world. Thus, I suggest that one good starting point to engage in this type of study, in choosing a reliable set of variables, is to utilize both the dichotomous and Likert scale coding conventions in the same study. It was also determined that relying solely on the reliability analysis in choosing the suite of variables for the indicators could lead to some good variables being dropped or disregarded. Rather, a combination of the knowledge of the variables advanced in the resilience literature; reliability analyses of the captured variables with Cronbach's alpha reaching or exceeding 0.50, at least at this exploratory stage; and an intuitive knowledge of what variables could contribute to resilience in the context of the community concerned must be considered. Having selected the best variables for the various indicators, scores were aggregated to obtain the composite resilience metrics for 2012 and 2018. It was found that the difference between the overall resilience metrics for the two years was not statistically significant at the $\alpha = 0.5$ level, even though there was marginally enhanced resilience in the social, economic, and community indices for 2018. Institutional and infrastructural indicators experienced decreased resilience values. Thus, while the community received less government presence, it corporately strove to offset (albeit with little success) that disadvantage in its corporate social, economic, and community capital networks. Results from this study hold great promise for application in communities that may be exposed to traumatic experiences induced by flood disasters, particularly in developing world environments. In this case, areas of the most need can easily be determined, and communities can be compared in terms of their developmental levels. Thus, such research may

become part of the fabric of grassroots developmental policies. Another important empirical finding in this study is that issues regarding community perception of resilience may not be completely resolved by employing a quantitative analysis of respondent perceptions. It fails to present concrete and reliable information regarding the "perception" of the future resilience state of the community. Therefore, a better approach that allows a more fluid contribution of opinion or judgment in this regard will throw more light on resilience perception. This has been suggested. Further recommendations for future work have been put forth.

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"If it had not been the Lord who was on our side, now may Israel say; If it had not been the Lord who was on our side, when men rose up against us …" (Psalm 124:1-2; KJV).

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CHAPTER ONE

INTRODUCTION AND AIM OF THE STUDY

1.1 Introduction

Disasters are distressing events that seriously disrupt the natural functioning of communities or societies, introducing large-scale human misery and environmental, material, and/or economic losses. Disasters have frequently been grouped into two main types depending on their origin: (i) technological events or disasters caused by the failure of human-made systems and (ii) "natural" events resulting from the impact of physical environments upon elements of human systems. These include earthquakes, wildfires, floods, hurricanes, etc. Although it is more convenient to refer to disasters as "natural", there is a current consensus that disasters are ultimately due to human interactions with and impact on the natural environment around them (Montz, Tobin, & Hagelman, 2017).

According to Mileti (1999), the origin of any disaster can be found in the inter-relationships between the social, economic, cultural, and political conditions affecting a specific place. Therefore, while, for instance, the "natural" environment might be responsible for the impact of a flood, it could also be argued that other factors such as clearing vegetation and locating a settlement in a floodplain may be accountable for the disaster and the accompanying impacts (March and Leone, 2013). Mileti (1999) highlights the role that culture (i.e., attitudes, behaviors, and values) plays in the creation of disasters, while Hewitt (1983) argues that disasters or calamities tend to reflect the existing social order, such as poverty, particularly in many developing countries where it is a significant factor. UNCTAD (2012) notes that even though the term is used extensively in both the literature and practice, the term "natural disasters" in its most accurate interpretation is incorrect, as disasters arise because of hazards and vulnerable societies interacting with each other.

From the arguments made in the various papers cited above, some responsibility for the disasters that happen to people and communities may sometimes be placed at the doorsteps of those victims. For instance, in the State of Florida, USA, some people prefer building or buying houses close to the ocean front with the ever-present danger of ocean surges and in the path of tropical storms/hurricanes. I witnessed a similar situation during the field work for this study, where people built their homes very close to the River Benue in Nigeria, even with the ever-present danger of water overflowing the river channel and causing flooding and damage. Yet others, for

instance, in California, expose themselves to other dangerous situations when they prefer to build in rural suburbs away from the cluster of cities, thereby placing their homes and property in danger of the usual wildfires occasioned by drought-induced dryness in the environment.

1.2 Background of the Study

Between July and September 2012, there was a major flood in Nigeria that was described in superlative terms by both local and international media and agencies. The United Nations Office for the Coordination of Humanitarian Affairs (UN OCHA, 2012a) and the Nigerian Red Cross described it as the worst disaster in 40 years. According to Dung-Gwom (2013), the West Africa Insight online magazine described it as the "great Nigerian flood"; Business Day newspaper as "Nigerian *annus horribilis*" (i.e., Nigerian year of disaster or misfortune); while the Nigerian President tagged it "a national disaster". The spatial extent and magnitude were overwhelming for the communities and cities affected across the country, as floods of that scale had never been witnessed before. More than 7.7 million people were affected, and 2 million others were displaced (UN OCHA, 2012b). This created a huge humanitarian crisis, leading to the internal displacement of about 1,440,968 people and the death of 363 persons (UN OCHA, 2012c). Thirty-three (33) of Nigeria's 36 States were affected, and 14 States more severely than the others. The total value of damages and losses across all sectors of the Nigerian economy was estimated at $16.9 billion (FGN, 2013).

Several key drivers were responsible for the problem. First, heavy rainfalls were observed between July and October 2012. Second, water was released from reservoirs, notably the Kainji, Shiroro, and Jebba dams along the Niger River; and Lagdo dam in the Upper Benue Basin in Cameroon on August 20, 2012. Third, the unprecedented increase in the water volume at the confluence of the Niger and Benue Rivers accounted for the inundation of the southern States downstream in Nigeria.

The upsurge in vulnerability to hazards and increasing losses resulting from disasters in recent times worldwide has led to a substantial shift in hazard research from a focus on vulnerability to emphasizing how to make communities more resilient to disasters when they occur. Consequently, disaster resilience as a concept in disaster management and planning is relatively new or is still in its infancy. Despite its recent emergence into the disaster literature, however, research in this area appears to be growing by the day.

As a characteristic of both natural and human systems, which include cities and coastal zones, resilience becomes a desirable concept considering a range of potential stresses, which include meteorological hazards (UN/ISDR, 2002). The subject of recovery or resilience from a natural disaster has become central in the global discourse of natural disasters in the face of extreme events accompanying climate change and other forms of disaster arising from either technology (e.g., nuclear disaster) or what are generally termed "Acts of God" (e.g., earthquakes). No matter what measures are put in place, however, disasters always strike, and the capacity of a community to recover from such tragedies becomes all-important. The general thinking is that if a community can increase its resilience, it can recover from adverse situations more quickly than if little or no investments were made in building community resilience (Cutter et al., 2010). Hence, there is considerable interest in resilience as a mechanism to mitigate disaster impacts on local communities. The subject of resilience has assumed such importance that even in the U.S., the Office of Resilience has been established within the National Security Council in the White House, and the policy community has accepted it as one of the guiding principles to make the country safer (Cutter et al., 2010).

The subject of resilience has gradually shifted from a mere concept to an ideological survival blueprint or entrenched and canvassed survival strategy for firms, infrastructural facilities, systems, and societies that are prone to the misfortune of environmental, economic, and political uncertainties. Concerning natural disasters, the research community has followed up on the objective of measuring resilience or attaching numerical values to resilience by developing indicators that have been applied to certain regions in the United States. They include indicators of Social, Economic, Institutional, Infrastructural, and Community resilience. Using 75 variables to define these indicators, for example, Mayunga (2009) studied the resilience of 144 coastal counties and Parishes in the U.S. States, stretching from Texas to Florida. Cutter et al. (2010) defined the indicators with 35 variables and compared the resilience of the counties in eight states of the Southeastern United States to natural disasters. Results from both studies were encouraging. To develop a metric to measure resilience, the researchers used different variables to develop indices and then obtained a single composite indicator for the counties by combining all the indicators into one metric. This way, different counties were compared.

1.2.1 Theoretical and conceptual framework of resilience

In the 1970s, research into differences in individuals' responses to environmental stress, including disasters, stimulated further interest in resilience thinking in developmental and social psychology (Wesley, 2014). A lasting mark of the psychological approach, as contributed by Norman Garmezy, a well-known psychopathologist, is that an individual's level of functional resilience does not have to be extraordinary or optimal to navigate a crisis successfully. He suggested that it must only be relatively better than others experiencing the same level of environmental shock. Social psychology, as a sub-discipline, focuses on the family and the neighborhood (Downes et al., 2013) and defines resilience relatively broadly as a dynamic process that includes important adaptations within the context of monumental adversity (Luther et al., 2000). The dimensions of community resilience recognized in social psychology include, "strategic self-organization" (Sherrieb et al., 2010), "strong people-place connection" or "place identity" (Putnam, 2000), "mechanisms for information sharing", "strategic social networking" (Obrist et al., 2010), "connection to government entities" (Ungar, 2011), "economic diversification" (Attaran, 1986), etc. By the middle of the 1990s, a natural disaster-specific element of resilience thinking had begun to emerge within social psychology that was mainly focused on examining how urban communities, especially at the neighborhood level, engaged in or were engaging in resilience-building activities (Wesley, 2014).

Humans are inclined to react to adverse situations in diverse ways. While some are unaffected by some form of misfortune, others are devastated. The same situation applies to human communities affected by some collective misfortune or trauma. We may then ask, what qualities do people or communities possess that enable them to survive and even thrive when faced with stressful situations, shock, or disturbance? In the case of a community, however, the collective response or output is not the additive effect of individual reactions in the event of a disaster but results from the unique capacity that the community embodies before experiencing the hazard (Sherrieb et al., 2010). It is, therefore, important to know the characteristics or qualities that communities possess that make them adapt to difficult events.

Resilience has been defined variously depending on the level of analysis employed, for instance, individual, community, or ecological system, and so on. Most definitions, however, integrate a stressor and the concept of adaptation and a return to pre-stressor levels of performance (Norris et al., 2008).

The concept of resilience has been used in social science to describe the behavioral response of economies, institutions, and communities (Klein et al., 2003).

Cutter et al. (2008b, p.599) defined resilience as:

> "*the ability of a social system to respond and recover from disasters, and includes those inherent conditions that allow the system to absorb impacts and cope with an event, as well as post-event adaptive processes that facilitate the ability of the social system to re-organize, change, and learn in response to a threat*."

One of the major obstacles regarding the concept of resilience has been that there was no common definition of the idea (Cutter et al., 2008a) since most existing viewpoints were born out of varied epistemological perspectives. But this "common understanding" is critical to developing a measurement technique and strategies to implement a community's resilience to hazards. Resilience, as an attribute of a social group or community, had for a long time been thought of as an intangible, immaterial, vague, and perhaps elusive idea. So, it was hard to think of it as a concrete, tangible, and quantifiable metric. But Cutter et al. (2008a) argue that although resilience is dynamic, to operationalize or measure it, it must be viewed in a static mode. In other words, resilience can be viewed or measured at certain intervals t = n (where, for instance, n = number of years) from the point or time of a stressor. So, identifying standards and metrics to assess resilience has been a major challenge to the research community.

Resilience as an idea can be applied to social, economic, natural, and engineered systems and at various units of analysis – the individual level, the household level, and the community level or region (Cutter et al., 2008b). This dissertation, however, examines resilience at the community level and assesses comparatively the resilience of the community before, or at the point of the flood disaster, and at the time or point of the field data (about 5 years after the environmental stressor) by using quantifiable indicators, and the variables to define these indicators.

The extant literature on composite indicators is a vast reservoir of the methodology for constructing and validating indices (Cutter et al., 2010) and usually involves several specific stages (Freudenberg, 2003; Nardo et al., 2008). Some methods for determining composite indicators exist at both global and local scales, some of which are key to social and environmental change (Cutter et al., 2010). For example, some indicators are designed to measure national well-being (Neumayer, 2001). Metrics have been constructed from indicators to assess the quality of life and

sustainability globally such as, the "Human Development Index" (UNDP, 1990), "Environmental Sustainability Index" (Esty et al., 2005), "Vulnerability of Natural Environments Index" (Kaly et al., 2004), "Ecological Health and Environmental Sustainability Index" (National Research Council, 2001). In studies bordering on sea level rise, composite indicators have also been used to determine the "physical and social vulnerability of the coastal environment" (Pethick and Crooks, 2000). Within the indicator literature, there are several common criteria to assure the quality of the variables, yet no specific set of indicators or framework has been established for measuring resilience. However, according to Cutter et al. (2010), there is agreement among researchers that the concept of resilience is multi-layered or multidimensional and includes social, economic, institutional, infrastructural, ecological, and community elements.

In the pioneering work in measuring resilience, Mayunga (2009) combined five of the six elements above into four and termed them as "Capitals". These were termed Social Capital, Economic Capital, Physical Capital, and Human Capital, having compressed the Institutional and Infrastructural elements into one – Physical Capital. Using a set of 75 variables to define these indicators, he studied the resilience of 144 coastal counties and Parishes in the U.S., stretching from Texas to Florida. Developing the resilience index for these counties involved determining how the various forms of capital accessible to people are used to address the issues relevant to the distinct phases of natural disasters – hazard mitigation, disaster preparedness, disaster response, and disaster recovery. His result showed that Florida counties are the most resilient, while Texas counties are the least. In related work, Cutter et al. (2010) employed five indicators (excluding the ecological element) as resilience indicators – Social resilience, Economic resilience, Institutional resilience, Infrastructural resilience, and Community resilience. She used 35 variables to define the indicators and compared the resilience of the counties in eight states of the Southeastern U.S. to natural disasters. Results from their work showed that spatial variation in disaster resilience exists in the counties, particularly between metropolitan and rural areas. Nevertheless, while these studies are significant since they were both conducted in the United States, one might question their validity if applied in different socio-economic environments, particularly in a less wealthy country, as explored in this dissertation.

Resilience has been studied using both qualitative and quantitative methods. For instance, Torres (2017) used qualitative means in the study of how "*Lessons from a Past Disaster Can Influence Resilience and Climate Adaptation in Broward County, Florida, United States*", and

found that risk perception based on earlier experience (particularly of long-term residents) with storms may influence the ability and willingness of individuals to prepare for a disastrous weather event, and consequently adapt to it. Ultimately, such adaptive measures may lead to increased resilience. A few other studies (Mayunga, 2009; Cutter et al., 2010; Sherrieb et al., 2010; Bowne, 2011; and Wesley, 2014) have looked at resilience through the quantitative prism. However, literature in resilience studies utilizing qualitative methods far outstrips those in which a quantitative approach has been used. The quantitative methods used in the study of resilience are only a recent trend. In the search for suitable reference materials for the quantitative measurement of resilience in this study, I perused and scanned (in some cases), well over 350 peer-reviewed publications: about 15 books and book chapters, 12 doctoral dissertations, and 9 Masters' theses from different databases around the world relating in one way or another to the subject of quantifying resilience. The subjects of many of these published research papers were natural hazards and disasters, flood control and flood risk management, risk perception, ecological resilience, and socio-ecological resilience etc. There were several other papers with remote relevance to the subject of interest that were equally perused. For instance, those papers on recovery or resilience from the trauma of wartime and earthquakes. However, only 5 of these materials had direct relevance to the measurement of resilience to natural disasters which is the subject being explored in this dissertation – one doctoral dissertation (Mayunga, 2009); two peer-reviewed papers (Cutter et al., 2010; and Sherrieb et al., 2010); and two Masters' theses (Bowne, 2011; and Wesley, 2014). Since the resilience studies of Sherrieb et al., (2010) and Bowne (2011) did not relate to disasters, they were not considered for exhaustive review. A detailed discourse of resilience and related concepts will be considered in the Literature Review (Chapter Two), while the approach of the authors highlighted above will be discussed further in the Data and Methodology section (Chapter Three).

1.3 Statement of the Problem

Without a doubt, Makurdi community, the administrative capital of Benue state (Nigeria), located within the Lower Benue Basin, was one of the worst-hit communities along the Benue/Lower Niger River axis by The Great Flood of 2012. Like many other communities affected by the disaster, people had moved on with their lives after the disaster. To the outsider, however, the degree of trauma experienced by those affected at the time of the disaster may never be apparent, and the extent to which the community recovered afterward may also never be known if indeed there has been any recovery at all. However, it is important to gauge how much a community that has suffered such a high degree of environmental stress has recovered from the trauma. This way, it can be ascertained whether the measures put in place during and after the disaster worked or did not work, and if indeed they worked, then to what extent they had worked; but no such research has been carried out.

Although the findings of Mayunga (2009) and Cutter et al. (2010) stated earlier are inspiring, situations of missing data for some counties may arise that may introduce error into the results obtained and, consequently, any conclusions reached. As noted in Mayunga (2009) in the citation of Zahran et al. (2006), other limitations include the fact that while some counties are disadvantaged in terms of political power, others have powerful central units. Also, counties vary greatly in geographical and population size, with some being hundreds of times larger than others (e.g., Harris and Kennedy counties (TX), with populations of over 3 million, and just 4 hundred people, respectively). Further, since the county is not considered a social unit, measuring disaster resilience at that level presents problems since social interactions and networks take place at the community level and not the county level (Mayunga, 2009). Thus, the county unit of analysis is too large to reflect the true situation at the grassroots level. Besides, such units of data may not be available in many developing countries in a detailed form.

1.3.1 Specific Objectives

The purpose of this study, therefore, is to fill this gap in our knowledge by deploying indicators that have successfully been tested elsewhere in the developed world to study resilience in a data-limited, developing world environment using a range of variables to be obtained locally from a mainly structured survey in the community under study (Makurdi, Nigeria). The goal is to determine whether the index works for the community, with the overall aim to operationalize the concept of resilience and thereby facilitate the ease of decision making, planning, policy

formulation, and management at the community level in Nigeria, and perhaps Africa and the developing world at large, using primary data.

1.4 Research Questions

Concerning natural disasters, people often estimate or measure their ability to cope with an advancing or future event by comparing it to a previous "similar" situation and assume they have grown or become more resilient. For instance, several people refused to heed the warning to move from the path of the coastal landfall of Hurricane Michael in Florida in October 2018 because they believed they had seen hurricanes too many times to be bothered by this one. Thus, such people believe they are better off in their present state of resilience, having witnessed a similar situation before, and are therefore in a higher state of resilience and ability to cope, which turned out not to be so.

Resilience research is ongoing, and to date, it has not fully addressed the circumstances of changing socio-economic and cultural conditions. It will be seen, therefore, in Chapter Four that individuals' perceptions (or "thinking" as in the case cited above) cannot be relied upon to assess resilience, as all factors that promote resilience have not been considered in previous research about perception. It becomes necessary, therefore, to ask the following research questions in light of the foregoing discussion:

(i) "What is the measured change in the resilience of the subject community over the five years since the flood disaster? Has the community become more or less resilient?"

The expected (predicted) answer or Hypothesis (H1) to this research question, to be determined using the survey from the community, is that the community is expected to be in a worse-off resilience condition. Thus:

H1: The community has a decreased resilience index

(ii) What support system contributed the most to the recovery of the community under study?

The answer to this question (H2) is drawn from my knowledge of the Nigerian situation, where help never comes when people are in need, and people tend to draw support from their social networks. Thus:

H2: The community relied most on their social networks to pull through the situation

(iii) What contribution did the experience that was gained from the previous flood events make to the community's perception of enhanced or diminished resilience? In other words, to what extent did people rely on their experience from previous disaster events in thinking they would prevail or succumb to the next disaster? This question is intended to test the validity of "perception" in resilience thinking.

People who have experienced repeated floods or weather-related disasters often think of resilience to such events in the context of their past experiences and say to themselves, "We have seen this situation many times before, and we will pull through this one as well as we have done in times past". In the situation of this community and the event under study, more people are likely to think that they can cope with the level of flooding and disaster witnessed in 2012 (i.e., a higher level of flooding events) than those who think they cannot, just because of their experience from past flooding events. The expected (predicted) answer/outcome or the hypothesis (H3) to this question is, therefore, that the community perception contributes nothing to the resilience status of the community.

H3: The community has a mistaken belief in resilience from previous experience

(iv) What specific indicators and variables in the study can be used to determine a community's level of resilience?

H4: The variables suggested in the literature, which were found to be reliable in the test analyses and used in aggregating the sub-indices, were social, economic, infrastructural, institutional, and community capital.

1.4.1 Research Objectives

The core aim of this research is to employ quantitative means (or indices) to determine the resilience status of a community affected by the 2012 flood, about 5 years after the event. In other words, whether the community has become more resilient, diminished in resilience, or has remained the same in terms of resilience. This can then serve to operationalize the concept of disaster resilience at the community level that may also be applicable elsewhere in Nigeria or elsewhere outside Nigeria with similar developmental status or history. To achieve this overall aim and answer the accompanying research questions, the objectives enumerated below will be followed:

Objective 1 – To explore the existing theoretical frameworks, definitions, conceptual models, and applications of the concept of disaster resilience.

Objective 2 – To explore and attempt to develop the conceptual framework that will make existing disaster resilience indicators applicable to larger political units in the U.S. (Counties and States) applicable in a community of a developing country like Nigeria.

Objective 3 – To define, in the context of the local communities, indicators and variables adapted from existing literature that can capture, in a structured survey, underlying manifestations of community resilience and assess the reliability and validity of these variables in achieving the overall aim.

Objective 4 – To develop a Community Flood Disaster Resilience Index (CFDRI) for a community victimized by a flood disaster at two separate periods, and from the indices, determine whether the community has become more resilient or more vulnerable between those two time periods.

Objective 5 – To gain a deeper understanding of the community's collective perception of recovery or resilience through logistic regression of respondents' oral responses to the relevant question.

1.4.2 The Flow Chart for the Research (Research Model)

Actualizing this research and, hence, providing answers to the research questions posed above involves integrating these stated objectives (objectives 1 to 5). It is hereby explicated in a flow chart format (Figure 1.1). The desired aim in the study is to obtain a metric, the community flood disaster resilience index for the community under study (or for any other community for that matter) for a specific year. Now, comparing this value with that for another year for the same community, or comparing two different communities with similar cultural contexts to determine their developmental situations, will help to operationalize the resilience concept.

In Figure 1.1, the starting point to achieve the "Desired Aim" is exploring the existing theoretical and conceptual frameworks, definitions, models, etc., of the resilience concept. This exploration produced the Cutter et al. (2010) model used in this research and the existing resilience indicators in the literature, namely, the social, economic, infrastructural, institutional, and community capital indicators. To define these indicators, Cutter et al. (2010) developed sub-indicators, which themselves were defined using variables (secondary data) for the United States environment. However, for these sub-indicators and variables to have relevance in the Nigerian community being studied (or any other community), a conceptual framework has to be developed that allows certain reliable variables to define the sub-indicators, taking into account the cultural and environmental context of the community under study. Thereafter, the selected and reliable

variable values are aggregated to produce the Community Flood Disaster Resilience Index (CFDRI), which feeds back to our desired aim.

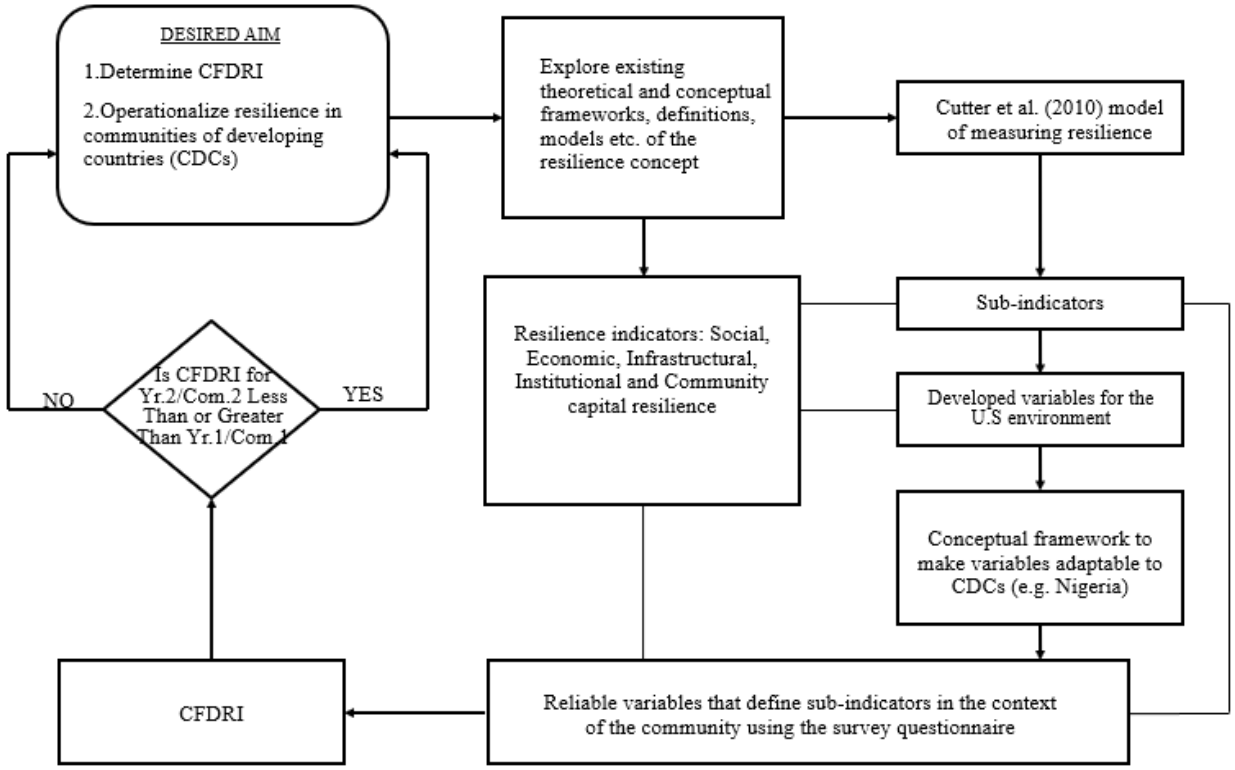

Figure 1.1: Research model to compute CFDRI and operationalize resilience at the community level of developing countries (CDCs) like Nigeria (Source: Author).

1.5 Significance of the Study

Very few studies have been conducted to measure disaster resilience (see Mayunga, 2009; Cutter et al., 2010), and even these have been carried out using coarse county and State data that may not necessarily apply to all communities within their boundaries in equal measures. In understanding the real dynamics of recovery from or resilience to natural disasters, it is therefore imperative to obtain grassroots data (most of which cannot be captured from extant databases) and transform them into metrics to obtain quantitative measures of disaster resilience. This is what this dissertation is set to achieve – specific or quantitative measures of resilience.

This dissertation holds the potential for monitoring the recovery (or lack of it) over time of communities that have been victimized by a flood disaster using primary data, with great promise of its application in developing countries where data acquisition and storage often present

challenges. Because indices will be developed for the various indicators that reflect the multi-dimensional nature of resilience, viz, social, economic, institutional, and infrastructural resilience, and community capital, it will therefore be useful for monitoring the most underdeveloped sub-index (or indices), in concrete terms, i.e. the sector where the community is lagging the most. Again, it will form the basis for comparing disaster resilience and, by implication, the developmental level of different communities within the same geo-political zone for decision-making, policy formulation, planning, and management by the government of the day and its agencies. Furthermore, this research will provide a useful measurement tool for emergency management officials for comparative assessments of disaster communities within neighboring zones and determine which ones may need more help.

1.6 Scope of the Study

Although several towns and cities along the major rivers of Nigeria (Rivers Niger and Benue) were inundated by The Great Flood, Makurdi, the administrative capital of Benue state, situated within the Lower Benue Basin (Figure 1.2) was selected as the study area.

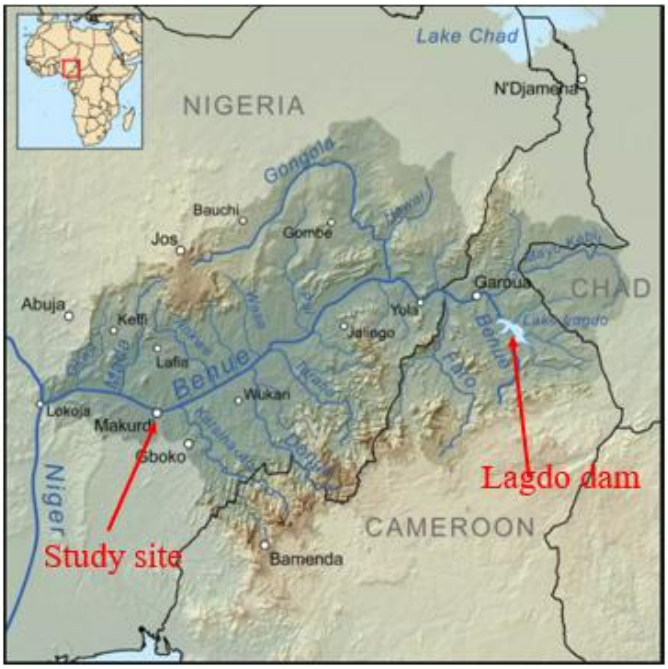

Figure 1.2: Map showing the location of Makurdi, the study area in Nigeria, and Lagdo dam in Cameroon (source: www.eoearth.org)

It is one of the few cities divided into the northern and southern sections by the river and bordered on both banks by a floodplain of variable width (Ojanuga and Ekwoanya, 1994), with developments on both sides of the river. The study site proper is a community located within Makurdi town. The River Benue contributes to flooding in Makurdi and reaches a mean flow of 3,150 m^3/s (100 km^3/yr) for a 305,000-km^2 watershed (Clement, 2013). For over 20 years, the reported annual flow has been maintained at 97 km^3/yr. The mean absolute low flow is 240 m^3/s, and the mean annual flood flow reaches 12,000 m^3/s (Clement, 2013; Andersen et al., 2005). Being a university town, several researchers have contributed to the extant literature by studying this and other flood situations in the town.

Makurdi developed from being a small river port in the 1920s, with a few thousand people, to a population of about 238,000 in 1991 and is subdivided into 11 administrative divisions known as "Council Wards" (Tyubee and Anyadike, 2015). It is situated within the Lower River Benue Basin (LRBB) in central Nigeria, at 7° 44′ 01″ N, and 8° 31′ 17″ E, and an elevation of about 92m (301ft) above sea level. In the town, traditional houses can be observed to blend indiscriminately with modern residential and commercial buildings. Certain sections of the town sit prominently on higher elevations, offering a vantage point from which the river and many areas within the floodplain can be seen. It also serves as a link town on the rail and road transportation highway connecting eastern and northern Nigeria. It has an area of about 810 Km^2 (Shabu and Tyonun, 2013), and a population of 300,377 at the 2006 census that was projected to be 348,990 by 2011 (see https://www.citypopulation.de/php/nigeria-admin.php?adm2id=NGA007013).

The town has a humid climate with climatological (1981-2010) average monthly rainfall ranging from 0.7mm in December to 225.5mm in August (from Nigerian Meteorological Agency, NIMET, records). Using the same climatological period, monthly average maximum temperatures range from 30.1° C in December to 37.5° C in March. Average minimum (nighttime/early morning) temperatures range from 17.5° C in December to 25.6° C in March/April (NIMET records). Because of the generally low relief of the town, considerable portions of it are usually waterlogged and flooded during the rainy season, particularly during heavy rains (Ocheri and Okele, 2012). The town is drained primarily by the River Benue, which, as noted above, divides it into two – Makurdi North and Makurdi South – with the two banks linked by two bridges connecting the highway and the railroad from the south to the north.

According to Ocheri and Okere (2012): *"the geology of Makurdi town is of cretaceous, and consists of fluvio-deltaic sediments with well-bedded sandstones which are of hydrogeological significance in terms of groundwater yield and exploitation."* (p.98).

However, Clement (2013) described the geology of Makurdi as principally composed of sedimentary rocks, of which sandstones are the main rock type. The low-lying areas, such as Wadata community, are overlain by shale (Clement, 2013; Kogbe, 1989). The sandstone is separated into micaceous and feldspathic sandstones, some of which are exposed in some places in the town. There are two basic soil types in Makurdi (Clement, 2013; Nyagba, 1995). They include: i) hydromorphic soil, which is developed on alluvium sediments found along the River Benue, and ii) red ferrallisols, which is developed on sedimentary rocks some distance away from the immediate vicinity of the river channel. Human activities have also impacted the nature of the soil in the town through farming, reclamation, and construction activities.

At its formative period in 1912, the town was populated mainly by the Tiv and Jukun tribes (Shabu and Tyonun, 2013). Today, the Idomas and other tribes, including the Etilos, Egedes, Hausas, Yorubas, and Igbos, have also added to the city's demographic mix. However, in terms of number, the Tivs are the dominant tribe in the town.

Figures 1.3 and 1.4 show the sketch and Google maps of the communities that were worst affected by the flood. Figure 1.5 shows the flood susceptibility map of the surrounding area. Typically, street maps are not readily available in most places in Nigeria. Still, a close look at the Google map (Figure 1.4) shows well-arranged streets in a gridiron pattern, which made for relatively easy delineation of the site for sampling purposes. Streets with such patterns in Nigeria are usually well-numbered, with odd and even numbers on opposite sides of the road. However, parts of the city closer to the waterfront were not properly numbered or were not numbered at all.

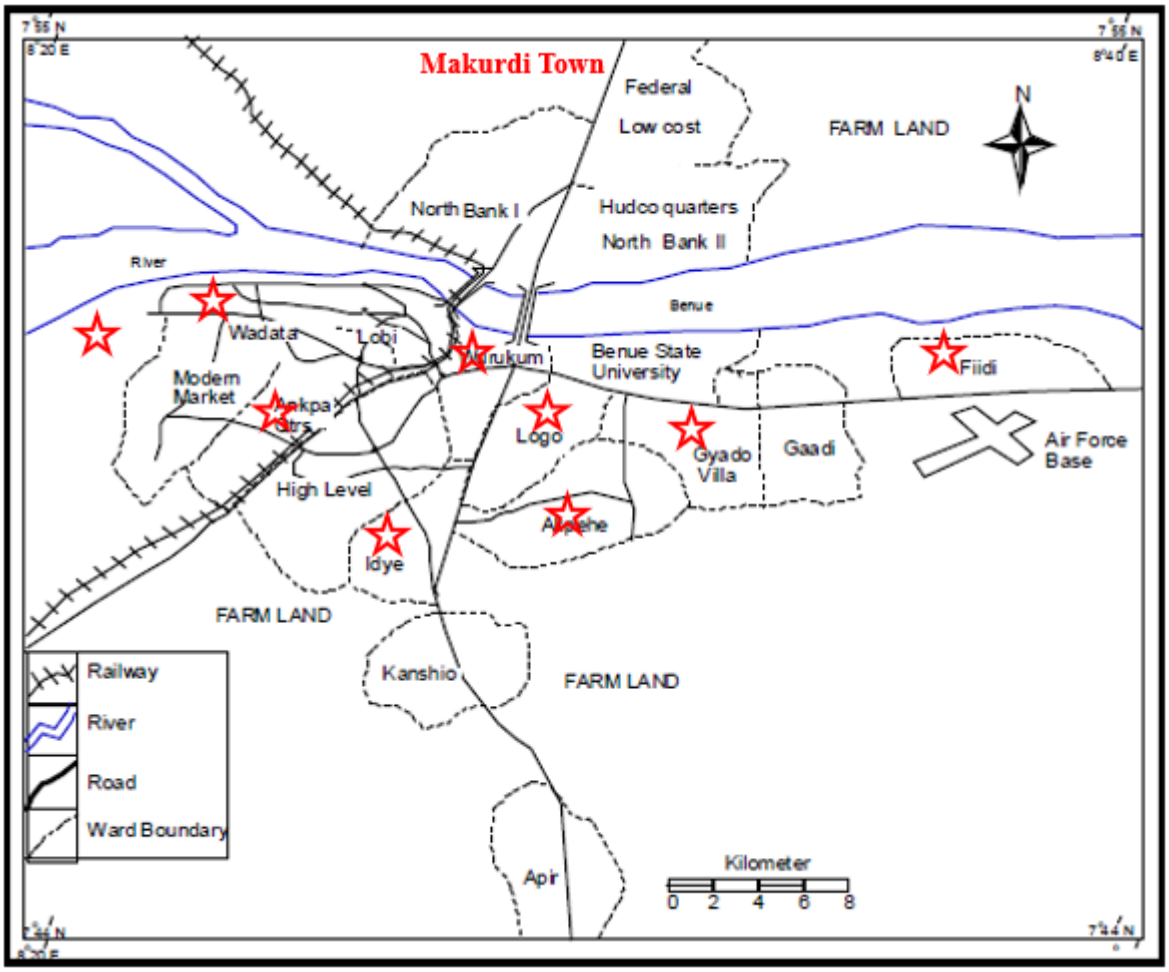

Figure 1.3: Sketch map of Makurdi Town showing some of the worst affected Wards in red stars (Adapted from Shabu and Tyonum, 2013).

Figure 1.4: Google map of the study site showing the affected communities enclosed within the circles

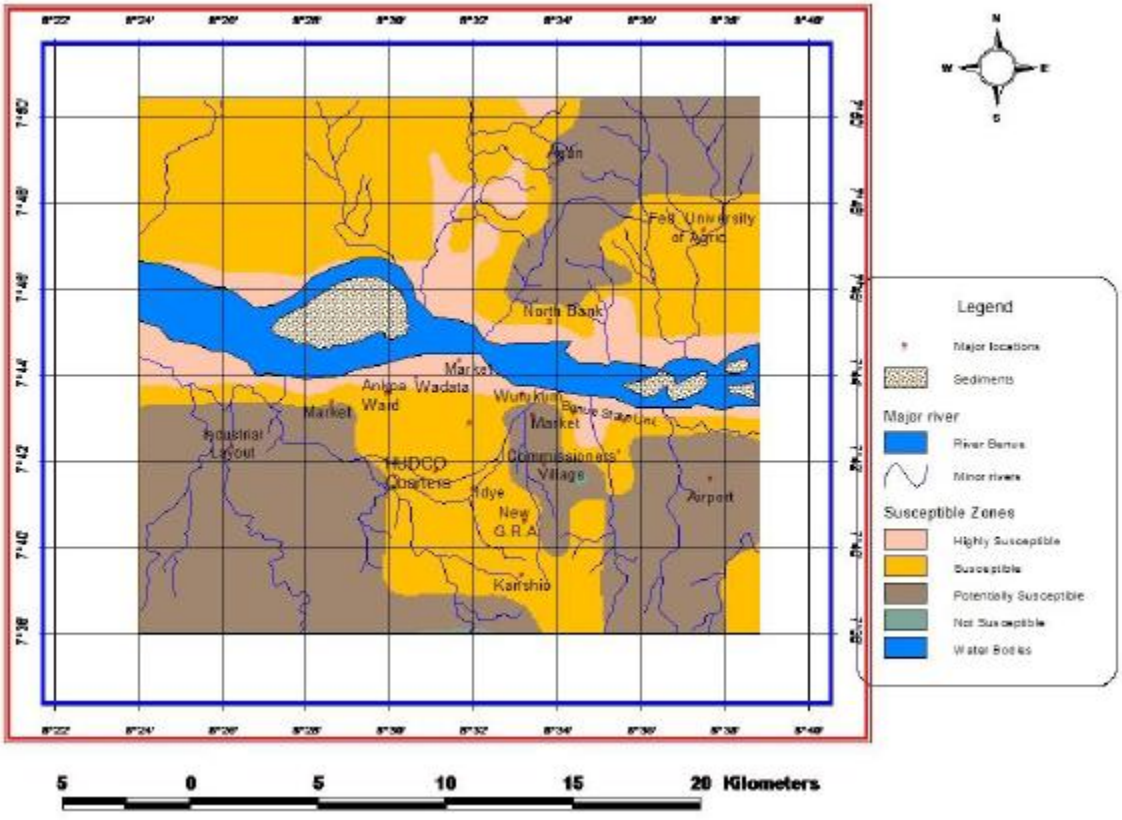

Figure 1.5: Flood susceptibility map for Makurdi (Source: Clement, 2013)

A couple of researchers have documented the effect of "The Great Nigerian Flood" of 2012 on this study area. However, of relevance to this study is the work of Unaegbu et al. (2014), in which the 2012 flood in the community was used as a case study to assess the perception and attitude of the community toward flooding in the Lower Benue River Basin. Although more than 10 wards (a ward is about the size of a census tract in the United States) were affected by the flood namely, Gyado villa, Atsusa, Wadata, Logo1 and Logo 2, Idye, Wurukum, Nyiman, Ankpa Quarters extension, and Akpehe (Shabu and Tyonum 2013), only 2 of the affected wards (Wadata and Nyiman) were used for the survey in Unaegbu et al. (2014) to evaluate which of 6 sectors of economic activities, health, transportation, agriculture, housing, and water that were most affected. Results showed that economic activities, housing, and agriculture were the worst affected by this flood incident. Therefore, Unaegbu et al. recommend a preferential provision of adaptive solutions to the most affected sectors. In other words, paying more attention to agriculture, housing, and the economy of the community will help offer adaptive capacity against flooding.

However, I argue in this research that perception alone is grossly insufficient and unreliable, especially in determining the coping capacity of a community against a disaster. Perception is a fickle emotion and changes depending on the mood of individuals. So, it cannot be used accurately to evaluate the needs of different communities and produce comparable results. A more robust measure currently used in hazards and disaster literature is 'resilience', of which adaptation is only a component. My research aims to obtain a quantitative measure of the resilience of this community in both 2018 and 2012 and use their difference to determine the resilience status of the community at the point of the study. This is to be achieved by analyzing a suite of indicators that are used as proxies for resilience (see Schneiderbauer & Ehrlich, 2006; Cutter et al., 2008b), and have been used successfully elsewhere in the U.S. (Cutter et al., 2008b; Mayunga, 2009; Cutter et al., 2010). The indicators and variables used to define them, as measured through structured interviews, quantitative assessments, or metrics, will be obtained and used to compare the two different years (2012 and 2018) for the study area.

1.6.1 The Study Site in an Urban (or Modernist) Development Context

There is clear evidence of modernist planning in the colonial parts of the city with the government reservation area (GRA) and its unique "garden city" concept located on the higher elevation part of the town west of the lower left to the mid-sections of Figure 1.5. These areas still

house many government offices and residential areas for some of the more privileged people. Indication of some deliberate form of planning during the colonial era is evidenced by a comment by a British colonial administrator working for the colonialists in the 1930s, thus: *"It is difficult to credit the lack of forethought, of imagination, and of attention to the elementary amenities of life, in the planning of many of the stations. Had the usual form been followed, Makurdi would have been dumped at the foot of the hill on the water's edge and adjacent to the native town, and the government houses would have been built in rows close to one another as in a London suburb."* (Home, 1983; p.174). This officer was alluding to a better job in the execution of physical planning in Makurdi than the policy had provided for.

The development of much of Makurdi into a suburban center from the late 1960s became much more pronounced from 1976 but was never based on a wide-ranging land use plan as practiced in more advanced societies (Ojanugo & Ekwoanya,1994). This was due to the creation of Benue State out of the old Benue-Plateau State and making Makurdi the state capital in 1976. Thus, an all-inclusive land use planning as a basis for the development of the town was never undertaken, hence, no provision was ever made based on the characteristics of the soi1 or other features on the landscape for places to be developed as either the urban center, open or recreational spaces, agricultural land, or as locations to be conserved for special purposes in, or at the fringes of the town. Because of this failure to properly delineate the floodplain and protect it from use by any Edict or Ordinance, there has been aggressive encroachment on such lands by developers of private property over the years. Only a policy based on all-inclusive land use planning for the development of the urban center at all levels of government could have protected such floodplains/lands for agricultural purposes from unauthorized development. Thus, failure to properly zone the town to satisfy the socio-economic demands of the population has ultimately produced the resultant occasional catastrophic flooding episodes during this era.

1.7 Organization of the Study

This dissertation has adopted a six-chapter format for its presentation. Chapter One is dedicated to presenting a synopsis of the entire study. The discussion of the subject of resilience to natural disasters cannot begin without the pre-condition of disasters that necessitate them in the first place and then proceed to show how the entire study is interconnected. Chapter Two considers the review of relevant literature and delves deeper into the subject of disasters and the associated

terms, viz., hazards, risk, vulnerability, resilience, etc., and selected definitions. Greater focus, however, will be given to resilience, particularly from a historical perspective, to firm up the theoretical and conceptual foundations established in Chapter One and then connect them with the concept of measuring disaster resilience (the focus of the research) from the global perspective to the community of interest in this dissertation. Chapter Three will deal with the Methodology of the study – the theoretical framework for selecting indicators, the choice of the indicators and the variables to define these indicators; the data-gathering process from the survey data and the allocation of quantitative values to interview responses; reliability analysis (Cronbach's Alpha) and the concept of reliability and validity. Chapter Four shall be dedicated to measuring disaster resilience using data from the study site – the use of indicators and indices, the step-by-step procedure to calculate the sub-indicator and indicator indices, and ultimately the composite index (metric), findings, and answering the research questions. Chapter Five will focus on discussing the results obtained from the study, while Chapter Six will conclude by tying up all the thoughts expressed throughout the previous chapters, limitations and difficulties of the study, policy implications of the findings, concluding remarks, and recommendations for future work.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

Natural hazards occur from the complex interaction between physical processes and human activities. That interaction sometimes produces negative consequences, which we call natural disasters for the human use system. The losses from such events are not just due to the extreme geophysical forces but are often caused, aggravated, or perpetuated by human activities. This, therefore, takes the search for solutions into the realm of human activities – "the where" and "the how" that they conduct their business in the environment, the living space. Thus, urban planning becomes relevant in the scheme of things. However, this chapter and the subsequent ones will not discuss urban theory in any measured detail.

The previous chapter has given a cursory account of the issue of natural disasters, the vulnerability that predisposes populations to them, and the resilience through which the re-establishment of pre-disaster conditions is sought. This chapter will explore the broader theoretical and conceptual framework within which the concept of resilience is embedded, particularly as it relates to this dissertation. This chapter will explore approaches that have been used within the hazard and disaster literature space to study or measure resilience and how the approach adopted in this study presents leverage over the earlier ones, particularly as it concerns communities in developing countries.

The definitions of "risk", "exposure", "severity", "vulnerability", and the more stabilizing concept of "resilience" are given briefly to understand their linkage and how they feed into the study. The Resilience indicators discussed in the literature and adopted in the two earlier attempts at measuring resilience and employed in this study are also discussed. The gap in the resilience measurement study that has necessitated this research is also highlighted.

2.2 Natural hazards and disasters

Before defining "natural hazards", it is appropriate to define the terms often associated with this concept, namely "exposure", "risk", and "severity" of natural hazards. The Intergovernmental Panel on Climate Change, IPCC (2014) defines exposure, risk, and hazard thus:

Exposure:

> **"***Exposure is the presence of people, livelihoods, species or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected*." (p.4)

Risk:

> ***"****Risk is the potential for consequences where something of value is at stake and where the outcome is uncertain, recognizing the diversity of values. Risk is often represented as probability of occurrence of hazardous events or trends multiplied by the impacts if these events or trends occur. Risk results from the interaction of vulnerability, exposure, and hazard." (p.5).*

Risk is the possibility of getting harm or the chance of an injury or loss resulting from the occurrence of a hazardous event (Cutter *et al.*, 2009). Risk from natural hazards arises because of the interaction or intersection of the hazard and vulnerability, which predisposes harm, personal injury, damage to property, possible loss of life, and interruption of economic activity. The elements at risk when this occurs include communities, populations, the built and natural environments, economic activities, and services that come under the threat of disaster in an area (Letsie, 2015). The relationship between risk, hazard, and vulnerability is given by Risk = Hazard x Vulnerability.

> ***"****Hazard* ***is t****he potential occurrence of a natural or human-induced physical event or trend or physical impact that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems, and environmental resources. In this report, the term hazard usually refers to climate-related physical events or trends or their physical impacts." (p.4)*

Paton et al. (2000) adapted their definition from Hood and Jones (1996) thus:

> *"The concept of risk describes the assessment of the frequency of occurrence and magnitude of consequences associated with hazard (stressor) activity".*

By the above definition, risk does not inevitably imply the occurrence of compulsive or negative outcomes. Paton et al. (2000) indicate from Hood and Jones' (1996) definition that risk management typically involves "looking forward" (anticipation) and "bouncing back" (resilience), thereby conferring upon risk management models the potential to capture perspectives that cover growth and distress.

Buckle et al. (2000, p.9) think of risk in this way:

> *"Risk is a concept used to describe the likelihood of harmful consequences arising from the interaction of hazards, communities, and environment. The chance of something happening that will have an impact upon objectives. It is measured in terms of consequences and likelihood. A measure of harm, taking into account the consequences of an event and its likelihood"*

While "risk" is the frequency of the occurrence of a natural hazard, "severity" is the relative magnitude of the threat arising from that natural hazard. According to Turner et al. (2003), hazards are a threat to a system and are comprised of shocks and stress, and sources of such stress. "Shocks or perturbations" are the main spikes in a system (for example, a tidal wave or hurricane) that are beyond the usual range of variability in the fluctuations of the system and are frequently initiated from outside the system or location in question. On the other hand, "Stress" is a continuously and/or slowly increasing pressure (for instance, soil degradation) that is usually within the range of normal variability. In short, risk may also be expressed as the possibility of death affecting an individual exposed over a given period or expected losses of lives, personal injuries, property damage, and economic activities disrupted due to a specific hazard for a given locality and period of reference.

To fully describe hazards and disasters, it is unavoidable to superficially describe the associated terms of vulnerability and, occasionally, resilience. In any definition of disaster, it is always vital to consider both the extreme physical event and the vulnerability of the population (Sussman, 1984). This is because, without people, disasters are unlikely, as it takes the presence of people for disasters to occur, and poor people are usually more vulnerable than rich people. Therefore, Sussman (1984) defined disaster as "the interface" or the overlapping consequence of an extreme physical event and a vulnerable human population.

The definition of a disaster given by UN/ISDR (2009) is:

> *"A serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources*" (UN/ISDR, 2009, p.8).

Several notable research studies have described disaster as an interruption of routine or nonroutine events that create physical damage and social disruption, thereby upsetting the physical and social system and requiring external intervention to support its return to stability (Moreton, 2016). This view tends to imply a cycle of stability, disruption, and adjustment or adaptation, and is echoed in many frameworks and policies that fundamentally consider disasters as linear systems consisting of a sequential set of mostly predictable stages. Disasters, however, are far more than just a disruption of routine. They are typically experientially traumatic, large-scale events that collectively impact a group, often sudden in onset time and severe in effect, and attributable to natural, technological, or human causes. Disasters produce significant damage and human suffering that is overwhelming and exceeds the capacity of the community to contain, at least at the initial stages of the event, needing time and external support to achieve new system stability (Quarantelli, 1999; Raphael, 2007). Besides being physical in nature, disasters are also social events that affect individuals, families, communities, and their social systems, and necessarily will generate social responses (Quarantelli, 1999). Researchers recognize that communities respond to disasters themselves and that their social networks and the connections that they have maintained are usually part of that response (Quarantelli and Dynes, 1977).

However, whether an event is understood to be a disaster or not, described or experienced as one depends on additional factors like the degree of the community as a unit, the physical vulnerability of the community and the personal vulnerability and risk of those within that community, the degree of devastation as a result of the event itself, and the nature of the recovery agency involved in the response and how effective they are. Of utmost importance in determining whether a disaster is understood to be one or not, though, is the extent of inherent resilience within the community traumatized by the crisis (Quarantelli and Dynes 1977).

Hazards have been progressively viewed since the 1970s as acts that require humans as agents and arise from the (potential) interaction and conflict between humans and extreme natural

events (Paul, 2011). Traditional notions of hazards stress that hazards are processes of nature in which their anger is randomly inflicted on unfortunate people. However, many contemporary researchers (e.g., Hewitt, 1983) have argued that hazards occur more from social than geophysical events or processes and blame the impacts of hazards on society and its associated institutions. It is well known that hazards happen because humans and/or their activities are often exposed to natural forces, and humans often create/intensify hazards or modify the effects of hazards. For instance, it is believed that many wildfires are set intentionally or deliberately by humans. Also, hazards are partly socially constructed by individual perceptions and experiences (Paul, 2011). So, hazards can vary by culture, age, gender, socio-economic status, race, and political structure. For instance, while floods may be considered hazards in many Western societies, they are considered a necessary event in some other places. While a "moderate" temperature may be deemed very high in a naturally cold region of the globe, it may be considered cool in a very warm/hot region.

According to Mileti (1999), hazard research has presently spread to other disciplines such as geography, economics, climatology, engineering, geology, law, meteorology, planning, seismology, and sociology. The paper notes that the work of the different professionals in these and other fields has improved our knowledge of the physical and social processes underlying both the natural disasters and the decision-making that accompany them before, during, or after their passage.

In geographical research, a natural hazard refers to physical threats in the environment to people and places arising from the interaction of human and natural systems (Cutter, 2003; Cutter et al., 2003). Natural hazards emanate from the complex interaction between physical processes and human activities that finally produce negative consequences known as natural disasters for the human use system. Losses from such events are not simply the result of extreme geophysical forces but are often caused, aggravated, or perpetuated by human activities (Montz, Tobin, and Hagelman, 2017). Natural hazards, however, have a significant physical component that must be addressed if we are to fully understand them. Natural hazards – whether meteorological (local storms, tropical depressions, cyclones, typhoons etc.), hydrological (floods, flash floods, avalanches, storm surges), geophysical (earthquakes, tsunamis, landslides), or climatological (droughts, heat waves, cold waves, forest fires) – are generally high-magnitude events with short life span, except for prolonged or severe droughts; and when they become disasters they cause considerable damage or harm to human lives in large numbers, physical infrastructure, and the

environment at large, and leave huge financial losses in their aftermath. Some of the natural disasters that the world has witnessed in recent years include the Asian Tsunami of December 2004; hurricane Katrina and superstorm Sandy in 2005 and 2013 respectively in the United States; the 2005 earthquake in East Pakistan; the Indian floods of 2007; the tropical cyclone in Haiti in 2010; and the 2011 floods in Australia, and Sri Lanka

A natural hazard signifies the potential or probable interface between humans and extreme natural events. It typifies the potential or likelihood of an event occurring but not the actual event itself. Therefore, natural hazards are a threat to society. However, hazards exist because humans and their activities are constantly exposed to natural forces. For example, when the property is situated in a floodplain, or agriculture activities are undertaken on the slopes of an active volcano, or when homes and resorts are developed in hurricane- and/or flood-prone coastal zones, humans expose themselves to the consequences of natural hazards. Only after an event has occurred can we term it a "natural disaster". A disaster is described as an event that has a significant effect on society, and geophysical events do create disasters. Unfortunately, there are no threshold boundaries where disasters could be deemed to have begun.

Figure 2.1 shows the delicate relationship between natural hazards and natural disasters. In both cases, the overlap between the human use of physical systems is of interest, with the difference between them regarding "potential" versus "actual" occurrences (Montz, Tobin, and Hagelman, 2017). That is, hazards represent potential events, while disasters are a result of actual events.

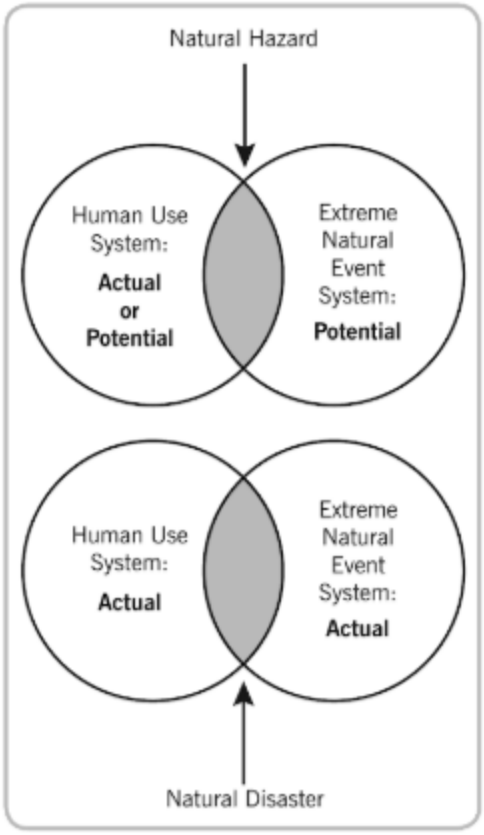

Figure 2.1: Natural hazards and natural disasters. (Source: Montz, Tobin, and Hagelman, 2017 with permission)

Vulnerability is a concept used about a situation (vulnerability to what?) or location- or place-specific (where is the vulnerability?). Thus, for vulnerability to harm to arise, there must be an interaction of individual(s) or group(s) of individuals (community) with the societal sub-system. The consequence of this interaction then creates exposure and predisposition or susceptibility to social, economic, political, and environmental imperfections and potential harm within the system. However, the level of risk of the element so exposed (the individual, group of individuals, or community) is temporally and spatially differentiated. This means that every aspect is at a different risk level because of a differential capacity to absorb such risk and invariably recover from the potential harm, whether this harm emanates from a natural or social system or the built environment. Thus, vulnerability is about exposure to harm, the ability to cope with the harm if and when it comes, and finally, the chances of recovery.

In the context of the community being studied, we see how all these concepts define their situation before the flood disaster. A potential of human-induced and natural events (hazard of channel overflow from Lagdo dam) existed for the communities along the Benue Basin (exposure to harm), where the possibility of loss of life or property existed (risk). Their resulting capacity to be hurt (vulnerability) created the eventual severe disruption of community life (disaster) that followed. But to get the community back on its feet required a reorganization of community life to ensure minimal intervention the next time around (resilience). This is the ultimate aim being explored in this literature review chapter and the subsequent chapters.

2.3 Scales of Resilience

Resilience can be exhibited at various levels or scales (Figure 2.7) – the individual level, family level, and community level. As cited by Kimhi and Shamai (2004), individual resilience is frequently understood as the attributes of a person that may include "hardiness" (Kobasa, 1982) or "sense of coherence" (Antonovsky, 1987). As a characteristic of a personality trait, resilience includes such factors as "the will to live", "perception of a situation as challenging", "sense of commitment and control", "sense of meaning", "self-efficacy", and "learned resourcefulness" (Kobasa, 1982; Antonovsky, 1987; Kimhi and Shamai, 2004). Human relations like care, social support, and warmth have equally been recognized as critical in coping with stress besides individual qualities (Cowen et al., 1995; Kimhi and Shamai, 2004). These deductions are comparable to studies that are concerned with human systems like the family (family resilience). However, because there is limited knowledge concerning community resilience, the term is loosely defined (Sonn and Fisher, 1998). The three-pronged description of community resilience as recognized by Kimhi and Shamai (2004) includes: (i) The resistant direction – which deals with the capacity of a community to diminish the effects of a disturbance (Halling et al., 1995); (ii) The recovery direction that is concerned with the capacity, and rate of recovery from a perturbation (Adger, 2000; Breton, 2001; Patton and Johnston, 2001); and (iii) The creativity direction – describes the capacity of a social system to constantly create and recreate in a fashion that the community need not have to react to adversity each time, but rather react in a manner that enables it attain a more advanced level of performance (Kulig, 1996; Kulig and Hanson, 1996).

Often, the aspect of these three directions of community resilience that is visible is the "creativity direction." For instance, if a community that has been affected by a disaster builds back

better and transforms into a higher economic activity and vibrancy, it is more visible than the other two aspects.

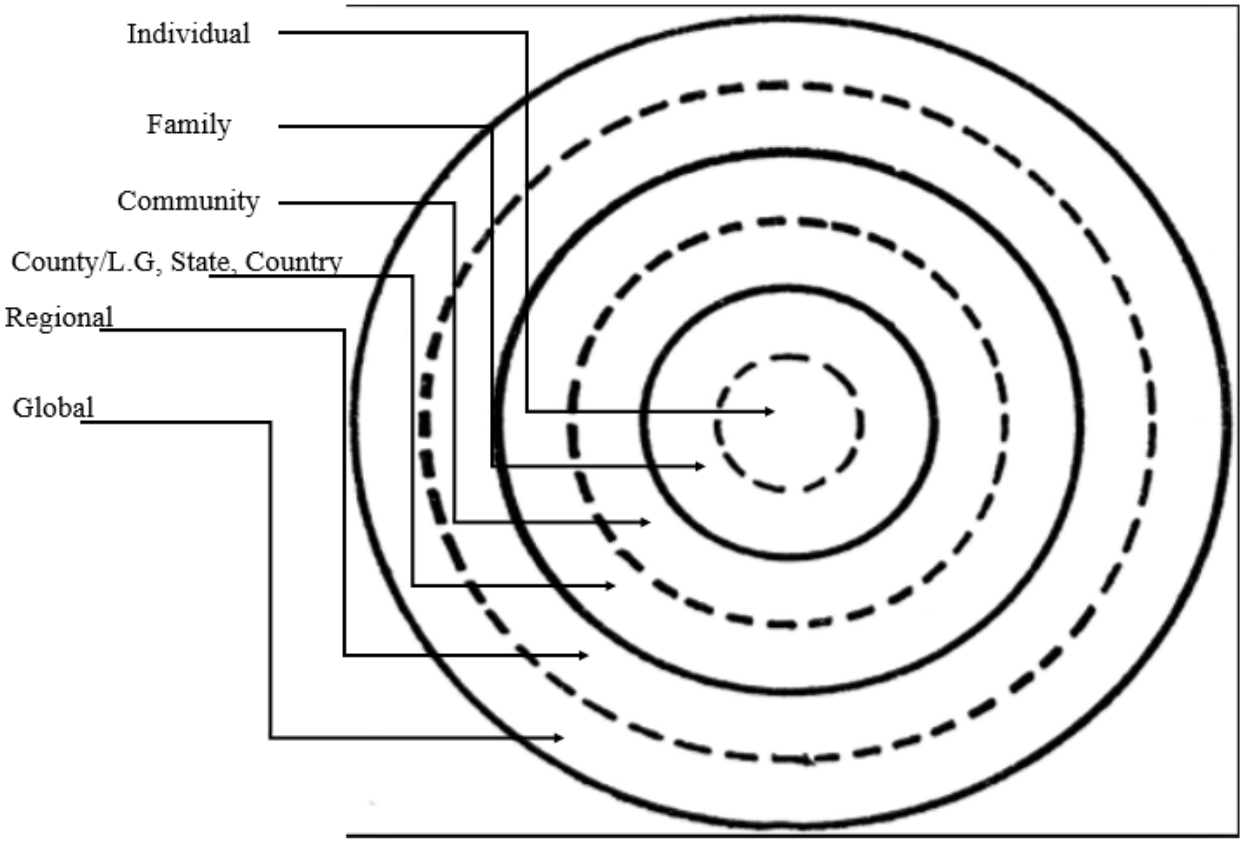

Figure 2.2: Scales of resilience (Source: Author)

2.4 The Concept of Community

What is a community? The notion of "community" is fundamental to the associated idea of "community resilience", "community capital", and "community recovery." Moreton (2016) defined a community as:

"*a complex and dynamic system of physical, environmental, economic, political, social and sometimes familial sub-systems*" (p.22).

Contemporary disaster literature holds the opinion that through the established inter-relationships between people within the community and the sense of attachment that they have to the place (Norris et al., 2008; Cox and Perry, 2011), and to a considerable extent, contribution in,

and connecting to the communal life, a community defines itself. This participation also normally involves community members engaging with schools, places of worship (churches, mosques, etc.), local associations, and other community groups. Community members go through a common fate in the event of a trauma, or if not common to all members of the community, at least they all share in the reality of the trauma (Cox and Perry 2011). All community members are usually corporately impacted by a disaster of a large scale, to which they normally respond as a group (Boon et al., 2012).

Although the foregoing definitions of community may convey the notion that in a community, members necessarily live close to one another. However, this is not always the case. It is possible for people to feel very strongly connected to a place even when they do not reside there. By the same token, those who belong to a local community may develop ties to other people or groups of people who live somewhere else. However, when we define community in a very strict sense, we may not include people or groups who reside outside, yet their strong tie to the community could arise through their personal or family connections or social networks (Boon et al., 2012). If we include this later consideration, a community may no longer be defined just by the people living in the community, or by where the community is physically situated, but to also include people who feel strongly connected to the community, and who are equally impacted by the experience, incidents or disasters that significantly affect other members of the community.

This rather fluid definition of community recognizes that communities are linked to one another and can also be a somewhat dynamic system made up of people and groups of people (Moreton, 2016).

2.5 Working Definition of Community Resilience

Using the three-directional description of community resilience proposed by Kimhi and Shamai (2004), namely the resistant, recovery, and creativity directions, a working definition of community resilience is hereby proposed as the innate ability or capacity that people or groups of people within a community possess, that enables them, when flipped into a different state of function in a disaster, to cope and recover from its effects by carrying out adaptive measures in a fashion that minimizes social dysfunction within the community.

2.6 Why resilience is important

Godschalk (2003) advanced two reasons why resilience is important. One, because the vulnerability of social and technological systems is not entirely predictable, resilience (the capacity to gracefully endure change without disastrous failure) is vital in times of disaster. If the exact time, location, and mode of occurrence of disasters in the future were predictable, then systems could be engineered to oppose them. However, since those involved in hazard planning have to cope with uncertain situations, it becomes essential to develop cities that can effectively handle contingency situations. Two, people and properties in a resilient city affected by a disaster should do better than in less adaptive and flexible places faced with an unusual stressor (Bolin and Stanford, 1998; Comfort, 1999; Godschalk, 2003). In resilient cities, there should be fewer collapsed buildings and fewer electricity failures; there should be fewer families or households in harm's way; there should be fewer injuries and deaths; there should be fewer breakdowns of communications and coordination efforts.

However, it is contested in certain quarters that resilience, although laudable, is impractical and so unattainable (Godschalk, 2003). He used Tobin's (1999) "*Sustainability and community resilience: the holy grail of hazards planning*?" in his argument. Tobin used "*a conceptual framework based on theoretical models of mitigation, recovery, and structural-cognitive interation"* to paint a somewhat pessimistic view that attracted comments from Godschalk (2003). Godschalk argues that the analysis of state-wide data rather than individual cities led Tobin to the rather pessimistic outlook regarding practicable resilience with the finding that (unlikely):

> *"major changes in political awareness and motivation would be necessary to overcome obstacles to resiliency and sustainability from Florida's existing demographic traits, spatial patterns, and hazard conditions"* (Godschalk, 2003 p.138).

Godschalk further argues that a resilient community is not just a utopian dream but is achievable through systematic research on natural hazard mitigation, where existing experience is currently the most; particularly through risk reduction policies and programs in the political, social, and physical aspects of hazard mitigation.

2.7 Existing Quantitative and Qualitative Research Approaches to Measuring Resilience

Many articles in the hazards and disaster literature mention resilience often in conjunction with vulnerability and as the flip side of it. Consequently, actions that are seen to reduce vulnerability are deemed to enhance resilience. Much as this may be true in many situations, it does not present the complete picture in all cases as resilience is both multi-dimensional (involving both biophysical, social, ecological, and even political facets), and multi-layered or multi-scaled (beginning with the individual level of analysis and increasing (Norris et al., 2008)); and it is a much more intricate concept than vulnerability. However, while the bulk of existing literature see the physical structures erected to, for instance, control flooding, withstand hurricane force winds, stem the tide of sea level rise, etc., as reducing the vulnerability of those exposed to the hazards, they "perceive" the resilience of the population as being enhanced. One may then say that determining resilience in this form relegates it to the abstract realm, is not concrete, and may not be very useful for management and policy formulation.

2.7.1 Qualitative research study of resilience

One way that resilience has been studied is through the content analysis of textual material. Resilience has been studied and defined across the entire disciplinary spectrum of social sciences (less environmentally in nature), the socio-ecological systems, and the natural sciences (less connected with the socio-ecological system). We may need to know the processes that produce resilience or how knowledge regarding it is generated using empirical research. How is resilience studied across the disciplinary spectrum? (Downes et al., 2013). While social and ecological systems are at the two extremes, the coupled social-ecological or socioecological systems reflect a mix of the two (Downes et al., 2013). To highlight how study at the two ends of this spectrum is conducted, Downes et al. obtained 3,759 and 2,789 datasets (reviewed papers) from the social science entries and the ecological science entries on resilience, respectively. These datasets were systematically reduced to 73 and 76 papers that were social and ecological resilience papers, respectively, rather than intersections of ecological and social research.

According to Downes et al. (2013), comparing the two studies showed a clear disparity regarding how the study of resilience is conducted. It was found that studies on social science resilience paid overwhelming attention to individual people, while research on ecological resilience was concerned more with groups of people (i.e., communities and populations). Social

resilience studies focused on change events arising from human sources, like political and economic change, and stress sources, like family violence or illness. On the other hand, studies in ecological resilience focused on human and ecological change events, for instance, climate change and hurricane or drought events, respectively. Again, the spatial and temporal scales for the studies were different between the social resilience and the ecological resilience works. While social resilience studies were carried out over short periods, ecological resilience studies comprised longer long-time periods.

Finally, Downes et al. (2013) noted that more diverse methods were applied to research ecological resilience in the studies they reviewed than for the social science research drawn mainly from one-off surveys that were explorative. Social-ecological systems are intricate systems where people form part of nature (www.resalliance.org, Berkes and Folke 1998). Hence, social-ecological resilience emerges due to the linkages between human systems and the environment, and the importance and unavoidability of disturbances in ecosystems is recognized. The study of social-ecological resilience, therefore, involves the promotion of management techniques that tend to balance opposition to change with the necessity to utilize the desirable prospects of transformations that may become available during or after the occurrence of a disturbance (Walker et al., 2004; Folke, 2006). Human actions are the controlling factors in social-ecological systems (SESs), therefore, the ability of the system to adapt is primarily dependent on the social component (i.e., the groups and individuals who act to manage the system).

Similar to, but not the same as, the method used by Downes et al. (2013) above to qualitatively study or determine resilience is the content analysis of textual material used by Torres (2017). She used this method to investigate how resilience is used in local government documents by applying it to answer the question: "*What it means to become more resilient*" in three communities in Florida - the city of Punta Gorda, Lee County, and Broward County. To do this, she conducted content analyses of county and city documents to extract definitions of resilience that were unambiguous, as well as definitions that were implied based on context clues by carefully choosing keywords. She found that the term "resilience" appeared 684 times in documents from Broward and Lee Counties and the city of Punta Gorda, yet only one document provided any explicit definition. Based on a keyword analysis, it was found that across all three study areas, the concept of resilience, as applied in engineering, was the most prevalent. This finding implies that their understanding of the relevant socio-ecological resilience required to pull out of or recover

from a traumatic natural disaster situation is poor and thus registers an ambiguous reading in the "barometer" of the study. There is, therefore, a need to swing toward a more realistic and broad-based social-ecological conceptualization of the resilience of communities.

2.7.2 Quantitative research study of resilience

As noted in Chapter One, only very few research studies have been devoted to measuring quantitative resilience, and it is only a recent trend, for that matter. Only two of these studies have a direct relationship with the approach adopted in this dissertation, even as this study is an adaptation of their approach – the doctoral dissertation of Mayunga (2009) and the peer-reviewed article of Cutter et al. (2010).

The work by Mayunga (2009) was titled *"Measuring the measure: A multi-dimensional scale model to measure community disaster resilience in the US Gulf Coast region"* and was aimed "*at developing a theoretically-driven index that can be used to measure disaster resilience in the coastal counties in the U.S. Gulf region*". Employing some conceptual frameworks, and the existing theoretical models of some notable researchers in the hazards literature – the "*sustainable and resilient community framework"* of Tobin (1999); "*the sustainable livelihood framework*" of Chambers and Conway (1992) and Glavovic et al. (2002); "*the community resilience framework*" of Maguire and Hagan (2007); plus "*the disaster resilience of place model*" of Cutter et al. (2008) that emphasizes the antecedent conditions of the social, natural and built environments of a community – Mayunga noted that all the four stages of disaster management, viz, mitigation, preparedness, response, and recovery were critical to the ability of a system to absorb or resist the effects of a disaster, and when affected can rebound in a comparatively speedy manner; and the capacity to gain experience from the disaster event, and then alter its structure and performance in other to adjust to threats of the future.

The paper then proceeds to identify four key forms of capital, which were termed "indicators", viz, social capital, economic capital, physical capital, and human capital, which are then applied to the four disaster stages highlighted in the previous paragraph. Each of these four forms of capital was then applied to the four distinct phases of disaster. To do this, the forms of capital were first defined with different variables. The author began with 120 such variables, which were subsequently weighted and then standardized before being passed through a reliability analysis (Cronbach's alpha test). At the end of the test, 75 of the variables were retained. To

construct the proposed community disaster resilience index (CDRI), the 75 selected variables were distributed among the four capitals, as shown in the Table below.

Table 2.1 - Total indicators used to calculate the Disaster Resilience Index in Mayunga (2009)

Author	Indicator	No. of variables used	Total No of variables
	Social capital	9	
Mayunga (2009)	Economic capital	6	75
	Physical capital	35	
	Human capital	25	

The goal was to determine the CDRI using these indicators by taking the average of the scores of the different variables and obtaining the index score for an indicator. Further, the county index scores are obtained for the four indicators by adding them up and taking their mean to produce the CDRI for each of the 144 counties for comparison.

The work by Cutter et al. (2010) was titled *"Disaster resilience indicators for benchmarking baseline conditions"* and is similar to the work of Mayunga in many respects. The purpose of the work was to initiate a methodology for measuring resilience so that the resilience of places can be monitored and compared over time. To achieve this, a set of indicators that have been put forth in the literature and considered to be drivers of disaster resilience was used. The procedure for aggregating the CDRI is the same in the two studies, except for a few individual preferences and considerations. One prominent difference between this work and the earlier one highlighted (Mayunga, 2009) appears to be parsimony. While Mayunga (2009) began with 120 variables that were trimmed down to 75 by the reliability analysis, Cutter et al. (2010) began with 50 and eventually retained 35 for the indicators given in Table 2.2.

Table 2.2 - Total indicators used to calculate Disaster Resilience Index in Cutter et al. (2010)

Author	Indicator	No of variables used	Total No of variables
	Social Resilience	7	
	Economic Resilience	7	
Cutter (2010)	Institutional Resilience	8	35
	Infrastructural Resilience	7	
	Community Capital	7	

The other difference in the two approaches is that while Mayunga (2009) used 4 indicators, Cutter et al. (2010) used 5 indicators. This is because of the two indicators of Institutional and Infrastructural resilience being combined as one (physical capital) by Mayunga (2009). The third difference, which in any case is not very significant, is the terminology for the indicators. While Mayunga termed each of the indicators as "capital", Cutter et al. termed them as "resilience." Again, while Mayunga employed the "Z-score" in standardizing the variables for the 144 coastal counties, Cutter used the "Minimum-Maximum" method for the counties of the 8 States of the southeastern U.S. In obtaining the overall metric score, while Mayunga (2009) used the average score of all indicators, Cutter et al. (2010) summed up the scores of the different indicators.

"*Measuring community resilience to disaster",* Wesley (2014), was undertaken at the University of Missouri-Columbia. It concerned measuring the community disaster resilience at the neighborhood level in the City of St. Louis, Missouri. According to the author the study was motivated by three reasons: One, the reliance on linear systems science to characterize the human dimensions of resilience (dimensions that, according to him, are thought and examined to be nonlinear, dynamic and complex in other scientific disciplines); two, that most variables used as proxies for community resilience are not indicative of community resilience but describe individual-scale behavior, and household-scale socio-economic features; and three, that the existing practice of aggregating resilience indicators to large and diverse geographic areas to communicate community-level resilience can mask and mischaracterize the local, and place-specific variability of the indicators. Regarding this third reason, Wesley argues that if, for example, the sum of economic indicators in a country points to a net gain in standards of living, pockets of quite substandard living conditions will possibly exist, just as superior living conditions, and anywhere in between these two. In such situations, he argued, it would not be wise to use data aggregated to large-area spatial units to report on the state of community standard of living for a specific location because of the inherent variability of individual communities within each unit. He suggested a shift toward the study of specific small-area localities to bring geographic studies of community resilience in harmony with the current and future information needs of emergency personnel.

However, his proposed "dual index" approach to the determination of absolute changes to a community's vulnerability/resilience scores deviates significantly from the much more reproducible methods of Mayunga (2009) and Cutter et al. (2010). The Analytic Hierarchy Process

(AHP) approach employed is a rather complex process that may not be easily understood by a wide range of professionals outside the field of mathematics, engineering (particularly industrial engineering), or mathematical sciences. According to Wesley (2014, p.60), the AHP was originally developed in the field of "*industrial engineering for using expert ratings to select preferred means from a set of alternatives to achieve a normative production outcome*". Wesley then makes clear his intention to introduce the idea from other disciplines in the following sentence:

"*While many researchers recognize both the inevitability of a certain amount of stove-piping in academia as well as the benefits of theoretical maturation this process provides, it is contended that, at the very least, there exists a strong, largely unrealized potential for trans-disciplinary collaboration which includes cross-adaptation of theories and methods*." (Wesley, 2014, p.6).

The AHP approach, Wesley continues, "*can be used to define the relative importance of study indicators within an index, ... and to retain the information regarding relative indicator importance for the purpose of defining weights*" (Wesley, 2014, p.60).

Because not many researchers in social science can fully grasp the theory of this method, it was not exhaustively and conclusively perused. However, the result was presented in relative terms between communities and their neighbors as "Relative Resilience."

2.8 An Overview of the Approach Adopted in this Study

Although interest in disaster resilience is considerable due to its importance as a mechanism to mitigate the effects of disasters on local communities, identifying the metrics and standards to measure it has been a challenge (Cutter et al., 2010). It became important, therefore, to develop a suite of indicators that measure basic features of communities that exhibit resilience to monitor changes in future resilience for a particular community or compare different communities and places (Cutter et al., 2010).

This dissertation is based on the set of indicators used by Mayunga (2009) and Cutter et al. (2010), namely Social, Economic, Infrastructural, Institutional, and Community capital indicators. These have been proposed in the hazards and disaster literature as chief contributors to disaster resilience. These indicators are further combined into a composite indicator (or metric). Thus, a composite indicator aggregates all the data in the chosen suite of indicators and variables (Nardo

and Saisana, 2008), and its output is a single score (in the case of a single community) indicating the performance of that community when compared to other communities. The weaknesses and strengths of composite indicators depend mostly on the quality of the underlying variables. So, the selection of variables should be determined by their relevance, analytical soundness, accessibility, etc. (Nardo and Saisana, 2008).

In the following sub-sections, I wish to present the theoretical frameworks upon which the selection of the five indicators highlighted above, namely, the Social, Economic, Institutional, Infrastructural, and Community resilience indicators deployed in the computation of the resilience metric (Community Flood Disaster Resilience Index, CFDRI) is hinged. A total of over 35 sub-indicators were used in Cutter et al. (2010) from which this study was adapted. It is therefore impracticable to exhaustively explain all. Therefore, only a few of such sub-indicators will be highlighted in the subsequent subsections on resilience indicators. However, all the variables used in their place in this study are given in chapter three.

2.8.1 Defining Social Indicators

When people live and work together in a community or society, they build networks of relationships that enable that society to function effectively. These include networks of influence such as belonging to a family, having friends, and maintaining other contacts. Through these networks, there is goodwill that becomes available to the individuals and groups within that network and that society. This is the concept of social capital. The central principle of social capital is that social networks have value (https://www.hks.harvard.edu/programs/saguaro/about-social-capital). Therefore, the aggregate value of all the social networks, or everyone and entities (e.g., companies) that people know, can be of economic value, and the dispositions arising from these networks to do things for one another constitute social capital (Jones et al., 2015). A social network consisting of people and companies that trust and assist each other can become a powerful asset in which everyone thinks of the good of the other (http://www.investopedia.com/terms/s/socialcapital.asp). In their citation of Lin (2001), Norris et al. (2008) indicate that the simple idea behind social capital is that people invest, access, and utilize capitals that are entrenched in social networks to their benefit. Social factors, as a form of capital, have been known to influence the building of communal capacities in dealing with disasters (Dynes, 2002; Haque and Atkin, 2007). According to Beeton (2006), without social

capital, a community will lack the needed cohesion to organize itself and maintain itself and its environment.

2.8.2 Defining Economic Indicators

An economic indicator refers to cash or money, property, and other assets. This indicator captures the economic vibrancy of the community, including employment, size of business, equitable income, housing capital, and access to a physician (Cutter, 2010).

"Income and equity" is one of the sub-indicators to compute the economic indicator and is determined with the GINI Index as the variable. Income equality measures equality in the distribution of income in the community. The GINI index may also be used to measure other forms of inequality (e.g., age inequality) within a population. The more equitable the distribution is, the more resilient the community. This is measured by the GINI coefficient, with the coefficient ranging from 0 to 1. The lower the income inequality, the lower the coefficient and the more resilient the community; conversely, the higher the inequality, the higher the GINI coefficient, and the lower the community resilience. The graph in Figure 2.1 is used to determine the GINI coefficient.

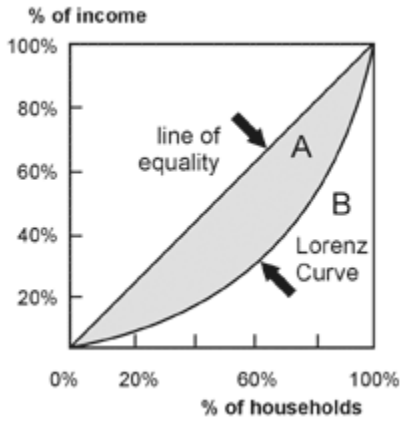

Figure 2.3: GINI coefficient and the Lorenz curve (Source: www.mackinac.org)

GINI Coefficient = Area A/Area(A+B) and can be determined with an Excel spreadsheet using the income distribution of the sample.

2.8.3 Defining Institutional Indicators

While Cutter et al. (2010) treat Institutional and Infrastructural indicators separately, Mayunga (2009) combines them into a single indicator – Physical capital – with far too many variables to determine it.

The Institutional indicator, according to Cutter et al. (2010), relates to long-term planning, mitigation, and experience from any prior disaster, especially by Local, State, and Federal authorities, and gauges the capacity of the local community to reduce risk by engaging in mitigation measures. It measures the contributions of institutions (especially of government) in proofing the community such that disaster risk is reduced, and resilience is enhanced or built.

"Municipal services" is a sub-indicator/variable used in Cutter et al. (2010) and refers to the periodic (e.g., annual) financial commitments of the municipal authorities to bolster emergency management through the fire department, police, and other emergency services (first responders). However, in many developing countries, the governance structure is different. While in Nigeria, for instance, the federal government is responsible for the police and fire service, some state governments, like Lagos (Cobin, 2013) and Benue State, also have and cater to the fire department. The fire service appears to exist only as physical entities, as they are never sufficiently empowered to effectively carry out their responsibilities. Besides, their role as first responders is often limited to fire incidents only.

Political fragmentation is another sub-indicator used by Cutter et al. (2010). Regarding this variable, Norris (2008, p.128) writes:

> "*the whole is more than the sum of its part, meaning that a collection of resilient individuals does not guarantee a resilient community*".

Thus, any form of political fragmentation will negatively impact corporate resilience. Since a much smaller unit than the county or state level is considered here, the ethnic make-up of the community becomes our proxy. Stewart (2016) summarized the issue of conflict thus:

> "*Remove the secondary causes that have produced the great convulsions of the world and you will almost always find the principle of inequality at the bottom. Either the poor have attempted to plunder the rich, or the rich to enslave the poor. If, then, a society can ever be founded in which everyman shall have something to keep and little to take from others, much will have been done for peace* (de Tocqueville 1835, quote from 1954 edition: p.266)".

The story of the Tiv and Jukun ethnic groups of Benue (where the study area is located) and Taraba states are that of perennial conflict (Joshua, 2016), ostensibly due to a desire of one

ethnic group to lord it over the other from a socio-economic vantage position. However, the field observation of the ethnic make-up of the affected communities shows that the Tivs are in the overwhelming majority in most of the communities and the entire city, followed by the Idomas, and then the Igedes. The Jukuns appear to be in the majority only in one of the community units (Wurukum), a principally fishing community, as many of them are fishermen. When people of uniform customs, tradition, language, and culture live in communities, it tends to foster unity and cohesion within that group, which enhances resilience, particularly in times of corporate adversity.

Mitigation (also used as a variable for this indicator) refers to actions taken ahead of a natural hazard to avoid the long-standing risks that it poses to property and humans (Godschalk et al., 1999). Activities that constitute hazard mitigation are focused on foiling hazards before they manifest or reducing their chance of occurrence. Such activities may be structural or non-structural (www.training.fema.gov/). While the structural tools include seawalls, levees, retrofitting, and engineering facilities, the non-structural mitigation tools include land use planning, building codes, design and construction, hazard identification and mapping, financial incentives, and public education programs.

2.8.4 Defining Infrastructural Indicators

This is mainly focused on the disaster response phase and appraises the capacity of the community to respond and recover from disaster (shelter, healthcare facility, etc.). Thus, it takes stock of what is available if disaster response and recovery are required. It also assesses the amount of private property that may be susceptible to damage and consequent economic losses (Cutter et al., 2010).

2.8.5 Defining Human Capital Indicator

In simple terms, human capital is the ability to work, or the labor force (Mayunga, 2009). The paper further gives the economist's definition of capital indicator by Smith et al. (2001) as the capabilities existing within the working age of a population that allow it to sustain the economic productivity of that population while utilizing other forms of capital. Human capital defines the existing interrelationship between people and their wider neighborhoods and communities (Norris, 2008; Cutter et al., 2010). These definitions tend to suggest an overlap between Social and Human capital indicators. However, care is taken to avoid duplication of sub-indicators.

Three key social psychological dimensions of social capital are targeted for capture by this indicator, namely, citizen participation, place attachment, and sense of community (Norris, 2008).

"Sense of Community" defines the bonding attitude or belonging and trust with the other members of one's locality, manifested in mutual concerns and shared values. There is usually a sense of community, respect, and service to the other members of the community, a sense of connection, and fulfilment of needs. Related to a person's sense of community is "Place attachment" (Norris, 2008). This suggests emotional connections to one's neighborhood, slightly different from the connection of the specific people that live there. Place attachment is what motivates citizens of a community to revitalize the place, and this is essential for community resilience. "Citizen participation" is the descriptive term used when members of a community engage in formal organizations like religious organizations, resident and school associations, neighborhood watches, and other self-help groups (Norris, 2008). Citizen participation is thus a central element for community resilience.

Concerning the political engagement sub-indicator (one of the indicators to define the human capital indicator), any group of individuals marginalized either by minority status, gender, poverty, or disability has a greater propensity to be more vulnerable when sudden disaster events occur (Morrow, 2008). The political power to affect decisions, for example, economic development, using public resources to develop infrastructure and services, and locating technological and environmental hazards, determines which communities or households become the most vulnerable. Therefore, holding some positions of authority in decision-making, especially during the recovery period of a disaster, can be to the advantage of a community and ultimately enhance resilience. This is because, in the time of reconstruction, economic and political power determine what is rebuilt (Vale and Campanella, 2005).

The extent of social innovation in a community can be measured by the pool of creative professionals in the community. In other words, talent, or the knowledge-based workforce, can be agents of innovation in the community. Florida (2002) defines talent as people with elevated levels of human capital and measured as the percent of the population that has a bachelor's degree or higher. According to the paper, the talent and high-tech industry work both independently and collectively to generate high regional incomes. Therefore, a high talent rate is expected to enhance regional or community resilience.

2.9 Reliability Assessment of the Indicators

Composite indicators from the measuring variables are accepted depending on the outcome of the reliability analysis. Reliability tests ensure the credibility of results. Reliability refers to "*the consistency, stability, and repeatability of results*" (Twycross and Shields, 2004, p.36). The variables are first analyzed for reliability or internal consistency. Internal consistency is relevant to composite scores and determined from Cronbach's alpha. The formula for the standardized Cronbach's alpha is given below:

$$\alpha_{\text{standardized}} = \frac{K\bar{r}}{(1 + (K-1)\bar{r})}$$

K = Number of indicators (or number of items/variables)

$\bar{r}$ = Mean of inter-indicator correlation

$1 + (K-1)\bar{r}$ = The total variance in the composite scores

Reliability guarantees constant results in similar situations and on separate occasions, and it must be ascertained whether there are significantly high correlations between individual variables to make them retainable. According to Ferkekitch (1991), items (or variables) with an inter-item correlation of 0.20 to 0.70 should be retained. Additionally, from SPSS-generated results, items (or variables) needing to be deleted usually produce a lower Cronbach's alpha when included with the rest of the variables but a higher overall Cronbach's alpha when deleted. Thus, when deleted, they enhance the overall reliability of Cronbach's Alpha. Several authors (Schilling, 2000; McAllister and Bigley, 2002; Spector et al., 2002; Rothbard and Edwards, 2003) have suggested a reliability (Cronbach's Alpha) value of 0.70 as the threshold of acceptable reliability (Cronbach's Alpha).

However, Lance et al. (2006) argue that Nunnally (1978), from which most of these authors have lifted this threshold value, has recommended values based on unique research situations. In the argument of Lance et al. (2006), it quotes Nunnally (1978) as stating that "*what a satisfactory level of reliability is depends on how a measure is being used*". Nunnally (1978) put forward three threshold values for reliability. A Cronbach's Alpha of 0.70 was put forward for exploratory research. In other words, 0.70 is the minimally acceptable value of Cronbach's Alpha for Exploratory Research, while 0.80 and 0.90 are the minimally acceptable values for Basic and

Applied Research, respectively. Although there may be some slight confusion as to the proper interpretation of Alpha values, Schmitt (1996) suggests that even a low level of alpha may also be useful. However, there is a preponderance of suggestions in the literature that in the preliminary stages of research, values of alpha approaching 0.70 are acceptable. The suggestion of Schmitt (1996) regarding Cronbach's Alpha level has been adopted in this exploratory work.

2.10 Validity Assessment

Another important assessment for the acceptability of the composite index (metric) is the concept of validity, often taken in tandem with reliability assessment. Validity means that "*a tool measures what it sets out to measure"* (Twycross and Shields, 2004, p.28). Thatcher defined it as "*the extent to which any measuring instrument measures what it is intended to measure*" (Thatcher, 2010, p.124). For instance, a pain assessment tool that measures blood pressure rather than pain intensity is not valid, if it is meant to assess pain intensity, then it must measure pain intensity. Thus, a measure (variable) is valid only if it measures what it set out to measure and is invalid if it does not (Carmines and Zeller, 1979). However, the validation of indices is a complex process because the experimental data required are not always obtainable (Vincent, 2004; Simpson, 2006; Cutter and Finch, 2008c). There are various measures, though, that indicate the quality of a research study (Twycross and Shields, 2004). The validity of a study is evidenced by the measures that assess the data collection tools.

Measures that assess how valid data collection tools are include content validity, construct validity, and criterion validity (Twycross and Shields, 2004). Face validity (physical inspection) is an uncomplicated way to evaluate content validity to ascertain that a tool is measuring what it claims to measure. A more demanding way is to engage professionals in the field to give their judgment on how valid a tool is. Only this validation technique has been applied to this study – the use of a questionnaire to extract the right information needed to measure the variables of interest. Construct validity tests the relationship between a measure or variable and the theory underlying that measure or variable. It is ascertained when results are compared with those obtained with other tests or related variables. When the correlation coefficient is high, it is considered valid. Criterion validity is measured with concurrent or predictive validity (Twycross and Shields, 2004). Concurrent validity compares an existing, well-accepted measure with an

entirely new one. For instance, comparing the ratings for a new blood pressure measuring tool with an old one whose ratings have been validated. Predictive validity measures the degree to which a tool can forecast an event of interest in the future. Since only one community is being studied in this research, most of these validation techniques cannot be applied.

2.11 The Knowledge Gap filled by this Dissertation

The major drawback of Wesley's Analytic Hierarchy Process (AHP) approach discussed earlier is that it employed a rather complex procedure that may not be clear to the majority of researchers in the social and behavioral sciences. Besides, the method tends to only compare neighboring communities in relative terms of the one that is better than the other. Thus, two communities that are distant from each other may not be justifiably compared since they do not have quantitative measures to be compared.

The systematic procedure of computing resilience by Mayunga (2009) and Cutter et al. (2010) appears relatively easy to follow and reproducible as well by a wide range of professionals, and the statistical computations encountered are equally simple to understand and reproduce. However, using too many variables to define the indicators as was done by Mayunga (2009), where 75 variables were used, may make this method cumbersome, especially since the research is to be conducted in a third-world community. Fewer variables, as used by Cutter et al. (2010), are easier to handle.

Nonetheless, in using counties as units of analysis, the outcome of the resilience results for the larger-scale county units may not adequately represent the component communities within the county, and the results, therefore, will be misleading. While some counties are politically limited in power, others have central units that are powerful. Again, counties vary greatly in geographical and population size, with some being hundreds of times larger than others (e.g., Harris County (TX), with a population of over 3 million, is by far larger than Kennedy County, also in Texas, with just 4 hundred people). The question of scale in the computation of resilience was noted by Wesley (2014) as important. This is a major drawback in the works of Mayunga (2009) and Cutter et al. (2010). Further, since the county is not considered a social unit, measuring disaster resilience at that level presents a problem since social interactions and networks take place at the community level and not the county level (Mayunga, 2009).

Thus, the county unit of analysis is too large to reflect the true situation at the grassroots level. Again, since secondary data is not readily available for communities of developing countries, conducting regular surveys and storing such data appears to be the only viable way of feeling the pulse of communities with regard to environmental performance and the way that government activities impinge on them. This gap in knowledge is what this dissertation sets out to fill using primary (survey) data.

By and large, applying the methodology of Mayunga (2009) and Cutter et al. (2010) at the community level as carried out in this research, without doubt will enhance urban planning. Not just that communities within counties can be compared, but ultimately different counties as well. When sectors within communities or Counties/Local government areas are compared, it will help determine where intervention is most needed.

2.12 Summary

Natural disasters exert a heavy toll on populations and societies, killing substantial numbers of people, damaging property, and destroying homes the world over every year. Some of the unseen hands orchestrating this situation are attested to in Montz, Tobin, and Hagelman (2017) and include global climate change, changing land uses, population growth, and urbanization. Thus, populations, communities, and societies become victims of disasters either because they become vulnerable to these conditions (e.g., land use changes) or because they become vulnerable to disasters because of them (e.g., climate change). But as the prospects of environmental change that impact populations become higher, the need for communities and societies to develop resilience to counter their adverse effects becomes even more compelling.

This chapter has given a relatively short historical account of natural disasters, particularly in the last 50 years. It has also discussed a few concepts often associated with it. Further, the chapter considered the literature review upon which the theoretical and conceptual foundations for this work were conceived, especially some of the "prisms" through which the vulnerability to and resilience from natural disasters are viewed. Vulnerability and resilience appear to be viewed differently by various researchers, arising from varying epistemological perspectives, and this has made a unified or common definition of the two concepts rather problematic. Various other related concepts were equally reviewed to provide a better understanding of the concept of vulnerability

and resilience, their vital components, and how they should be intellectualized and applied in hazards and disaster work. Finally, the "take-away" from the vulnerability discourse is that living in a "risky" zone is not all that constitutes vulnerability. The "economic muscle" of the population concerned and the resources accessible to them ultimately become very relevant in determining their vulnerability. On the other hand, every effort to ensure that those hit by disaster get their lives back after the disaster, with their community back to its near-state-of-functioning as before, constitutes resilience thinking. Also, the concept of "community", central to this work, was explored, and a working definition of community, vulnerability, and resilience was put forward.

The theoretical frameworks for resilience indicators that have been suggested in the literature – social, economic, institutional, infrastructural, and community capital – were explored. In some cases, the conceptual frameworks for modifying some of the variables, adapted from Cutter et al. (2010) to contextualize them to the community of study were established. To close this chapter, the gap in knowledge that these frameworks (theoretical and conceptual) are utilized to fill is re-echoed, and there must be a consciousness of disaster resilience, and it must take root in the national culture of people until it becomes a natural right of all people.

In the next chapter, the data collection and analysis procedures are presented, and the resilience indicators are contextualized to the community. Also, the procedures to determine the reliability of the selected variables are outlined. Finally, the systematic aggregation of scores to determine the Community Flood Disaster Resilience Index (CFDRI) is given.

CHAPTER THREE

DATA AND METHODOLOGY

3.1 Introduction

The focus of the previous chapter was the approach of previous researchers in studying resilience, particularly those bordering on qualitative and quantitative methods. Regarding qualitative or quantitative research, however, a survey is often very necessary. Conducting surveys is an unbiased approach to decision-making, and they describe the characteristics of a large population. No other research method provides this broad capability that ensures a more accurate sample to make important decisions and draw conclusions. However, the modes of extracting information from the population are different. While the one (qualitative research) allows for a free expression of viewpoint by respondents, the other (quantitative research) constrains them to certain response choices. Because of the nature of this study, the quantitative approach is emphasized. Therefore, in this chapter, greater attention will be paid to the quantitative method of analysis of a survey. This is because of certain advantages that quantitative research has over qualitative research, especially in the social sciences. For instance, participants' "closed-ended" responses allow a meaningful comparison of these responses. Statistical tests of hypotheses can also be conducted, and the researcher is not swayed by the feelings and often fluid contributions of the respondents, which allows him/her to make very objective judgments.

Special attention is given to the fact that this study is an adaptation to the community level in a developing country context of two previous attempts by Mayunga (2010) and Cutter et al. (2009) at quantitatively determining resilience at the County and State levels in the United States. Table 3.1 shows the number of variables used in the two previous studies and this study.

Table 3.1: Indicators and total number of variables used to calculate Disaster Resilience Index in Mayunga (2009), Cutter (2010), and the total number tested for this dissertation.

Study	Indicators used	No of variables used	Total No of variables
Mayunga (2009)	Social Capital	9	75
	Economic Capital	6	
	Physical Capital	35	
	Human Capital	25	
Cutter (2010)	Social Resilience	7	35
	Economic Resilience	7	
	Institutional Resilience	8	
	Infrastructural Resilience	7	
	Community Capital	7	
Variables tested for this study	Social Factors	7	36
	Economic Factors	7	
	Institutional Factors	9	
	Infrastructural Factors	6	
	Community Capital	7	

It is important to note that the variables employed by these two previous researchers had passed the reliability tests for them to be used. However, additional reliability tests of the variables have become necessary to ensure that the contextual questions posed to respondents capture the same variables in the adapted study (Cutter et al., 2010).

3.2 Research Design

Principally, this dissertation is designed to answer three major questions:

(v) "To what extent has resilience changed over the five years since the flood?"

Resilience, as we know, is an intrinsic property of any system. However, this property can change over time depending on the changing characteristics of the system itself. Concerning the community under study, it follows that up to the point of the flood disaster in 2012, the community possessed some measure of resilience. To deal more appropriately with future disasters of the kind encountered in 2012, the community was expected to develop enhanced resilience. However, the operating political and economic forces may not make this possible. This research question is therefore designed to quantitatively determine the community resilience after about five years to see if the overall lot of the community is better regarding resilience, or is unchanged, or is worse off. To do this, approximately 200 responders answered a total of about 76 questions (36 questions for each of the two different years) designed to capture about 36 variables distributed across the five resilience indicators. Thus, while the resilience indicators are the dependent variables, the variables (or the sub-indicators that they capture) are the independent variables.

(vi) To what extent did the experiences gained from previous flood events contribute to the community's perception of resilience or lack of it?

For this research question, the same number of respondents (about 200) are engaged, but only three questions are posed in this case (to be discussed in detail later). It is designed to test whether respondents can accurately predict future flood disaster resilience using the information at the point of the survey (summer 2018).

(vii) What specific indicators and variables in the light of the study can be used to determine a community's level of resilience?

Regarding this question, the focus is on the 36 variables that are employed in answering research question number one (RQ1) across the five resilience indicators. In other words, those variables from which the Community Flood Disaster Resilience Index (CFDRI) is computed.

3.3 The survey and data

The data for Cutter et al. (2010) from which this study was adapted were drawn from the national and other databases in the United States. Unfortunately, to actualize this type of research in a third or developing-world context where fine-grained or granular and detailed data are usually unavailable, our only recourse is to a survey. According to Vega (1992), an effort to study resilience in a specific community will have to prominently feature the local culture and mores. Thus, a well-structured questionnaire is designed to capture the very essence of community life exemplified in the survey for this research and, at the same time, meets the ideals of the original variables used in Cutter et al. (2010).

3.3.1 Approval to Conduct the Field Survey

Approval to conduct a survey abroad on human subject research for this work was granted by the Institutional Review Board (IRB) in Research Integrity and Compliance at the University of South Florida in Tampa, Florida, USA, where this research was initiated. As the Principal Investigator (PI), I had to pass through a rigorous procedure for the IRB certification. First, I had to pass the Collaborative IRB Training Initiative web-based certification for Social/Behavioral Investigators and Key Personnel to move on to obtain IRB permission for the research. The key requirement of the IRB was an assurance that no identifiers of the survey respondents would be required of them. Other documents submitted for approval included the recruitment script, the verbal consent form, and an institutional support letter from Nigeria, which was obtained from Benue State University, Makurdi, the project site. All these conditions were met before the IRB consent was granted for the fieldwork to commence.

3.3.2 Recruitment and training of the research assistants

Ten (10) graduate field research assistants were paid to cover the 10 Wards (a Ward is the equivalent of a census tract in America) that were worst affected by the 2012 flood disaster. This arrangement was facilitated by a friend and volunteer field coordinator in the Department of Geography and Environmental Sciences, Benue State University, Makurdi, Nigeria, who is also a faculty member (lecturer) in that department. Besides the fact that these graduate students were conversant with survey-taking techniques, as attested to by their lecturer, I had to administer a two-day training to acquaint them with the variables that I sought, and in some cases, the underlying theoretical or conceptual framework for those variables. The research assistants were

encouraged to ask questions during the training sessions and before going to the field, and call me from the field if they needed any clarification on any issue. As expected, some of them did. This was to ensure that the data collected was of the highest quality possible. They were also encouraged to bring feedback from the field, which was shared after each day's work.

3.3.3 The survey

Two hundred (200) respondents were polled, including two who did not respond to some questions. However, missing data were not considered in the analyses and aggregation of the indices. The stratified approach to survey-taking was encouraged. In this case, equal numbers of young people (male and female) and older people (male and female) were polled. Each assistant was assigned 20 respondents to poll (5 respondents for each of the 4 demographic classes). However, this was not to be strictly adhered to since exigency could dictate otherwise. Polling the different demographic classes was to ensure that opinions across the age and class strata were represented in the survey. The target minimum age for respondents was a little over 20 to make their minimum age at the time of the 2012 flood 15 or 16 years old. This was to ensure that everyone polled in the survey was old enough at the time of the flood to make the right judgments about the situation as would be required in the survey. However, the respondents that were polled ranged in age from 19 to 82, making one of the respondents 13 years old at the time of the flood. The survey was also systematic. This was to ensure that the 20 respondents assigned to each assistant were spread over the entire area. Again, the survey was random, ensuring that no biases were introduced into the data.

To go to the field, the research assistants were armed with a recruitment script, a verbal consent form, and a questionnaire. They would hand out the recruitment form, and where the respondents were willing to provide information, they would read out the consent form. The survey (Appendix A) was then administered face-to-face while the assistant indicated the responses of the respondents on the structured questionnaire. This was intended to reduce respondent fatigue in filling out a very lengthy questionnaire to be returned on a different day. At the end of each day, the filled copies of the questionnaire were entered into the computer Excel spreadsheet in a coded format, beginning with the dichotomous scheme at the onset.

As indicated earlier, the survey questionnaire was designed to capture situations just before the flood or at the point of the flood (which serves as a control or reference) and at the point in time that the questionnaire was administered (summer 2018). The questions (and proxies) defined

the variables used by Cutter (2010) for the sub-indicators defining social, economic, infrastructural, institutional, and community capital factors that help build community resilience.

3.3.4 Sample size and data entry

Working in the same study area as in this research, Shabu (2013) employed the Taro Yamane formula to determine a sample size of 338 that was randomly polled. The Taro Yamane formula is given by:

$$n = \frac{N}{1+N(e)^2}$$

Where n = corrected sample size; N = population size; and e = Margin of error (MoE), or allowable error (%); e = 0.05 (a 5% baseline or reference is used for most polls).

With the closest population estimate for 2012 at 348,990, n ≈ 399. For ease of handling, however, a much smaller data size is advised (https://www.quora.com/What-is-Yamane-sample-calculation). A sample size of 200 respondents was therefore polled in this study. However, 2 of these polls were inconclusive. Table 3.2 gives the distribution of the number of respondents polled in the different Wards.

Table 3.2: Distribution of respondents in different wards of the community

SN	Ward	The number of respondents polled
1.	Idye	20
2.	*Nyiman & Fiidi	7 & 11 respectively (plus 2 incomplete polls)
3.	Logo 1	20
4.	*Ankpa Extension & Rice Mill	7 & 13 respectively
5.	Logo 2	20
6.	Gyado Villa	20
7.	*Atsusa & Fiidi	14 & 6 respectively
8.	Akpehe	20
9.	Wadata	20
10.	Wurukum	20

*Wards with additional polls for make-up

The 20 targeted respondents could not be polled in Nyiman, Atsusa, and Ankpa Extension wards, as those who live on higher ground in those wards did not experience the flood. The required number was therefore made up with additional polls from Fiidi and Rice Mill wards (see Figure 1.3 in chapter one), the other wards badly affected by the flood but missed out in the original list for the wards to be surveyed.

This poll generated a combined total of about 28,800 coded data values for both the dichotomous and Likert scale coding conventions that were entered into IBM SPSS and analyzed. Details of these analyses are provided in section 3.6.

Although the Likert convention was employed in the design and coding of the questionnaire, some variables were naturally dichotomous and could not be coded in a Likert fashion. These include home ownership. A person is either a homeowner or a renter. Regarding "Place Attachment" arising from place of birth, a person was either born in the community or was not – no middle ground. Although these variables were assigned a "1" (for renters and respondents born outside the community, respectively) and a "4" (for homeowners and respondents born in the community, respectively), they were not considered when run on the Likert scale. Their inclusion as variables for aggregation for the relevant indicator is based on their reliability performance as dichotomous variables. There are, however, three other variables that appeared dichotomous, but which can be tweaked and used as Likert scale variables. They include phone ownership, transportation ownership, and employment status. For instance, a person may not own a telephone but may have access to one, and so this could be run as a Likert scale variable. Fortunately, most of the 200 respondents polled owned mobile telephones during the two periods of interest in this research. Only a comparatively few people did not own phones during the two periods – 15 respondents in 2012 and 12 in 2018. Whether on the dichotomous or the Likert scale, however, the selection of variables as reliable for score aggregation is based on their inter-variable correlation and reliability score performance using a stepwise reduction technique in which variables were dropped one at a time to observe the effect on the Cronbach's alpha (the measure of the reliability). It should be noted, however, that every variable being tested had passed a reliability test in the original research where they were deployed (Cutter et al., 2010). They are being tested again in this study to see how the variables have been represented in the context of the community under study. This argument made thus far for phone ownership also holds for transportation ownership and employment status, as will be shown later.

3.3.5 Data quality control

To ensure quality control, all 76 responses of each respondent and all 200 respondents polled were reviewed for the dichotomous and Likert coding schemes. Each of the entries for the 200 respondents was equally cross-checked to see that they were both appropriately coded and entered. The few missing data points were coded as "999," in which case it would not run on SPSS. Finally, the output results were checked to see that the desired dataset was used as given by the data size.

3.4 Defining indicator variables

A set of the variables used by Cutter et al. (2010) and the proxies for those variables that cannot be applied directly to the community under study (e.g., those variables about immigration, ability to speak English, etc.) were adopted for this study. An additional variable relevant to the community was also added and tested. These variables derive from features that sustain individuals, families, or the community to minimize the effects of disasters in terms of supporting activities of preparedness against disasters while sustaining or supporting recovery efforts.

For this research, the five indicators or forms of capital to be used shall be referred to as "indicators" or "factors" rather than "resilience" to distinguish from the study of Cutter et al. (2010). The fifth indicator shall be referred to as the Community Capital Indicator. As indicated earlier, it is hoped that the indicators and the sub-indicators that define them will capture the differential capacity for the community between the two periods (pre- and post-disaster).

3.4.1 Social Indicator

In the work of Cutter et al. (2010), the sub-indicators for the social indicator of resilience are educational equity, age, access to transportation, communication capacity, language competency, special needs, and health coverage. Proceeding from here, and adapting to the local context in some cases, if a community has high educational attainment; low incidence of the disabled, or household members with mental challenges; high vehicular ownership; ability to speak the local "pidgin" English; high ownership of a telephone line; and health insurance coverage, it will exhibit greater resilience. Therefore, this community is expected to show a change in resilience

by using appropriate variables (or responses) to capture these sub-indicators for the two periods under study. The variables that define these sub-indicators are outlined below:

(i) Educational equity sub-indicator

Those with higher education usually have greater earning power and, by implication, have greater resources to cope with disaster situations.

Table 3.3: Variables defining educational equity

Model	Variable	Effect on resilience
Cutter et al. (2010)	The ratio of the percentage population with a college education to the percentage population with no high school education	Positive
This Dissertation	The ratio of respondents with at least a two-year college (Polytechnic) education to the sample with just a high school Diploma and below.	Positive

(ii) Age sub-indicator

Resiliency depends on agility and strength. Age is very often used to determine the ability of a person to respond and recover quickly from a disaster. Old people are less likely to heed the warning to evacuate in an emergency (Morrow, 2008).

Table 3.4: Variables defining Age

Model	Variable	Effect on resilience
Cutter et al. (2010)	Percent non-elderly population	Positive
This Dissertation	Percent non-elderly of respondents (percent < average age of respondents).	Positive

(iii) Transportation access sub-indicator

Easy access to a vehicle to evacuate family members in emergencies is of immense value.

Table 3.5: Variables defining transportation access

Model	Variable	Effect on resilience
Cutter et al. (2010)	Percent population with a vehicle	Positive
This Dissertation	Percent of respondents who own a vehicle	Positive

(iv) Communication Capacity sub-indicator

Ownership of a telephone line (a GSM mobile phone in the study area) to call for help when needed is valuable.

Table 3.6: Variables defining communication capacity

Model	Variable	Effect on resilience
Cutter et al. (2010)	Population with a telephone	Positive
This Dissertation	Percent of respondents who own a telephone	Positive

(v) Language competency sub-indicator

The ability to communicate in English (a language different from the mother tongue, "pidgin" English in the study area) to call for help is an advantage.

Table 3.7: Variables defining language competency

Model	Variable	Effect on resilience
Cutter et al. (2010)	Percent of population not speaking English as a second language	Positive
This Dissertation	Percent of respondents who can speak Nigerian "pidgin" English	Positive

(vi) Special needs sub-indicator

The frail, elderly, and the very sick or mentally challenged often need the help of family members to get to safety in disaster situations. Relocating these to safer places constitutes an additional burden to families and caregivers.

Table 3.8: Variables defining special needs

Model	Variable	Effect on resilience
Cutter et al. (2010)	Percent population without a sensory, physical, or mental disability	Positive
This Dissertation	Percent of respondents/family members without physical or mental disability	Positive

(vii) Health coverage sub-indicator

Only people in government employment (particularly the Federal Government) have some form of access to health insurance in Nigeria. This leaves the vast majority without health insurance. In any case, the ability to have one's medical bills settled by the Health Insurance Company produces a healthy and resilient community.

Table 3.9: Variables defining health insurance coverage

Model	Variable	Effect on resilience
Cutter et al. (2010)	Percent of population with Health Insurance coverage	Positive
This Dissertation	Percent of respondents with health insurance coverage	Positive

3.4.2 Defining Economic Indicators

This indicator captures assets. The sub-indicators and the variables used in defining them are given.

(i) Housing Capital sub-indicator

Housing capital constitutes part of the wealth portfolio of a person and an asset from which they can derive money. Therefore, ownership of a house enhances a person's ability to access funds and improve the quality of their life.

Table 3.10: Variables defining housing capital

Model	Variable	Effect on resilience
Cutter et al. (2010)	Percent Homeownership	Positive
This Dissertation	Percent of respondents who have home ownership	Positive

(ii) Employment sub-indicator

Employment guarantees earnings. Earning enables people to handle the financial challenges that they face, especially in dealing with disaster situations.

Table 3.11: Variables defining employment

Model	Variable	Effect on resilience
Cutter et al. (2010)	Percent Employed	Positive
This Dissertation	Percent of respondents who are employed	Positive

(iii) Income and equality sub-indicator

Income equality measures equality in the distribution of income in the community. The more equitable the distribution is, the more resilient the community. The GINI index is measured from 0 to 1 and is in inverse relationship with resilience. Since the coefficient and resilience are in inverse relationship (higher coefficient giving rise to lower resilience and vice versa), the resilience index can be determined on a sliding scale by reversing the order. Since both the GINI coefficient and index score are on a scale of 0 to 1, the transpose score of the GINI coefficient will be the resilience index.

For instance, if the GINI coefficient is 0.25, the resilience index will be 0.75 (i.e., 1-0.25).

Table 3.12: Variables defining income and equality

Model	Variable	Effect on resilience
Cutter et al. (2010)	GINI coefficient	Positive
This Dissertation	GINI coefficient	Positive

(iv) Single sector employment dependence sub-indicator

This variable provides the level of diversification of the local economic base. A diversified economic base (different professions) means a more resilient community, but if the economic base is based principally on a single sector like fishing or agriculture, then the community is less resilient (Cutter et al., 2010). The engagement of the community in single-sector employment means that in a disaster situation affecting that sector, for instance, fishing or farming, the community will be deprived of much of its earnings and economic vibrancy. According to Shabu (2013), a sizable population of the community under study is engaged in fishing activities. In this study, fishing and farming were considered as a single sector

Table 3.13: Variables defining single-sector employment dependence

Model	Variable	Effect on resilience
Cutter et al. (2010)	Percent population not employed in farming, forestry, and extractive industries	Positive
This Dissertation	PROXY: Percent of respondents not employed in fishing/farming	Positive

(v) Gender employment sub-indicator

The engagement of women in the workforce is an economic boost to the community

Table 3.14: Variables defining gender employment

Model	Variable	Effect on resilience
Cutter et al. (2010)	Percent female labor force participation	Positive
This Dissertation	The percentage of respondents who are in female labor participation	Positive

(vi) Business size sub-indicator

Large businesses contribute to the economic base and vibrancy of the community and, therefore, its resilience. The reference to a threshold staff size of 3 to measure this variable is purely explorative, emanating more out of knowledge of the Nigerian environment than any existing theoretical framework.

Table 3.15: Variables defining business size

Model	Variable	Effect on resilience
Cutter et al. (2010)	Ratio of large to small businesses	Positive
This Dissertation	(PROXY): Ratio of respondents who owned their businesses and employed at least 3 staff or more to those who also owned their businesses but employed fewer or none.	Positive

(vii) Health Access Sub-Indicator

Health access for populations is traditionally determined by the ratio of the number of doctors to 10,000 of the population and ranges from an average of 2 doctors per 10,000 in Africa to 32 doctors per 10,000 in the European Region. For Nigeria, there are 3 doctors per 10,000 of the population (http://www.who.int/whosis/whostat/EN_WHS09_Table6.pdf). The higher the ratio,

the higher the community resilience. The choices available to most people in Nigeria are either self-medication, consulting a quack, non-professional, or non-orthodox doctor, or consulting a professional. These choices are reflected in the questionnaire. The choice is usually determined by the ability to pay for the services.

Table 3.16: Variables defining health access

Model	Variable	Effect on resilience
Cutter et al. (2010)	Number of physicians per 10,000 population	Positive
This Dissertation	(PROXY): The ratio of respondents who consult a professional doctor at the first signs of ill-health beyond headache and mild fever.	Positive

3.4.3 Defining Institutional Indicators

This measures the contributions of institutions (especially the government) in proofing the community such that disaster risk is reduced, and resilience is enhanced or built. The unbiased method to extract this data is from the respondents themselves. Typically, government officials will claim everything has been put in place to forestall any future flooding, especially if money set aside for such purposes has been diverted or mismanaged.

In the study area, unlike in most developing societies, however, most of these functions are performed by the citizens themselves, either as individuals or as neighborhood groups. Institutional performance here is determined by the satisfaction level of respondents on institutional involvement in disaster mitigation.

(i) Mitigation 1 sub-indicator

Mitigations are actions taken ahead of a natural hazard to circumvent any long-standing risks that it may present to property and the human population (Godschalk et al., 1999). Activities that may be termed hazard-mitigating focus on hindering or reducing the chance of hazards occurring.

Table 3.17: Variables defining mitigation 1 (first mitigation plan)

Model	Variable	Effect on resilience
Cutter et al. (2010)	Percent population covered by a recent hazard mitigation plan	Positive
This Dissertation	The proportion of respondents who are satisfied with every measure the government (Local, State or Federal) and its agencies have put in place to forestall river overflow (e.g., sea walls, building code enforcement, etc.)	Positive

(ii) Mitigation 2 sub-indicator

The CRS (or Community Rating System) is an insurance program that generously reduces insurance premiums depending on the level of participation, particularly to promote safety for communities in the floodplain. Essentially, therefore, CRS is like "saving for a rainy day".

Table 3.18: Variables defining mitigation 2 (second mitigation plan)

Model	Variable	Effect on resilience
Cutter et al. (2010)	Percent of the population participating in the community rating system for flood (CRS)	Positive
This Dissertation	PROXY: Participation in any savings scheme against future disaster	Positive

(iii) Mitigation 3 sub-indicator

Table 3.19: Variables defining mitigation 3 (third mitigation plan)

Model	Variable	Effect on resilience
Cutter et al. (2010)	Percent population in storm-ready communities	Positive
This Dissertation	Percent of respondents in a storm-ready community	Positive

(iv) Mitigation 4 sub-indicator (added)

Occasional drills given to communities on the ways to handle disaster emergencies add an extra layer of safety to populations residing in dangerous zones.

Table 3.20: Variables defining mitigation 4 (fourth mitigation plan)

Model	Variable	Effect on resilience
Cutter et al. (2010)	Not applicable	Positive
This Dissertation	Percent of respondents who have received drills on what to do and how to act in the event of a flood disaster	Positive

(v) Flood Coverage Sub-Indicator

Flood coverage refers to insurance plans that pay back in times of flood damage. or other plans by government agents to reduce vulnerability and recoup losses if and when they occur.

Table 3.21: Variables defining mitigation 5 (fifth mitigation plan)

Model	Variable	Effect on resilience
Cutter et al. (2010)	Percent of housing units covered by NFIP (National Flood Insurance Policy) policies	Positive
This Dissertation	Percent of respondents who think that their house is covered against loss by government plans	Positive

(vi) Municipal services sub-indicator

As discussed in Chapter Two, these are first responder roles.

Table 3.22: Variables defining participation of first responders

Model	Variable	Effect on resilience
Cutter et al. (2010)	Percent municipal expenditures for fire, police, and EMS	Positive
This Dissertation	Percent of respondents participating in a volunteer first-responder or vigilante group	Positive

(vii) Political fragmentation sub-indicator

As discussed in chapter two, ethnic fragmentation tends to create distrust, while uniformity of customs, tradition, and language favors community cohesion for greater resilience.

Table 3.23: Variables defining ethnic fragmentation

Model	Variable	Effect on resilience
Cutter et al. (2010)	Number of government and special districts	Negative
This Dissertation	(PROXY) Proportion of respondents that are Tivs, Idomas and Igedes	Positive

(viii) Previous disaster experience sub-indicator

When people receive compensation for damage suffered, it tends to make life better for them and enhance their ability to pull out of the situation. While the insurance and federal agencies occasionally compensate victims of flood disasters in the US, it is not so in many developing countries, including the study area. Often, money meant for disaster victims never reaches them but is misappropriated by government officials. Those who suffer damages expend personal resources to rebuild.

Table 3.24: Variables defining previous disaster experiences

Model	Variable	Effect on resilience
Cutter et al. (2010)	Number of paid disaster declarations	Positive
This Dissertation	PROXY: Percent of respondents that have had to rebuild	Positive

(ix) Mitigation and social connectivity program

This involves a locally organized and mobilized group of volunteers trained to support first responders in emergencies. In the U.S., the Citizens Corps, launched in January 2002, fulfills this role.

Table 3.25: Variables defining mitigation and social connectivity

Model	Variable	Effect on resilience
Cutter et al. (2010)	Percent of population covered by the Citizen Corps Program	Positive
This Dissertation	PROXY: Percent or proportion of respondents who know at least one volunteer group (whether in the Church, Mosque, schools, or in the community) dedicated to helping as a group in times of disaster	Positive

3.4.4 Defining an infrastructural indicator

An infrastructure indicator appraises the community's capacity to respond to and recover from disaster (shelter, healthcare facility, etc.). It takes stock of what is available if disaster response and recovery are required.

(i) Housing type sub-indicator

Housing type will indicate the strength of such structures and their ability to withstand adverse conditions like flooding. In the U.S., mobile homes and homes built before the mandatory building codes were enacted fall into this category (Cutter et al.,

2010). In the study area, shanty houses and other substandard buildings also fall into this category. The variables have been adapted from Cutter et al. (2010).

Table 3.26: Variables defining housing type

Model	Variable	Effect on resilience
Cutter et al. (2010)	Percent housing units that are not mobile homes	Positive
This Dissertation	Percent of houses of respondents that are NOT shanties	Positive

(ii) Shelter capacity sub-indicator

Emergency shelters are expedient arrangements to protect victims of disasters when they strike, even though they offer few resources as support (Tierney, 2009). Whether constructed in anticipation of floods, tornadoes, or hurricanes, they usually do not offer much in terms of living or survival support beyond a couple of hours. The length of stay in such facilities, however, depends on the degree of damage that their real homes have suffered.

The shelter capacity determines how many displaced people can be sheltered conveniently. The most common places available for emergency shelters in the study area are elementary and secondary school premises, away from the flood-vulnerable zones.

Table 3.27: Variables defining shelter capacity

Model	Variable	Effect on resilience
Cutter et al. (2010)	Percent of vacant rental units	Positive
This Dissertation	PROXY: Percent of respondents that can find a free place of shelter (homes of family members, relatives, or strangers; schools, hotels, etc.) outside the flood zone	Positive

(iii) Medical Capacity

This is about the medical facilities available to tend to those who may need help in an emergency. The more hospital beds per 10,000 people, the quicker the recovery and hence, resilience.

Table 3.28: Variables defining medical capacity

Model	Variable	Effect on resilience
Cutter et al. (2010)	Number of hospital beds per 10,000 of the population	Positive
This Dissertation	PROXY: Number of new hospital facilities since the incident.	Positive

(iv) Access/Evacuation potential sub-indicator

This is the ease with which people who need emergency help can be evacuated more easily from the flooded zone in the event of an incident. The more ingress and egress accessible to a community, the less vulnerable and more resilient the community.

Table 3.29: Variables defining access/evacuation potential

Model	Variable	Effect on resilience
Cutter et al. (2010)	Principal arterial miles per square mile	Positive
This Dissertation	PROXY: Percent of respondents whose houses are at the most 1 km of the main arterial road.	Positive

(v) Housing age sub-indicator

The older the house, the more vulnerable it is in a flood, and the less resilient the community. Conversely, the younger the house is, the less vulnerable and more resilient the community.

In general terms, in many Nigerian cities, the older residential houses appear to do better than the relatively more modern ones. According to Oloyede et al. (2010), there

have been alarming incidences of collapsed buildings in recent years in Nigeria's major cities of Lagos, Abuja, and Port Harcourt, leading to loss of lives. It would then make sense to assume that residential houses built a couple of decades earlier will withstand more stress than the recent ones. However, dual consideration was applied to the study site (Makurdi) given their continual experiences with flooding, which may indeed affect the quality of houses. This was done to conform to the general expectation of older houses being weaker than newer ones. Therefore, in one case, houses built before 1990 were assumed stronger, and in the other case assumed weaker, and their reliability as variables of infrastructural resilience was tested. In the data analysis, coding with the newer houses as being more resilient produced relatively better reliability.

Table 3.30: Variables defining housing age

Model	Variable	Effect on resilience
Cutter et al. (2010)	Percent of housing units not built before 1970 and after 1994	Positive
This Dissertation	PROXY: Percent of houses built after 1990	Positive

(vi) Sheltering needs sub-indicator

This provides public space in times of emergency for those who may not have alternative private shelters within a distance of easy reach.

Table 3.31: Variables defining sheltering need

Model	Variable	Effect on resilience
Cutter et al. (2010)	Number of hotels/motels per square mile	Positive
This Dissertation	Percent of respondents who know at least one new emergency shelter they can run to before temporary ones are erected	Positive

3.4.5 Defining Human Capital Indicator

As discussed in chapter two, three key social psychological dimensions of social capital are targeted for capture by this indicator, viz, citizen participation, place attachment, and sense of community.

(i) Place attachment 1 sub-indicator

This arm of place attachment measures the net flow of persons into or out of the State, County, or Community. Usually, a positive inflow is to the advantage of the community, while a negative flow works against it.

Table 3.32: Variables defining place attachment 1 – the net flow of persons

Model	Variable	Effect on resilience
Cutter et al. (2010)	Net International Migration	Positive
This Dissertation	PROXY: The net flow of residents into or out of the community. The proportion of respondents who think that the net flow of residents for the community is positive.	Positive

(ii) Place attachment 2 sub-indicator

This arm of place attachment measures the population born in the state or community and has remained.

Table 3.33: Variables defining place attachment 2 – birth and long-term residency

Model	Variable	Effect on resilience
Cutter et al. (2010)	Percent of the population born in a state who still reside in that State	Positive
This Dissertation	The proportion of residents who were born in the community or State and have remained in the community	Positive

(iii) Political engagement sub-indicator

Table 3.34: Variables defining political engagement

Model	Variable	Effect on resilience
Cutter et al. (2010)	Percent voter participation in the 2004 election	Positive
This Dissertation	The percent voter participation in the last (2015) election	Positive

(iv) Social capital 1 sub-indicator – Religion

Capturing social capital can be achieved through proxies like religion (Cutter et al., 2010). Often, adherents of religion socialize with others, thereby forming bonds that foster a sense of community and, ultimately, resilience.

Table 3.35: Variables defining social capital 1 - religion

Model	Variable	Effect on resilience
Cutter et al. (2010)	Number of religious adherents per 10,000 population	Positive
This Dissertation	Proportion of respondents belonging to a religious organization	Positive

(v) Social capital 2 sub-indicator – civic involvement

Social capital can also be captured through the various civic organizations that thrive in the community, all of which are geared towards a healthy neighborhood through voluntary participation.

Table 3.36: Variables defining social capital 2 – civic involvement

Model	Variable	Effect on resilience
Cutter et al. (2010)	Number of civic organizations per 10,000 population	Positive
This Dissertation	Proportion of respondents who belong to a social club	Positive

(vi) Social capital advocacy sub-indicator

This sub-indicator can be captured through the various organizations that may be involved in fundraising in times of disaster or for any vulnerable group in the community (Murphy, 2007).

Table 3.37: Variables defining social capital 3 – advocacy involvement

Model	Variable	Effect on resilience
Cutter et al. (2010)	Number of social advocacy organizations per 10,000 population	Positive
This Dissertation	Number of social advocacy organizations	Positive

3.5 The Procedure

It is noteworthy that there are TWO parts to the data analysis in this study. The first part deals with the analysis and aggregation of a composite indicator for the community just before or at the point of the 2012 flood disaster, while the second part deals with the analysis and aggregation of indices at the time of the survey in Summer 2018. However, the same procedure will be followed in arriving at a composite index for the two cases. For this study, the composite index (final aggregation of indices) for either party shall be termed "metric". The flow diagram for the build-up of the composite index (metric) is given in Figure 3.1.

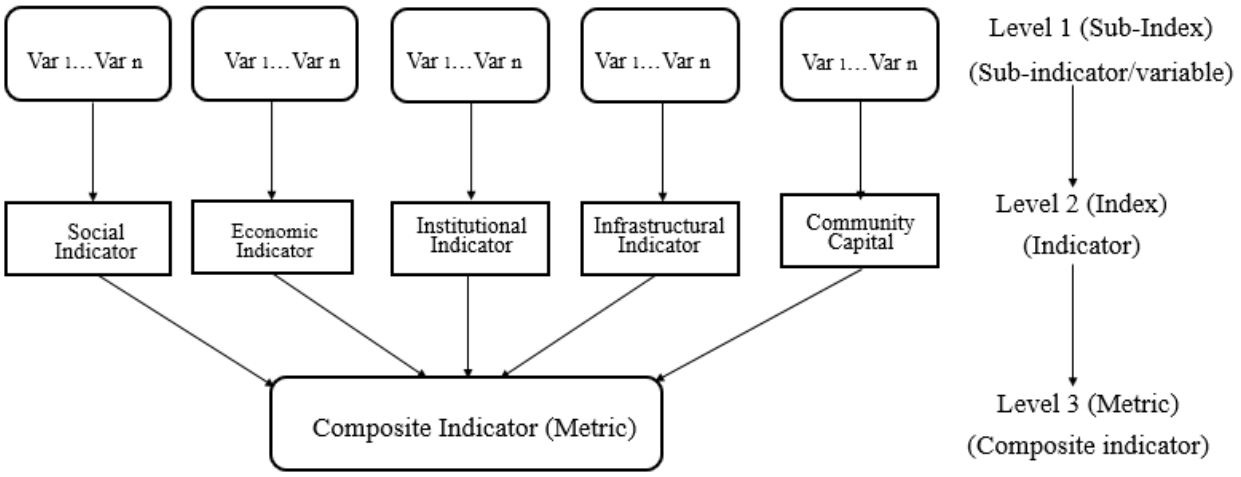

Figure 3.1: Flow chart for computation of composite indicator from the resilience indicator variables (Source: Author)

Most of the variables used in this research have been adapted from the existing research, principally that of Cutter et al. (2010), because of greater ease of adaptability to the local community, and to a lesser degree, Mayunga (2009) only to the extent that there are some commonalities between Cutter et al. (2010) and Mayunga (2009). It should be noted that some of the survey questions presented to respondents required YES/NO answers and as noted earlier, could not be framed in a Likert fashion, while the bulk of them were on a Likert scale (Appendix A). This presented a slight problem of either scaling up the dichotomous responses to mimic the Likert scale for standardization of the analyses or scaling down the Likert responses to a dichotomous scale. However, both methods were used and compared in the reliability analyses (Chapter Four). In either case, the proportions/ratios or percentages of the desired responses for measuring a variable in question were noted. For variable selection, it is necessary to analyze the variables for possible significantly high correlations between individual variables. This can be determined by the reliability analysis offered by Cronbach's Alpha. According to Twycross and Shields (2004, p.36), as cited by Adefioye (ND):

> *"Reliability refers to the consistency, stability, and repeatability of results, i.e. the result of a researcher is considered reliable if consistent results have been obtained in identical situations but different circumstances".*

Validity is defined by Thatcher (2010, p.124) as:

> *"The extent to which any measuring instrument measures what it is intended to measure". In other words, "validity means that a tool measures what it sets out to measure"* (Twycross & Shields, 2004, p.28).

A test can only be valid if it is reliable. Thus, a test that is valid must be reliable to ensure accurate results and conclusions (http://www.statisticssolutions.com/regression-analysis-validity/).

IBM SPSS was used to analyze the reliability of the chosen variables to define the FIVE resilience indicators – Social, Economic, Institutional, and Infrastructural indicators, and Community capital. It is noteworthy that because the data used in this study was obtained largely by survey (primary data), the units of the variables measured differ significantly from those in Mayunga (2009) and Cutter et al. (2010), where secondary data were used. For instance, "the number of religious adherents per 10,000 population" used as a variable for "social capital – religion" to determine Community capital in Cutter et al. (2010) was given as a simple proxy ratio (number per sample) in this study.

The assigning of binary scores of 1/0 for YES/NO responses by respondents depends on the contribution of the response to resilience. In other words, if a YES answer will enhance resilience from the theoretical framework provided for the variable, it is assigned a "1". However, if it will diminish resilience, it is scored a "0". Listed below are the scoring formats for the variables analyzed in the study. In the case of the Likert scale (Appendix A), a scale of 1 to 4 is adopted from the lowest weight to the highest, while the NO and YES on the Likert scale were assigned 1 and 4 weights, respectively, as earlier indicated but excluded when run with 1 to 4 scale variables. Appendix A shows how the Likert scale was adapted for analyses for the dichotomous scale. However, the dichotomous coding given below serves as a general guide when applied without adaptation from the Likert scale.

(i) Variables for Social Indicator

1. Education: ≥ Diploma (National Diploma, ND) = 1; < ND = 0
2. Age: Elderly (> average age) = 0; non-elderly (< average age) = 1
3. Transportation: Ownership of vehicle = 1; non-ownership = 0
4. Telephone: Ownership = 1; non-ownership = 0

5. Language: Speaking “pidgin” English = 1; non-speaking = 0
6. Physical/mental challenge: Challenged = 0; Not challenged = 1
7. Health Insurance: Insured = 1; Not insured = 0

(ii) Variables for Economic indicator

1. Home ownership: Ownership = 1; Rent = 0

2. Employment: Employed = 1; Not employed = 0
3. Income and Equity (PROXY: GINI coefficient)
   The actual computation of the GINI coefficient from the income distribution of all respondents using an Excel spreadsheet is discussed in Chapter Four
4. Single sector employment: Profession other than fishing/farming = 1,
   Fishing/farming = 0
5. Gender employment: Employed female = 1,
   Unemployed female/employed or unemployed male = 0
6. Business size: Own business with at least 3 staff = 1,
   Own business with less staff/No own business = 0
7. Hospital consultation: Pharmacist/Orthodox doctor = 1
   Traditional doctor/self-medication, etc. = 0

(iii) Variables for the institutional indicator

1. Government Assessment: Govt doing enough = 1; Not doing enough = 0
2. Savings participation: Saving = 1; Not saving = 0
3. Flood readiness: Flood ready = 1; Not flood ready = 0
4. Flood-readiness drills: Received = 1; Not received = 0
5. Government loss-coverage/compensation: Expecting compensation = 1
   Not expecting compensation = 0
6. First responders: Participating = 1; Not participating = 0
7. Ethnic composition: Tiv/Idoma/Igede = 1; Jukun and other tribes = 0

8. Rebuilding after previous flood: ≤ one-time rebuilding = 1,
   > one-time rebuilding = 0
9. Volunteer groups in the community: No volunteer groups = 0, ≥ 1 = 1

(iv) Variables for infrastructural indicator

1. Housing type: Not considered shanty = 1; Considered shanty = 0
2. Availability of free (family/relative/friend) Shelter in flood situations:
   Can find free shelter = 1; Cannot find free shelter = 0
3. New hospital since incident: ≥ 1 new hospital facility since incident = 1,
   No new hospital facility since the incident = 0
4. Distance from evacuation access road (s): ≤ 1 Km = 1; > 1 km = 0
5. Housing year: Built before 1990 = 0; Built after 1990 = 1
6. Emergency shelter within reach: None = 0; ≥ 1 = 1

(v) Variables for the Community capital indicator

1. Net flow of residents into community: Positive net flow = 1
   No change/Negative net flow = 0
2. Place of birth: Within state or community = 1; Out of state = 0
3. Participation in previous election: Participation = 1; non-participation = 0
4. Religious affiliation and participation: Participation = 1; non-participation = 0
5. Social club membership: Belonging = 1; Not belonging = 0
6. Social advocacy organizations: None = 0; ≥ 1 = 1
7. Education level: College/University degree and above = 1,
   Less than College/University degree = 0

The data entry into the IBM SPSS spreadsheet for reliability analysis is similar to Tables 3.36 and 3.37 for the dichotomous and Likert coding conventions, respectively.

Table 3.38: Reliability analysis using the dichotomous coding for variables (m = sample size; n = number of variables for the indicator being considered).

Respondent	Indicator variable						
	Var1	Var 2	Var 3	.	.	.	Var n
Respondent 1	1	1	0	.	.	.	0
Respondent 2	0	1	0	.	.	.	1
Respondent 3	1	1	1	.	.	.	0
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
Respondent m	0	0	1	.	.	.	1

Table 3.39: Reliability analysis using the Likert scale coding for variables (m = sample size; n = number of variables for indicator being considered).

Respondent	Indicator variable						
	Var1	Var 2	Var 3	.	.	.	Var n
Respondent 1	1	3	1	.	.	.	2
Respondent 2	4	1	1	.	.	.	2
Respondent 3	2	4	3	.	.	.	3
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
Respondent m	3	4	1	.	.	.	4

The reliability analyses are then run for the different groups of variables for both the dichotomous and the Likert scales, and variables are retained or dropped/discarded depending on the outcome of a combination of the inter-variable correlations and Cronbach's alpha values as indicated in Chapter Two. However, since this is exploratory research, extreme caution is exercised so as not to throw the baby out with the bathwater, especially as these variables have

been deployed successfully in earlier research. We now proceed with the analyses in the next section.

3.6 Analysis of Field Data

There are two kinds of analyses in this section – the reliability analysis of the indicator variables and the analysis of the Lorenz curve to determine the GINI index, a measure of community income equity.

3.6.1 Reliability analysis

Before the variables to be used to compute the desired composite index can be used, it is very important to carry out the reliability analysis. Thus, Cronbach's Alpha (a measure of the reliability of a suite of variables) estimates the internal consistency accompanying a composite score. Reliability is important because, when absent, it is not possible to have any kind of validity associated with the scores derived or indexed. Fundamentally, Cronbach's Alpha assists us in determining whether our interpretation of the aggregated scores is justifiable.

If, for instance, the Cronbach's Alpha is determined to be 0.60 for a group of variables from which a composite score is obtained, it means that 60% of the variability (and by implication variance) in that composite score should be considered a true score variance or internally consistent reliable variance while the error variance is 40%. From the discussion on the section on reliability assessment in Chapter Two, it is almost certain that the criterion to determine a universally acceptable level of reliability has not been thoroughly resolved. In the subsequent sub-sections, the reliability analyses and associated Cronbach's Alpha for the scores to be obtained from these resilience indicators, namely, Social, Economic, Institutional, Infrastructural, and Community Capital, are discussed for the two different years or periods involved in this study.

3.6.1.1 Reliability Analysis for Social Indicator Variables

The reliability test for the variables to determine the social indicator component of resilience was conducted at two levels (the dichotomous and Likert scales), and for the two different years (2012 and 2018). Being explorative research for which there are no earlier studies of this nature to refer, a lot of tweaking and trial modifications in the coding scheme and structural

change to a few questions and applicable responses were carried out. For example, different results on Cronbach's alpha were obtained when the coding convention for relative age below and above the Mean was switched. Assigning a 1 to the age below the average and a 0 to the age above it raised Cronbach's alpha (and consequently reliability) from 0.37 to 0.44 for the 2012 data and from 0.32 to 0.51 for the 2018 data. The Age (the younger and older folk) and Special Needs variables were dropped for not meeting the inter-item correlation condition of 0.20 to 0.70 (Ferkekitch, 1991). Doing so raised alpha values from 0.44 to 0.52 (dichotomous scale) and from 0.50 to 0.59 (Likert scale) for the 2012 data and from 0.51 to 0.55 (dichotomous scale) and 0.38 to 0.58 (Likert scale) for the 2018 data. Thus, the Likert scale coding convention produced better alpha values than the dichotomous coding scheme for the social indicator. The maximum attainable Cronbach's Alpha using Likert scale coding for the two different years were 0.64 and 0.68, respectively. Following the arguments in Chapter Two on reliability analysis that values approaching 0.70 are acceptable, and particularly that of Schmitt (1996) that even a low value may also be useful, five variables are therefore retained in this class for social resilience, viz: Education, Communication ability, Health Insurance, Transport ownership, and Phone ownership.

3.6.1.2 Reliability analysis for economic indicator variables

The reliability test for the economic indicator variables produced a somewhat different outcome from that of the social indicator variables. While the dichotomous coding convention produced better (higher) reliability results than the Likert scale convention for the 2012 data, the converse was the case (the Likert scale doing better) for the 2018 data. This is rather surprising given the fact that the questions were the same for the two years, except that the responses sometimes differed. This may suggest that the distribution of survey responses may determine the appropriate method of analysis.

Using the dichotomous coding convention for the 2012 data, Cronbach's alpha for the Economic indicator variables increased from 0.62 to 0.70 when House Ownership and Health Insurance variables were removed from the analysis as dictated by the application program (IBM SPSS) and the inter-item correlation condition. However, using the Likert scale convention, House Ownership and Business Ownership failed the test, and their removal increased Cronbach's alpha from 0.49 to 0.73. Regarding the 2018 data, the analysis failed abysmally using the dichotomous scaling scheme as Cronbach's alpha increased only marginally from 0.35 to 0.38 with the removal

of the House Ownership and Health Insurance variables, whereas the Likert scale attained the 0.70 reference only with the removal of House Ownership, Business Ownership and Health Insurance variables. Further analyses using the female sample (to determine the reliability and relevance of the Female Employment variable) raised the dichotomous alpha value for 2012 data from 0.70 to 0.85 and the Likert scale data for 2018 from 0.70 to 0.72.

It can be seen from these analyses that both the dichotomous scale and the Likert scale are relevant for the reliability analysis in the case of the Economic Indicator variable. Combining the analyses for the survey sample and for the female sample, the following variables are retained for the Economic indicator: Employment Status, Sector Employment, Business Ownership, and Female Employment. Although Home Ownership may be viewed as a veritable indicator of economic well-being, it could not pass the reliability test in this study, apparently due to a preponderance of renters over homeowners, which appears to be the hallmark in developing or third-world economies.

3.6.1.3 Reliability analysis for institutional indicator variables

All nine variables initially proposed for this indicator were subjected to the reliability test using both the dichotomous and the Likert coding schemes. It was found that using the dichotomous scale for the data for the two years produced relatively higher Cronbach's alpha and better reliability than the Likert scale coding convention. While the dichotomous scale increased Cronbach's alpha from 0.42 to 0.56 with the removal of three variables – Savings Scheme Participation, Storm Ready, and Rebuild Experience – the Likert scale only increased it from 0.42 to 0.47. Thus, the variables retained are First Responders, Number of Volunteer Groups, Drills, Ethnic Fragmentation, Satisfactory Government Action, and Government Coverage, especially as they meet the other conditions of inter-item correlation between 0.20 and 0.70.

3.6.1.4 Reliability analysis for infrastructural indicator variables

Although the variables in this group were some of the easiest to define in the Likert format, the dichotomously scaled data produced far higher Cronbach's alpha values than the Likert-scaled data. The initial run of the reliability test on the Likert scale data for the two years was so poor (low) that further runs with fewer variables were not even considered. Even though the dichotomous data produced a relatively low (concerning the 0.70 reference) value that increased

from 0.22 to 0.44 with the removal of the "Age of Building" variable, the consideration of their inter-item correlation justifies their inclusion. Although the literature suggests that the age of buildings should be important in their resilience, it has been excluded in this analysis because of the stringent reliability conditions that we have imposed. Thus, Family Shelter, Access to Exit, Strength of House, Emergency Shelter, and New Hospital Facility are the variables considered for inclusion in this group.

3.6.1.5 Reliability analysis for community capital variables

The reliability analysis for this group of variables presented a rather strange behavior and perhaps revealed some hidden information about this kind of research. Although the survey for the two years was polled at the same time and with related questions for each of the two years, Cronbach's alpha (and consequently the reliability) determined for the first year (2012) was too low (about 0.10) to be given thoughtful consideration. Besides, the inter-item correlation was negative for many of the pairs, which violates the reliability model assumptions. However, the second year (2018) produced better and more reliable inter-item correlation, with Cronbach's alpha increasing from 0.26 to 0.52 for dichotomously coded data with comparable results (from 0.27 to 0.50) for the Likert scale data. Applying these strict conditions, however, only three out of the six earlier proposed variables – Political Participation, Club Membership, and Religious Participation – could be retained.

On closer observation, however, it will be noted that "Birthplace" as a community capital, which was dropped for failing the reliability test, is perhaps the strongest of all the "community spirit" and ought to be retained. This is because Cronbach's alpha as a statistic is a function of both the number of items to be tested and the mean intercorrelation among the items. Thus, where there is a low correlation between items irrespective of their contribution to resilience, there will be a correspondingly low Cronbach's alpha and, consequently, reliability.

Both literature and human experience suggest that people usually develop strong ties to the place of their birth. There is no greater proof of this than the fact that in the community under study, some people who were born in that community have lived there for as much as 70 years – literally for all of their lives. So, they know nowhere else. However, using the length of residence time as a proxy for the "Birthplace" variable for those born in the community or state did not produce a better Cronbach's alpha. The importance of this variable is so obvious in measuring

attachment to one's place of birth that it is immortalized in this popular song that has been passed down through generations virtually throughout all cultures, telling us about home attachment and homesickness:

Oh, my home, Oh my home
Oh, my home, Oh my home
When shall I see my home
When shall I see my native land
I will never forget my home.

For the foregoing reasons, "Birthplace" is being added as one of the retained variables. This addition will not bias results since it is being added to both years in the metrics computation. The variables dropped from the suite of variables to compute this indicator are, therefore, the Net flow of residents, number of advocacy groups, and creativity, while four are retained – Political Participation, Club Membership, Religious Participation, and Birthplace.

Future questions to capture birthplace as a community spirit should, therefore, look beyond simply whether a person was or wasn't born in a place but focus on developing questions that capture the fact that if they were born in the place, what ties do they have to the place or community?

3.6.2 Computing the GINI Coefficient

The GINI index (Figure 3.2) is computed using the Lorenz curve

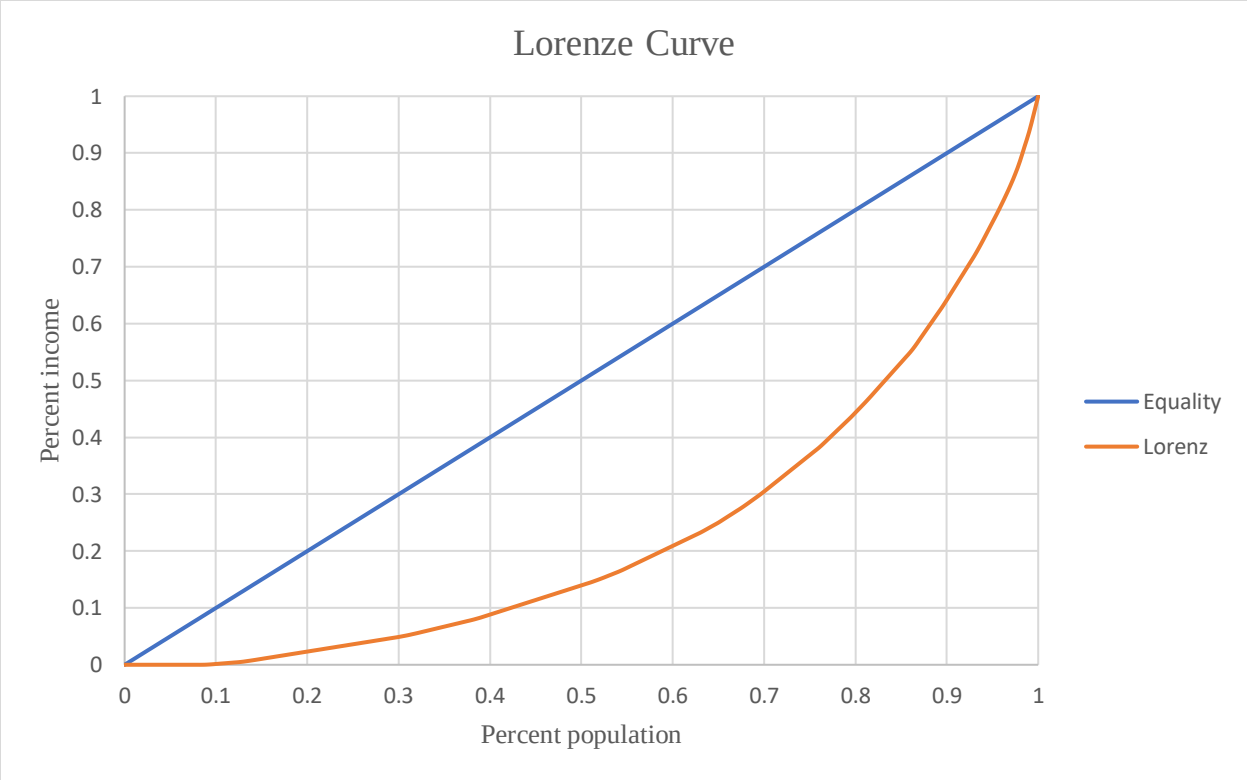

Figure 3.2: Income inequality measurement for the study community using the Lorenz curve (Source: Author)

The GINI index measures income inequality in the community. On a scale of 0 to 1, a lower GINI index corresponds to lower income inequality and a higher resilience index. The GINI Index is given by the area between the two curves divided by the area under the equality curve (0.5). Using an Excel spreadsheet, the GINI index for the community in 2012 was computed to be 0.5300, while for 2018, it was computed to be 0.5154. Thus, income inequality was higher in 2012 than in 2018. Conversely, the resilience index (1-0.5300 = 0.4700) was lower in 2012 than in 2018 (1-0.5154= 0.4846).

3.7 Weighting, Rescaling, and Aggregation of Scores

The measuring variable for the bulk of the variables in the dataset is defined by "ratio of …", "proportion of …", and "percent" of the item of interest. These are values reducible to decimals between 0 and 1 and are the sub-indices for the sub-indicators or variables (see Figure 3.1). The GINI coefficient for determining income inequality falls within this category and can easily be added to the other sub-indices. The variables that are given in the number 'counts' on the Likert scale define the proportion of respondents who hold the opinion that these numbers were relevant to the variable referenced. For instance, "number of volunteer groups" for computing the Institutional Resilience, or "number of new hospitals" for calculating the infrastructural index. Recognizing that the different numbers existed regarding the variables contributed to community resilience, irrespective of what the numbers were. The same argument is extended to the proportion of respondents who believed that "some number" existed (e.g., volunteer groups, new hospitals, etc.) and contributed to resilience when compared to those who believed "none" existed or did not know that any existed.

Given that there are five indicators of interest, the process is repeated for all the other FOUR (represented by "level 2" in Figure 3.1). However, since each variable is scored between 0 and 1, each indicator score will now depend on the number of variables used to determine its index. This means that for perfect scores, an indicator determined from 5 variables will score a 5.0, and one determined from 10 variables will have a 10.0. To reduce all indicators to the same scale, they will be rescaled on a sliding scale of 0 to 1 (equivalent to taking the averages). So, the maximum index for an indicator can only be 1. Finally, aggregating all these five indices will produce a single value for the composite indicator or metric (Figure 3.1) with a maximum value of 5. By obtaining two metric values for the community, one for up to the point of the flood and the other at the point of the 2018 survey, the scores can be compared. Depending on which number is higher, it can now be statistically tested (at an α-level of 0.05) to know whether the community is worse off in terms of its resilience before the flood or after it.

3.8 The step-by-step procedures for calculating the sub-indices and Composite Index (Metric)

The steps to follow in the computation of sub-indices and the Community Flood Disaster Resilience Index (CFDRI) are as follows:

(i) Step 1: Select the variables using the reliability analysis and other methods outlined in the "recommendations" in Chapter Four.

(ii) Step 2: After variables have been selected, sum the "proportions", "ratios", and "percentages" used as indicators measuring variables for the indicator in question (using the simple linear summation aggregation of Vincent (2004)).

However, because the number of variables differs for the different indicators, the minimum-maximum rescaling method (Freudenberg, 2003; Nardo et al., 2005) from 0 to 1 is used to standardize or normalize them. This is now the sub-index for the indicator in question (i.e., Social, Economic, Institutional, Infrastructural resilience, or Community capital).

(iii) The Community Flood Disaster Resilience Index (CFDRI) or Composite Index (Metric) score is then obtained by the summation of all scores for the resilience indicators as given below:

CFDRI = SI + EI + INI + IFI + CC, Where

SI = Social Indicator sub-index

EI = Economic Indicator sub-index

INS = Institutional Indicator sub-index

INF = Infrastructural Indicator sub-index

CC = Community capital sub-index

3.9 Analyses to Answer the Research Questions

It is important to reiterate that the underlying reason for this data through the survey is two-fold. One is to take care of fine-grained data requirements at the community level that may not be obtained in most databases, particularly in a third-world environment. Even in the developed

world, data may not exist at the community level in some situations, thereby necessitating the use of county data to represent interactions that occur at the community level. This may lead to misleading results regarding community resilience. Two, when deployed at the community level, it can be used to monitor a community's resilience over time and can be used to determine what areas of development a community may need intervention. It can also be used to compare two different communities.

This community survey helps to answer the research questions, namely, Research Question 1 (RQ_1): **"To what extent has resilience changed over the five-year period since the flood?"**

Obtaining the mean Community Flood Disaster Resilience Index (CFDRI) for the community over two time periods, μ1 and μ2, enables us to conduct t-tests to determine whether there is a statistically significant difference between these means of the same sample of resilience indicators when the sample size is small. The hypothetical population (of all possible indicators) standard deviation is unknown. Since we are comparing the means of the same indicators for the community at different times (at the flood occurrence and five years after), we deploy the Paired Sample t-test in our analysis.

The Mean of the differences (D) is given

$$D_{\mu} = \frac{\sum D_i}{n}$$

The standard deviation of the differences (δ) is:

$$\delta = \sqrt{\frac{(D_i - D_{\mu})^2}{n-1}}$$

The Paired Samples t-test is given by:

$$t = \frac{D_{\mu}}{\delta/\sqrt{n}}$$

where:

D_i = Difference for each indicator ($X_{2012} - X_{2018}$)

D_{μ} = mean of the differences between paired observations

δ = standard deviation of the differences

n = number of paired observations (same for both conditions)

We then set up the null hypothesis:

Null Hypothesis (H_0): There is no significant difference in the Mean of the community resilience indicators at the time of the flood and five years after the flood.

$$\mu_D = 0$$

Alternative Hypothesis (H_1): There is a significant difference in the Mean of the community resilience indicators between the two periods.

$$\mu_D \neq 0$$

where μ_D represents the mean differences between the paired indicator values.

Research question 2 (RQ_2) – **"To what extent did the experiences gained from previous flood events contribute to a community's present state of resilience or lack of it?"** – is also answered from the survey using three questions that were posed to the respondents, namely:

(i) Will you say that the community can cope better with that level of flood if it ever occurs again? YES or NO, and the second question is

(ii) Do you think that your answer is due to the number of years you have lived here, in other words, your experience with floods? YES or NO

(iii) How many years have you lived in the community?

These questions are posed to determine the corporate perception of the community to flood disaster resilience, as "perception" is so often discussed in disaster literature. The aim is to test whether the "perception" of resilience is something we can rely on. Although the question posed to respondents is futuristic, it also addresses the "now" (as the RQ suggests). This is because dealing with a future flood disaster will draw from the existing corporate or community resilience, which has not improved at the time this survey was conducted (the summer of 2018).

Here, Logistic Regression is being applied. The logistic regression is chosen because a qualitative (or categorical) response is being analyzed as the dependent variable, namely the "Perceived Resilience Status" (at least at the point of the survey and going forward), in which there are only two outcomes (resilient or non-resilient). The Logistic regression equation for multiple independent variables is given by:

$$\text{Log}_e \left[\frac{P(y=1)}{P(y=0)}\right] = \beta_0 + \beta_1 \mathbf{X}_1 + \beta_2 \mathbf{X}_2 + \beta_3 X_3 + \ldots + \beta_k \mathbf{X}_k \quad \text{where,}$$

βi = Change in log-odds for every one-unit increase in **X**i, holding all other **X**'s constant.

For three independent variables, this reduces to:

$Log_e = \beta_0 + \beta_1 \mathbf{X}_1 + \beta_2 \mathbf{X}_2 + \beta_3 \mathbf{X}_3$

β_0, β_1, and β_3 are estimated from survey data.

P(y=1): Probability of y belonging to the category coded y=1

P(y=0): Probability of y belonging to the category coded y=0.

y = Perceived Resilience outcome (1, 0) (Captured in question 1 on the supplementary list of Appendix A as YES =1, NO = 0)

$\mathbf{X}_1$ = Opinion or "thinking" of the respondent

$\mathbf{X}_2$ = Number of years of residence in the community of the respondent

$\mathbf{X}_3$ = Sex (Male = 1, Female = 0)

Wald's Chi-square statistic test is used to test the β's, whether the predictor variables $\mathbf{X}_1$, $\mathbf{X}_2$, and $\mathbf{X}_3$ are significant.

Using the odds ratio:

$e^{\beta i} = \frac{\text{odds after 1-unit change in X1}}{\text{original odds}} = \frac{P'(y=1)}{P'(y=0)} \Big/ \frac{P(y=1)}{P(y=0)}$ (useful for qualitative variables)

and $e^{\beta i} - \mathbf{1}$ (useful for quantitative independent variables)

IBM SPSS is used to generate $e^{\beta i}$, which is useful for interpreting qualitative independent variables (male or female, and the opinion in this case), while $e^{\beta i} - \mathbf{1}$ is useful for interpreting quantitative independent variables (experience or number of years of residence in the community). Consequently, the number of years of residence in the community (proxy for experience of previous flood events) and gender can be used to determine their roles or contribution to the dependent variable, the perceived resilience.

Conducting a hypothesis test and rejecting the null hypothesis will indicate that the logistic regression model can be used to provide useful predictions about y, the Community Perceived Resilience. Detailed results will be presented in Chapter Four.

The third research question, Research Question, RQ_3 wants to ask **"What specific indicators and variables in the light of the study can best be used to determine a community's level of resilience?"** Here, the reliability analysis employing the inter-variable correlation and Cronbach's alpha is used to determine the variables for aggregating the resilience metric. Considering the rigorous screening involved in the variable selection, these variables will form the core of variables to determine flood resilience metrics for this community and possibly other communities near and distant from it.

3.10 Summary

This chapter has presented the five resilience indicators – social, economic, institutional, infrastructural, and community capital – and the sub-indicators/variables used to determine them in the research study from which this dissertation has been adapted, namely, Cutter et al. (2010). It has also presented the variables employed in this study to study the Community Flood Disaster Resilience Indicator (CFDRI). Some of these variables are context-based. Also, the step-by-step data collection and analysis techniques, variable selection, and aggregation of variable scores were given. The chapter also employed survey and data analysis techniques to answer the research questions presented.

In the next chapter (Chapter Four), actual results obtained using field (survey) data will be presented, and hypothesis testing will be performed in detail to determine the resilience state of the community under study.

CHAPTER FOUR

CONTENTS AND RESULTS

4.1 Introduction

The previous section on methodology has presented the systematic procedure of engaging the various kinds of analyses deployed to obtain the parameters required to answer the research questions. This section is dedicated to delivering the results obtained from the analyses of the survey data and answering those research questions.

It is necessary to begin this section with the descriptive results of the entire suite of proposed variables and then apply the results obtained from the reliability analyses to compute the sub-indices and, subsequently, the composite index. Both the dichotomous and Likert datasets have been used in the reliability analyses.

4.2 Descriptive Results

The descriptive results for all variables deployed in this study are presented in Table 4.1. These results will be further discussed in section 5.2.

Table 4.1: Descriptive results for the proposed variables

Indicator	SN	Variable	2012	2018
Social	1*	Education: Percent of respondents with at least Associate degree (ND) to respondents with just high school diploma and below	33%	59%
	2	Age: Percent non-elderly (i.e. percent less than average age)	57%	57%
	3*	Transport Ownership: Percent of respondents that own a vehicle	24%	25%
	4*	Phone Ownership: Percent of respondents that own a telephone	92%	93%
	5*	Communication Ability: Percent of respondents that can communicate effectively in “pidgin”	83%	84%

Social (contd.)	6	Special Need: Percent of respondents and family members without special need	92%	94%
	7*	Health Insurance: Percent of respondents that have health insurance	10%	9%
Economic	1	House Ownership: Percent of respondents that own their own houses	30%	72%
	2*	Employment Status: Percent of respondents that are employed	61%	58%
	3*	GINI Index (see section 3.1)	0.5300	0.5154
	4*	Sector Employment: Percent of respondents not employed in fishing/farming sector	51%	77%
	5*	Female Employment: Percent of women employed in the female labor force	29%	27%
	6*	Business Size: Percent of business owners who employed at least 3 staff to those who employed less	40%	34%
	7	Health Consultation: Percent of respondents who consult professional caregivers	58%	63%
Institutional	1*	Satisfactory Government Pre-emptive Action: Percent of Respondents satisfied with government measures to improve safety of life and property	15%	16%
	2	Savings Scheme Participation: Percent of respondents who participate in saving schemes	38%	41%
	3	Storm Ready: Proportion of respondents who have taken adequate measures against severe flooding	54%	13%
	4*	Pre-emptive Drills: Proportion of respondents that have received some measure of flood drills	47%	56%
	5*	Government Coverage: Percent of Respondents who think they are covered against loss by government	50%	17%

	6*	First Responders: Percent of respondents who participate as First Responders	15%	16%
	7*	Ethnic Fragmentation: Percentage of respondents that are Tivs, Idomas, and Igedes (major tribes)	80%	80%
	8	Rebuild Experience: Percent of respondents who have rebuilt only once or none after previous flood damages	67%	61%
	9*	Number of volunteer Groups: Percent of respondents that know at least one volunteer group	16%	29%
Infrastructure	1*	Strength of House: Percent of houses that are NOT shanties	47%	47%
	2*	Family Shelter: Respondents who can find at least one place of shelter in the event of displacement by flood	55%	62%
	3*	New Hospital Facility: Percent of respondents who know at least one NEW hospital outside the flood plain that has been constructed since the last flood disaster	-	41%
	4*	Access to Exit: Percent of respondents who live 1 km at the most from the arterial road	71%	71%
	5	Age of Building: Percent of houses of respondents built after 1990	32%	32%
	6*	Emergency Shelter: Percent of respondents who know at least one emergency shelter they can run to before temporary ones are erected	71%	75%
Community Capital	1	Net Flow of Residents: Proportion of respondents who think that the net flow of residents for the community is positive	64%	25%
	2*	Birthplace: Proportion of respondents who were born in the community or State	75%	75%
	3*	Political participation: Percent voter participation in the 2015 election	-	78%

	4*	Religious participation: Percentage of respondents active in their religious organizations	93%	93%
	5*	Club membership: Proportion of respondents that belong to a social club	72%	78%
	6	Number of advocacy groups: Proportion of respondents who know at least one advocacy group	9%	24%
	7.	Creativity: Percentage of respondents with the equivalent of a bachelor's degree	21%	25%

* Retained variable

4.3 Aggregating Scores for the Community Flood Disaster Resilience Indicator (CFDRI)

To compute the CFDRI, scores are aggregated for the different variables and indicators at three main levels, as indicated in the flow chart in section 3.1. At the first level, scores for the selected variables for each indicator are aggregated to produce the index for each of the five indicators at the second level. Then, finally, adding up these scores for the different indicators produces the CFDRI (resilience index or metric) for the two years under study, as given in Table 4.2

Table 4.2: Community Flood Disaster Resilience Index (CFDRI) table

SN	INDICATOR	RESILIENCE INDEX	
		2012	2018
1	Social	0.5186	0.5418
2	Economic	0.4551	0.4871
3	Institutional	0.3713	0.3578
4	Infrastructural	0.6102	0.592
5	Community capital	0.8035	0.8091
TOTAL (CFDRI or Resilience metric)		**2.7587**	**2.7878**

4.4 Answering the Research questions/hypotheses

We will now deploy the results in Tables 4.1, 4.2, and the supplementary questions (Appendix A) to answer the research questions.

(i) The first research question**: *"To what extent has resilience changed over the five years since the flood?"***

This research question aims to compare the quantitative measures of resilience obtained for two different years, 2012 and 2018, to make an informed inference about community resilience. Thus, the difference between the values of the resilience metrics obtained for the two (2.7587 for 2012 and 2.7878 for 2018) is 0.0291. To ascertain whether this difference is significant enough to indicate increased resilience over the period, we need to conduct a Paired Sample t-test for the means of the indicator values. Since these metrics were obtained from 5 samples for both years for the Social, economic, institutional, infrastructural, and community capital indicators, a test of significance of the difference between the two-sample means is conducted at the $\alpha = 0.05$ level of significance. The sample means for these variables for 2012 and 2018 are 0.5517 and 0.5576, respectively, and the difference between these two means is 0.0089. A hypothesis test for the significance of the difference between these two means at an α-level of 0.05 is given in Figure 4.1.

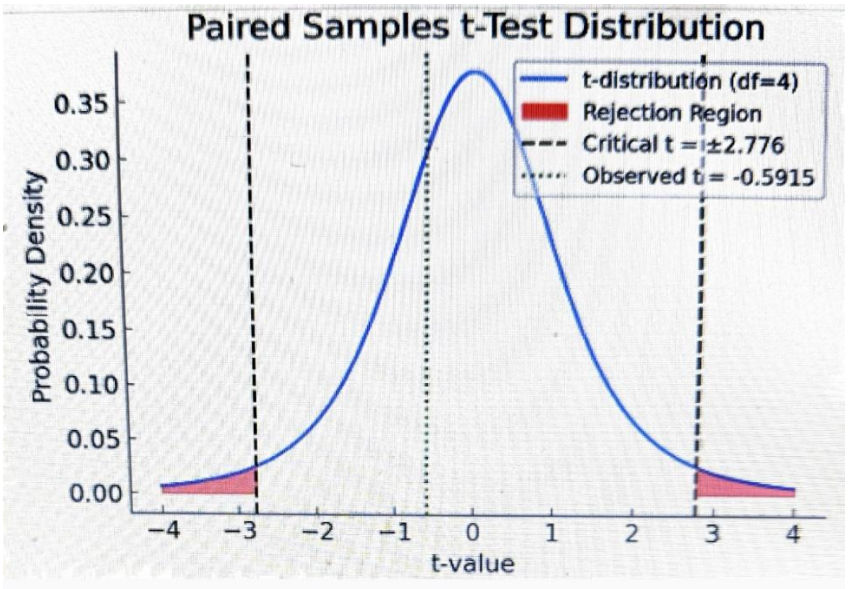

Figure 4.1: Paired sample t-test of Community Flood Disaster Resilience Index (CFDRI)

From the figure, we see that the t-statistic = ±2.776 (two tail test), df = 4

Using a t-table at $\alpha = 0.05$ (Figure 3.2), the critical t-value for df = 4 is 2.776

Comparing $|t| = 0.5915$ to $t_{critical} = 2.776$, we see that $|t| < 2.776$, so we fail to reject the NULL hypothesis.

Since the calculated t-value does not exceed the critical value, we fail to reject the NULL hypothesis. This means there is no statistically significant difference between the means of the two computations at the 0.05 significance level. Thus, there is no significant difference in the Mean of the community resilience indicators at the time of the flood and five years after the flood. That is, the community remains in a vulnerable state. (Details of this computation are in the Appendix.) We may, therefore, want to further investigate the character of the community that enabled them to gain the marginal resilience that was observed but which was not statistically significant by asking:

> ***"What support system contributed the most to the marginal recovery of the community under study?"***

As stated in Chapter Three, to determine what social system contributed most to the recovery of the community under study, the following semi-structured question was posed to the respondents. "*Do you think that recovery from the shock or trauma of that disaster was due to other reasons than the experience from previous floods alone? YES or NO. If YES, can you give reasons? In other words, if your recovery from the losses and trauma of that disaster was NOT because of experiences gained from previous years of flooding, then where did you draw support for recovery from?"*

This question was posed to all the 200 respondents polled in the survey, but only 47 felt that their recovery drew largely from their previous experience of flood events and therefore answered NO. However, only 34 people responded appropriately to the question, and translations were applied by the research assistants in some cases for those who could not express their opinion properly in good English. The opinion expressed by these respondents formed the basis of the textual analysis performed using MAXQDA software by using the standard coding procedure (Saldana, 2013), and the result is discussed in this section.

The opinions of the respondents, or the interpretations thereof, were entered as data into the appropriate column in Microsoft Excel and then exported into a new MAXQDA project. The main theme(s) of a respondent's opinion were then coded. The coding process was meticulous and

painstakingly performed across all the voiced expressions or translated expressions of the respondents. The codes were subsequently revised and refined.

Five themes were identified that connected the opinions of the respondents namely, the support of RELATIVES expressed as “family”, “parents” or “relatives”; FRIENDS, expressed as “friends” and “well-wishers”; CORPORATE SUPPORT, expressed as “churches”, “groups”, “NGOs” and “organizations”; SHEER WILL expressed as “courage”, “courageous”, “face our problems”, “… not sit and cry if the government cannot help us”; and OWNERSHIP/SENSE OF COMMUNITY being expressed as “… our own house or place”, “owner of the house”, or “… cannot run anywhere”. The frequency Table (Table 4.3) shows the frequency of the support systems representative of the sample.

Table 4.3: Frequency distribution of the support systems for the community

	Frequency	**Percentage**	**Percentage (valid)**
Sheer Will	17	8.50	50.00
Relatives	12	6.00	35.29
Ownership/Sense of Community	8	4.00	23.53
Friends	3	1.50	8.82
Corporate Support	5	2.50	14.71
Documents with code(s)	34	17.00	100.00
Documents without code(s)	166	83.00	-
Analyzed documents	200	100.00	-

The “percentage” represents the percentage of the 34 respondents who correctly answered the question, while “percentage valid” represents the percentage of the whole 200 people who were confronted with the survey question. Figure 4.2 shows the coded response from Table 4.3 as it affects the sample.

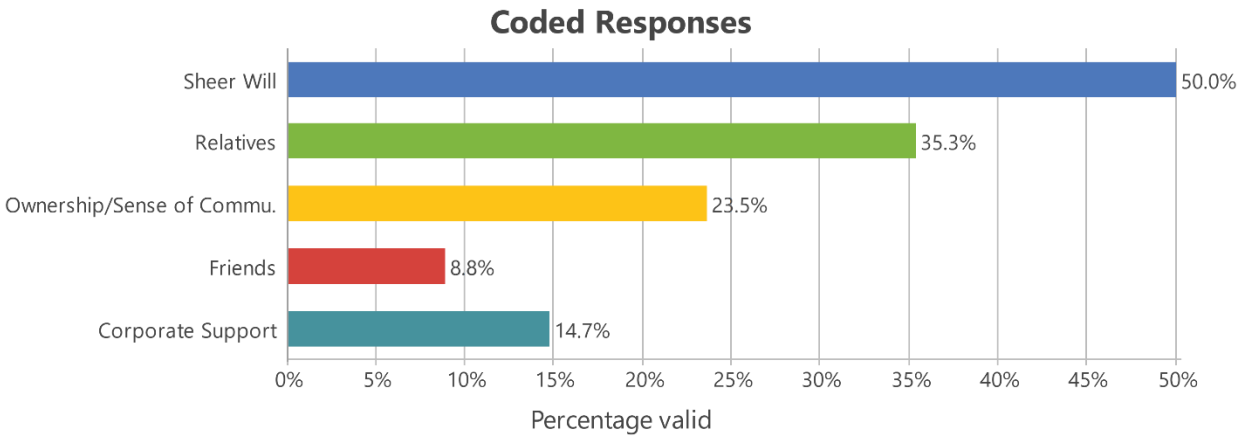

Figure 4.2: Coded responses of the social support for the survey sample

Thus, more people depended on their sheer will or fighting spirit to wade through the disaster and the accompanying trauma than those who received assistance from their relatives and friends or corporate bodies. This is not unexpected in a country where people are left to deal with corporate disasters, where support from the government is insufficient, or where the little help that comes is diverted to private or other purposes for which they were not meant.

It may also be necessary to see how the distribution of the age groups may have impacted the social support received; that is, whether the social support that respondents received depended on their age distribution. And MAXQDA can be used to conduct such analyses as presented in Table 4.4.

Table 4.4: Distribution of social support across the age groups

	Age Group							
	20-29	**30-39**	**40-49**	**50-59**	**60-69**	**70-79**	**80-89**	**Total (%)**
Question responded to by (%)	18.75	16.67	24.24	36.11	33.33	9.09	25.00	23.50
Corporate Support (%)		1.67	6.06	2.78	4.17			2.50
Friends (%)		3.33	3.03					1.50
Ownership/Sense of Community (%)	3.13	1.67	3.03	13.89				4.00
Relatives (%)	3.13	6.67	3.03	8.33	12.50			6.00
Sheer Will (%)	6.25	1.67	9.09	16.67	16.67	9.09		8.50
SUM (%)	31.25	31.67	48.48	77.78	66.67	18.18	25.00	46.00
N (%)	32(16%)	60(30%)	33(16.5%)	36(18%)	24(12%)	11(5.5%)	4(2%)	200(100%)

From the Table, the highest age group polled was the (30-39)-year group (30 percent) followed by the (50-59)-year group (18 percent), the (40-49)-year group (16.5 percent), the (20-29)-year. group (16 percent), the (60-69)-year group (12 percent), the (70-79)-year group (5.5 percent), and least, the (80-89)-year group (2 percent). The entire 70-79-year-old group who responded to the question expressed their opinion in favor of their recovery through the courage to face their situation. Their percentage (9.09 percent) is close to their proportion in the sample (11 percent). Generally, it can be said that those from age 40 to 79 depended the most, at least based on the analysis of their voiced opinion, on their willpower to overcome the tragedy while some of them also benefited from the support of relatives (12.5 percent).

In summary, because only 47 out of the 200 respondents polled think that experience with previous flood events is vital to pulling through the trauma of the disaster, it is arguable that the vast majority of the people therefore relapse into the notion that they can make it on their own without government support that would never come anyway. This is demonstrated in this textual analysis with the majority expression of SHEER WILL to survive. This is against the backdrop of the huge outpouring of both national and international financial and material donations in the

aftermath of that notable disaster, which never reached the people for whom these donations were meant, even several years after the disaster. It is, however, uncertain whether this same situation of not being compensated, as testified by most respondents in the survey for this study, also applies to other communities in other parts of the country, particularly in southern Nigeria. This is a subject for further research.

So, even though the will of the people to survive has resulted in a marginal increase in their social, economic, and community resilience, due perhaps to individual adjustments in the engagements in these areas of their lives, their overall resilience as a community has not been enhanced. This supports the finding that the community is not yet out of the woods.

(ii) The second research question: **"*To what extent did the experiences gained from previous flood events contribute to the community's present state of resilience or lack of it?*"**

This question seeks to determine whether the outcome of Research Question One (RQ1) could be accurately inferred from respondents' "perception" or "opinion" simply from the experiences gained from previous flood events, the proxy of which is the number of years respondents have lived in the community. If correctly inferred, it makes a case for individuals' perception as a powerful indicator; if not, it weakens "perception" as a basis for judgment on matters of "resilience". To statistically make this inference, TWO questions were posed to the respondents (a third one is extracted from the survey questionnaire) to be plugged into the logistic regression equation, thus:

(1) Will you say that the community can cope better with that level of flood if it ever occurs again? YES or NO

This question is FUTURISTIC even though the RQ addresses "the NOW." The community is expected to harness a possibly enhanced state of resilience at the time of the survey to deal with any future flood disaster situation.

(2) Do you think that your answer is due to the number of years you have lived here, in other words, your experience with floods? YES or NO

(3) Years of stay in the community are captured in the survey.

(4) The sex of the respondent is equally captured in the survey

Now, respondents' answer to question (1) is for dependent variable "y"; answer for (2) is for independent variable $\mathbf{X}_1$ the "opinion or thinking" of the respondent; "c" is $\mathbf{X}_2$, the number of years of living in the community; and $\mathbf{X}_3$, the sex of the respondent is registered in the survey.

From the logistic equation given below, β_1 represents the number of times the "perceived resilience" is increased or influenced by the "opinion, thinking, or judgment" of the respondent when the other variables are held constant.

The statistically determined value of β_2 (since $\mathbf{X}_2$ represents years of residence in the community) is the "increase in the odds of the 'perceived resilience' for every one-year increase in residence in the community" when the "judgement" of the respondent and the sex are held constant. β_3 is the number of times the "perceived resilience" is higher if the respondent is male, when the number of years of residence in the community, or the "opinion, thinking, or judgment" of the respondent, is held constant.

Invoking the logistic equation $\text{Log}_e = \beta_0 + \beta_1\mathbf{X}_1 + \beta_2\mathbf{X}_2 + \beta_3\mathbf{X}_3$

β_0, β_1, and β_3 are estimated from survey data.
P(y=1): Probability of y belonging to the category coded y=1

P(y=0): Probability of y belonging to the category coded y=0.

y = Perceived Resilience (1, 0)

x_1 = thinking, opinion, or judgement of respondent (1,0)

x_2 = Years of residence in community

$\mathbf{x}_3$ = Sex (M = 1, F = 0)

From the detailed Logistic regression analysis (Appendix B) and the summary Table (Table 4.3), it was found that the odds of Resilience Perception are 6.842 times higher for the respondents' opinion, and for every one-year increase in residence time in the community, resilience perception only increased by 0.4 percent.

Table 4.5: Summary Table of Logistic regression of perceived resilience

Dependent Variable	Independent variable	Results		Model statistics	
		Walds' Chi-Square	Odds ratio(exp.β)	Nagelkerke R-Square	% Predicted correct
Perceived resilience	Opinion/judgment	9.180*	6.842	0.098	58
	Experience	0.119	1.004		
	Gender (M/F)	0.555	0.796		

* Sig. at $\alpha = 0.05$

The odds of resilience perception are 0.796 times lower for a male respondent than for a female. This means that female respondents were marginally more optimistic than males regarding resilience.

For the test of the hypothesis on the variables at both $\alpha = 0.10$ and $\alpha = 0.05$, the Wald's chi-square statistic falls in the rejection region except for the "opinion or thinking" variable. This result shows that only "opinion or thinking or judgement" upon which the resilience perception is anchored (which can go either way) is a useful predictor of resilience when years of residence in the community and gender are held constant.

Further tests to assess the overall model fitness and usefulness of the Logistic regression include the Likelihood ratio test, the Strength of association test, and the Classification table test comparing the observed and predicted probabilities.

For the Likelihood ratio test (Appendix B), the Chi-square statistic falls in the rejection region at $\alpha = 0.10$. So, we reject the Null hypothesis at $\alpha = 0.10$ in favor of the fact that at least one of the model parameters is non-zero. The Logistic regression model, therefore, appears to provide more "useful" predictions of resilience perception than the null model. This is, however, corroborated in the preceding paragraph with the retention of only the "thinking or opinion" variable.

The Nagelkerke R-Square (with values ranging from 0 to 1) is used to measure the strength of association. A value of 0.098 (Table 4.3) suggests a very poor goodness-of-fit. This measure shows the degree to which the model parameters improve upon the prediction of the null model.

Lastly, the classification table (Appendix B) indicates that 92.8 percent of the respondents who think the community cannot cope better if the level of flooding witnessed in 2012 occurs again are correctly classified, while only 7.8 percent of those who think the community can were classified correctly by this logistic model. The overall percent of respondents who correctly think the community is less resilient or more resilient is only 58 percent (Table 4.3), leaving those who were incorrectly classified to be 52 percent (100-58 percent). This means that with the respondents' "opinion or thinking or judgement," there is a nearly 50-50 chance of a hit or a miss. This hit-or-miss situation is the domain of pure guesswork.

From the foregoing analyses, we can see that although the resilience index changed marginally in 2018, it is not significant in accounting for an increased resilience. The purpose of the Logistic regression is to predict resilience to a future flood disaster situation using the information available to respondents at the time of the survey. Rather than a 58 percent classification rate, a high (say 80 percent) or low (say 20 percent) overall correct classification of the respondents' thinking would have made the prediction situation more definite. Thus, a nearly 50-50 percent correct overall classification is pure guesswork and uncertainty regarding the prediction of future resilience. Again, since the community resilience situation is either of three possibilities – increased, decreased, or unchanged – this prediction cannot account for the state of resilience of the community at the point of the survey as the community was only marginally resilient in a few layers of the resilience spectrum and therefore largely considered unchanged. This probably reveals that future studies of perceived resilience would best be conducted using qualitative data, as this will offer respondents the opportunity to voice other innermost feelings about why they think the community will or will not be able to cope better in a future flood situation. In the present circumstance of using quantitative data for this research question, respondents' opinions or thinking cannot adequately predict a future resilience situation that is either enhanced, diminished, or unchanged.

Therefore, as we now know from research question one, the community's state of resilience has not improved since the marginal difference between the two years is not significant. But we have also statistically determined that even though "thinking or opinion or judgement" is a useful determinant of perceived resilience, using quantitative means to determine the state of resilience in this or future resilience is only a near 50-50 chance of getting it right or getting it wrong; and the years of experience with flooding in the community is not significant. Consequently,

perception, using quantitative data as a method to determine future flood disaster resilience, is fickle and unreliable.

(iii) The third research question: **"*What specific indicators and variables in the light of the study can be used to determine the community's level of resilience?*"**

To answer this research question, it is important to remember that this study was premised on the study Cutter et al. (2010) in which 35 variables which had originally passed the reliability analyses as determined by the researchers were used to define five indicators – social, economic, institutional, infrastructural, and community capital. An additional variable – Pre-emptive drill – was added to this suite for a total of 36, and then all the variables were defined in the context of the community for further reliability tests. Subjecting the analysis to tweaks, re-coding, and further reliability tests showed improvements in scores for the different groups of variables for the resilience indicators, as shown in Chapter Three. The order of importance of the variables to the indicators is given in the table below and is determined by the reverse order of their removal in the reliability analyses. That is, the variable that makes the most contribution to the indicator was usually the last to be dropped in most of the cases.

From Table 4.4, it can be seen that a total of 25 variables were selected out of the initial 36 that were proposed.

Table 4.6: Order of importance or contribution of variables to the indicator

			INDICATOR		
ORDER OF IMPORTANCE	Social	Economic	Institutional	Infrastructural	Community Capital
1.	Education	Employment status	First responders	Family shelter	Political participation
2.	Communication ability	Sector employment	Number of volunteer groups	Access to exit	Club membership
3.	Health insurance	Business ownership	Pre-emptive drills	Strength of the house	Religious partnership
4.	Transport ownership	Female employment	Ethnic fragmentation	Emergency shelter	**Birthplace

5.	Phone ownership	*GINI index	Satisfactory government action	New hospital facility	
6.			Government coverage		

*Separately determined **Included by special consideration

These variables can be said to determine the resilience of this community under study, but may not apply entirely in this fashion to other communities within or outside the geographical region of this study. Every community possesses its uniqueness of culture, social forms, ethos, etc., that distinguish it from others. These should be taken into consideration in designing the questionnaire to be administered. However, these may be suggested as the starting variables, while additional ones may be sought within the group of indicators suggested in the literature, namely the social, economic, institutional, infrastructural, and community capital indicators.

4.5 The Findings

(i) The inclusion or deletion of some variables increased Cronbach's alpha, or the overall reliability of the variables left in the suite. Conversely, the inclusion or deletion of some variables decreases the overall reliability. This may suggest that variables with the potential to enhance reliability may need to be tweaked somewhat, either by modifying the questions to capture them or re-coding them to make them usable and perform better.

(ii) Some of the discarded variables in this study may indeed be reliably related to the ones retained. The relatively lower value of Cronbach's alpha (reliability) associated with them may be attributed largely to the fact that they may be captured only on a dichotomous scale, but were analyzed along with those that could be graded more widely on a Likert scale. For instance, as noted earlier, home ownership can only produce one of two responses or outcomes. Therefore, analyzing it with variables exhibiting different patterns of change may produce lower alpha values since, essentially, variables measuring the same indicator will exhibit the same patterns of change. This also may explain why birthplace, as a community capital, does not seem

to be reliably related to community bonding arising from religious and club-level interactions, even though the literature and human experiences suggest otherwise.

(iii) Relatively low values of Cronbach's alpha may not be due to issues of reliability but rather to how the entire suite of questions is articulated. For instance, if the response to job status is "unemployed", the response to sector employment should naturally be "none". However, some self-employed people (like fishermen) responded as "unemployed" and yet as fishermen/farmers for sector employment. These responses, if not properly coordinated, may affect the composite behavior of the variables and, hence, reliability. In this study, however, I had to re-code such responses and re-run them.

(iv) The coding scheme adopted was another factor that was found to profoundly affect values obtained for Cronbach's alpha. For example, employing the dichotomous coding approach and assigning the 0 and 1 codes to the relative age below the mean and that above it respectively, the reliability analysis yielded a Cronbach's alpha value of 0.37 in 2012 for the social indicator. But when the coding scheme was flipped to 1 and 0, respectively, the alpha value increased to 0.44. When the "age" variable was removed entirely, the value increased further to 0.50. When the "Special Need" variable was deleted, Cronbach's alpha increased even further to 0.52.

In the case of 2018 data (i.e., between 0 and 1 for the relative age), the switch in the coding scheme caused a more dramatic jump in Cronbach's alpha from 0.32 to 0.51. Now, when the exercise was repeated for the 2012 data using a four-point Likert scale instead of the dichotomous scale with all the initial seven variables, the alpha value was 0.50; and with the removal of the Age and Special Need variables, it increased to 0.58. Again, when the "housing age" was re-coded to indicate that the newer houses (built after 1990) were stronger than those built before, it flipped the reliability (Cronbach's alpha) of the variables for infrastructure from well below our target threshold of 0.70 to well above it.

This means that both the coding scheme adopted and the variables included in the suite of variables are important in raising Cronbach's alpha value to approach or exceed 0.70, the minimum value often recommended in the literature for reliability. Since this study is purely explorative, very strict alpha values may not be enforced in all cases

considered. It is hoped that further research with survey data of this kind will produce the best suite of variables and the way to capture them in a survey.

(v) For some variables, the less the community engages in them, the less relevant they become in their reliability when analyzed with variables in which there is a more vibrant communal activity. In other words, the more the community members engage uniformly in that variable, the higher the alpha values. For instance, business ownership did not exhibit much relevance in 2012, with a low associated alpha value when only very few respondents had businesses of their own. However, when activity became more vigorous within this variable a couple of years later (by the summer of 2018), with more people owning businesses of their own, it became more relevant in that its reliability with the other variables became enhanced (increased Cronbach's alpha). Thus, some variables that were excluded in 2012 became more relevant and were included in the 2018 analysis.

4.6 Summary

This chapter began with the results of the descriptive analysis obtained from the survey data, particularly in the context of the original 36 variables proposed for this research. It then proceeded to aggregate the scores for the indicators using the flow chart of Figure 3.1, considering the GINI index, an index to determine income inequality in the community (Chapter Three). The high point of the chapter was having to address the three research questions posed in this work. Major findings during the process of data analysis and coalescing of results have also been spotlighted.

The next chapter (Chapter Five) will discuss the findings in this research and how they may open a vista for future research of this nature, especially in communities in the third world, where it is often difficult to obtain secondary data to assess grassroots resilience and monitor development.

CHAPTER FIVE
DISCUSSION

5.1 Introduction

This study has drawn extensively from the works of Mayunga (2009) and Cutter et al. (2010) and has been focused on adapting the existing methodology of determining disaster resilience for much larger units of analysis to communities, particularly in the third world or developing country environment where there is usually a dearth of archived (secondary) data at the grassroots level. To achieve this goal, existing definitions, theoretical frameworks, conceptual models, and applications of the concept of disaster resilience were thoroughly reviewed and understood. Particular attention was given to the existing methods for studying both qualitative and quantitative disaster resilience, and the leverage that the approach adopted in this dissertation has over the earlier ones has been highlighted.

Besides discussing the results obtained from the study, it also aims to condense and in doing so, highlight the common thread that runs through the entire chapters of this dissertation.

5.2 Discussions

The descriptive results Table in Chapter Four (Table 4.1) showed that while some variables took a hit because of the flood disaster, others received a boost. For example, while the net flow of residents into the community (community capital) took a hit and plummeted from 64 percent in 2012 to 25 percent at the time of the survey in 2018, the knowledge of Advocacy Groups received greater prominence with a rise from 9 percent to 24 percent. Apparently, more people are now becoming aware of the importance and perhaps the existence of such groups and are now looking out for existing help in the event of another future hit. The number of Volunteer Groups also received a boost from 16 percent to 29 percent. The foregoing observation had been noted by Boon et al. (2012) that when all members of a community are corporately impacted by a disaster of a large scale, there is usually a group response to such situations. And as we have seen in this situation, such a response can be a reaction (increased exodus from the community) against an "imposed" condition (living in the vulnerable floodplain), or where exit is not possible due to ties to the community, taking a recourse to inner personal resources – innovating to raise their

economic status – or looking out early for external help should that condition occur again like becoming more aware of volunteer groups.

Some variables, like Satisfactory Government Pre-emptive Action, however, remained on the low side, showing how dissatisfied people are in their opinion about government and its agencies. Worthy of mention is the GINI index, which gives a snapshot of income inequality. It can be deduced from the figures for the two years that income inequality was higher in 2012 than in 2018. One way to view this change is that the disaster may have propelled a lot more people to work harder and innovate to lift themselves out of the 2012 disaster economically. This point has been noted as part of the community reaction. This may be corroborated by the increase in the "Percent of people NOT in the fishing/farming sector" from 51 percent in 2012 to 77 percent by summer 2018, when the study was conducted. In some other situations, help may also have flowed from family members, friends, and individuals who may not physically be part of that community but who feel connected to it because of ties to people there, in keeping with the dynamic nature of communities espoused by Moreton (2016). These sources of help may also, to some degree and in some ways, account for raising the corporate economic leverage exhibited in the community with a higher economic resilience index in 2018.

The Flood Disaster Resilience Index (CFDRI) Table (Table 4.2) showed that while the institutional indicator produced the lowest index of all the indices computed, the community capital accounted for the highest. The high performance of the variables for the community capital accounted for the high value of this index, while the relatively lower performance of the selected institutional variables accounted for the index's lowered value. Thus, while the community capital index increased over time, the institutional index decreased, reflecting the lack of confidence of the people in the government and its agencies. The relatively higher income inequality in 2012 than in 2018 (Table 4.1) may have contributed to the overall lower resilience coefficient and consequently lower resilient index for 2012 that was observed.

As we now know, 2018 produced a "higher" resilience metric than 2012, even though, essentially, the resilience of the community has not changed since the disaster. However, while it also produced higher resilience indices for Social, Economic, and Community Capital indicators, scores were lower for Institutional and Infrastructural indicators, which largely measure the responsibility or effort of government and its agencies to assuage the effects of flood disasters on communities. Thus, the government and its agencies have not lived up to expectations in helping

the community even though the community as a group has endeavored to pull itself out of the hard experiences of 2012 with increases of the resilience index in some sectors.

From the findings to RQ2, we see that the logistic equation has established that we cannot infer or perceive resilience from either the years of experience with floods or as a product of gender (male or female), but rather on one "anchor" alone – "opinion/thinking" of the respondent(s) and nothing of substance. This proves the multidimensionality of resilience as a concept in recovery from disasters. Thus, we see the place of social factors, economic factors, institutional factors, infrastructural factors, and community capital factors in resilience building. Therefore, to infer community resilience as required by RQ2 will require a qualitative analysis of the survey rather than the quantitative one, as this study has tried to investigate. That way, a more fluid opinion as to why respondents expect an enhanced or diminished resilience may be captured, as the present Logistic regression quantitative approach is not able to account for one of the possibilities – an unchanged resilience situation.

The reliability analysis conducted in Chapter Four shows that variables that seem inappropriate to define an indicator could indeed be useful, depending on how it is tweaked and made amenable to produce better reliability. Thus, employing this model holds great promise in determining the resilience of relatively smaller community units, particularly in the developing world.

It was noted during the field work for this dissertation that institutional failure is at the heart of poor urban policy in Makurdi, where this work is centered. A personal interview with a highly placed official at the "Urban Planning Office" reveals that there are no existing statutes, edicts, policy documents, or laws that guide housing development, particularly in the floodplain. Under such situations, it is then unclear how such an institution of government functions.

5.3 Recommendations

(i) The term "Community," as used in this study, is a heterogeneous aggregation of homogenous communal units, all of which have suffered a similar fate in the flood disaster. For instance, while the Wurukum community unit is composed largely of the fishing ethnic Jukuns (a minority tribe), the other units are composed of other tribes that are in the majority, particularly the Tivs. Thus, some tribes tend to congregate in specific locations. Further research could consider studying resilience as it affects these

separate communal units with different dominant tribes to see if there are salient differences in outcomes. In such cases, the one tribe that earns a positive score for "political fragmentation" for being the dominant tribe in one unit will lose that status to another tribe that is in the majority in another unit. Another reason to suggest the study of these units or wards separately is that, from the data obtained in this study, for instance, some units appear to have received more drills for emergency evacuation (e.g., Logo I unit) than the others, apparently enhancing their resilience.

(ii) Since, by definition "community" may include those who live outside the community but who have ties to the community; it is suggested that future work considers capturing how much resources flow into the community from family members outside the community, or the social network outside the community that contribute to the community in building resilience.

(iii) Every stage in this resilience-measuring process requires a thorough evaluation of the variables being considered. That consideration is built on a deep knowledge of the resilience literature, general human, and personal experiences. This should be brought to bear in as practical a way as possible. For instance, questions should be structured in such a way that similar questions that elicit or capture the same response must be asked only once, even when they are targeted at capturing different variables, since some respondents may inadvertently provide different answers for the same questions that are repeated. An example of this is a situation where a respondent is asked whether he/she is employed or not to capture the employment status, and he/she says "NO"; yet to capture "sector employment" he/she says, "farming or fishing" (see questions 16 and 18 of the field questionnaire). This is because he/she does not view his occupation as a government/private sector "employment".

(iv) The dichotomous and Likert scale coding schemes tend to do better in the reliability tests of the variables. Therefore, it is recommended that both methods be applied to all variables in a study of this nature, as this may produce a preferred coding convention for the different variables and for different places or regions.

(v) Cronbach's alpha reaching or exceeding 0.50 may be considered good enough for exploratory research of this nature, especially when the variables concerned are established in the literature to contribute to resilience and if they at least meet the initial

and vital condition of inter-item correlation of 0.20 to 0.70. Deciding wholly on the values of Cronbach's alpha may be misleading, as this study has shown that the same set of variables and responses for an indicator for a specific year has produced a different value of Cronbach's alpha for another year. This is because Cronbach's alpha, as a statistic, tends to measure the behavior of variables that act similarly. It is reasonable to assume that if a set of variables is reliable for an indicator for one year, they should also be reliable for another year. In some other situations, however, a group of variables existing in the literature for an indicator may not exhibit resilience in the same direction as was observed in the case of community capital where the inclusion of "Birthplace" tended to reduce reliability when in fact it should be one of the strongest variables for the indicator. In this case, the "birthplace" question could be tweaked to conform to the pattern of the rest. For instance, instead of "Were you born in this community?", it may be better to ask, "Being born in this community (i.e., for those who are), how much tie or commitment do you have for it?"

Thus, Cronbach's alpha may not be relied upon very heavily as the basis for judging the reliability of variables in this kind of study, since it has been shown to vary according to the coding scheme (dichotomous or Likert) adopted.

(vi) From the findings in the previous chapter, to gradually build a robust suite of variables for Social, Economic, Institutional, Infrastructural, and Community resilience indicators, it is recommended that research be focused on these indicators one at a time until very reliable context variables are established, since the suite of variables that work for one community may not work satisfactorily for another, until such a time that the literature is sufficiently replete with trusted variables and how to poll them in a survey.

(vii) Car ownership in a third-world context is often considered a luxury, even for evacuation in a time of disaster. This was reflected in the reaction of most respondents during the field survey, who would scream on being asked whether they owned a car or not. Apparently, for these folks, car ownership was viewed as a luxury, and for the very rich. For them, a motorcycle or tricycle was as good as a car since they could equally use it in the evacuation of their families in a disaster situation. This may seem unlikely or unbelievable to a Western-trained mind. However, in everyday commuting

in many third world countries like Nigeria and India, many motorcycle or tricycle riders are known to convey as many as five family members (a wife and four children) or more on their motorcycles and tricycles. Therefore, for future studies, ownership of a motorcycle or tricycle could be treated as capable of contributing to the resilience of a household in a third-world environment, as opposed to not being considered at all in this study.

(viii) In the first or developed world, it is not uncommon to have some minors, particularly those between 16 and 18 years of age, who hold jobs while still in high school. So, involving such groups in a survey on resilience, which naturally involves asking questions about "employment" to determine economic stability, is not out of place. However, in the third or developing world, millions of youths who are out of college or university have no jobs, much less those of them still in high school. Since most of these people do not have sufficiently developed skills to earn a living, it is recommended that conducting a study of this nature in a developing world environment should only involve those who are at least old enough to be out of high school and are still searching for or have secured jobs. A reasonable minimum age to suggest for the survey of respondents at the time of the survey, therefore, is 20.

(ix) Crime in a community will certainly lead to weakened community values and resilience. Thus, the higher the crime rate in a community, the weaker the fabric of that community in developing resilience, as criminal tendencies often manifest in the attitude of looting during times of disaster. The loss of property to criminals, in addition to the prevailing disaster, adds an extra layer of burden and trauma to victims of disaster, making it difficult for recovery and building resilience. Since the community crime rate was not considered in this study, it is recommended that it be considered in future studies.

(x) Since human memory cannot be trusted to reproduce accounts for events that occurred several years previously accurately, it is recommended that accounts be recorded as they become available with the occurrence of disasters and stored in a database for future retrieval for resilience studies.

(xi) Again, human judgment may not be trusted to estimate the age of buildings to determine their resilience accurately. It may then be necessary, as a policy issue, for

house owners to make this information available to renters at the beginning of their contractual agreement if this becomes a relevant resilience variable.

(xii) To successfully conduct research of this nature employing the use of surveys, it is highly recommended not to rely on one method of judgment alone in selecting variables; but to rely on all three of reliability analysis (Cronbach's alpha), the variables suggested in the literature, and human experience or personal intuition and judgment as was used in selecting "birthplace" for community capital in this study.

5.4 Limitations and Difficulties of the Work

To the best of my knowledge, this is the first study of this nature in resilience measurement using a survey to define the variables in the resilience literature. Although it has largely captured the underlying resilience that the questionnaire was intended to, the study and findings are not immune to certain limitations and unanticipated difficulties.

5.4.1 Limitations of the study

The CFDRI composite index that is obtained is only a snapshot in time. In other words, at this point, it is being measured. It is, therefore, not able to tell what the situation will be like in the future, whether the community will continue to be more resilient or relapse into a worse vulnerability situation, or the resilience situation between two time intervals.

Again, the figures obtained as resilience metrics are abstract concepts; they do not convey a perceptible or visible notion of what the level of resilience is in the real world; it does not define what you see in the community to determine their resilience level. This study is also not able to tell any intermediate conditions that the respondents/community may have passed through between when the flood occurred and the time of the study. For instance, the study is not able to capture those who may have experienced a transient PTSD arising from the flood situation, but which had terminated or normalized before the study was conducted.

5.4.2 Difficulties of the study

Perhaps the most difficult part of the job was data entry. Two hundred (200) respondents polled on 36 variables for 2 separate years yielded 14,400 data values, and having to deploy both the dichotomous and the Likert coding conventions for analyses and comparison generates a monstrous 28,800 data values to be entered into the computer. Therefore, the process generates a large volume of data that takes many man-hours to both enter and analyze.

It is nearly impossible to determine how accurate the responses to questions regarding an event that occurred over five years before the interview are and how they may have affected the study because of memory decay.

Some questions are practically impossible to obtain the right answer. For instance, not many tenants in the Nigerian situation, if there are any, would know the age of the house they live in or exactly when it was built. It was often difficult to resolve some conflicting responses to related questions. For example, some would respond that they were not employed, and yet would indicate they were in the fishing or farming sector; or/and indicated a contrary response to another indicator being captured. Yet resolving these conflicts was necessary to minimize error in the study.

There was also the difficulty of appropriately placing retired people on the Likert scale. People whose status had changed from "employed" in 2012 to "retired" (by 2018) could be handled easily on the dichotomous scale both for "employment status" and "sector employment". But on the Likert scale, it was different. Placing them one level below the previous scale was used in this study.

There is no existing literature (at least for the communities used in this research) regarding the number of employees engaged by an employer that will contribute to the economic vitality of the community. Therefore, any assumed number of employees for a business owner to contribute to the economy of the community and enhance resilience is born out of the knowledge of the study area. Since this choice of number is arbitrary, its contribution to resilience is incidental and unknown.

In the context of regions of the world that are often devastated by hurricanes and tornadoes, the concept of "Rebuild" is well understood. However, it is not known how the use of such concepts or terminologies in a questionnaire in a region where such a degree of damage is seldom encountered (like the communities under study) is internalized, or how a "misconceived" understanding and response to the question impacts the overall research outcome. This is because

even frequent floods do not cause comparable destruction to homes but rather simply cause lower-degree damage to property.

It is difficult to determine when the experience of a person who was born in a specific location and frequently traumatized by disaster begins; that is, when they are old enough to recall events accurately and rationally judge things as they truly are. This is especially the case when the study is conducted several years after the disaster has occurred, and this ability to recall is likely to vary from person to person.

5.5 **Summary**

In this chapter, I have presented the descriptive statistics of the variables employed in this study to measure resilience for a community victimized by flood disasters. A discussion of the results obtained from this study has also been presented, particularly regarding changes in these variables over the two periods studied. Of utmost relevance in this study are the changes in indicator indices and the changes in resilience metrics for the two periods that have been studied as well. Recommendations are based on observations from the survey and analyses, and how future studies can be modified or adapted to avoid some of the challenges that conducting a study of this kind in a third-world environment presents. The chapter closed with limitations and difficulties of the work. The next chapter will present an overview of the research and its contribution to knowledge.

CHAPTER SIX
CONCLUSIONS

6.1 Introduction

Resilience as a concept has assumed center stage in global discourse because it is a property that is desirable for both human and natural systems, including cities and coastal zones, in the face of several potentially dangerous stressors, particularly weather-related hazards. Resilience has been used variously in several policy discourses and fora and has become a term that is used regularly in a variety of financial institutions, programs, policies, and documents from the international to the sub-national levels (World Bank, 2008). Although resilience as a concept appears very popular, it has, however, been criticized by several writers as a concept that is abstract in nature, confusing, ambiguous, lacking in substance and conceptual clarity, and lacking in practical application. Despite this seeming criticism, research in resilience will continue to grow, and its usage in contemporary times is ever-relevant.

This dissertation has focused on employing quantitative measures to determine the resilience status of a community devastated by a flood event in 2012 in Nigeria. To measure resilience in this study, the approach of Mayunga (2009) and Cutter et al. (2010) was adapted. However, rather than utilize secondary County and State data as in the two previous efforts, primary or survey data has been used. This mode of data was chosen to solve two fundamental problems. The first was to solve the problem of relatively large County and State units of analysis, which are coarse in nature, while the second was to solve the problem of the unavailability of data at the grassroots level, particularly in Third World environments.

The survey questions were framed to capture variables that define existing indicators in the literature to study resilience, namely social, economic, institutional, infrastructural, and community capital indicators. Using the survey data, scores were aggregated for the indicators and for the separate years whose resilience measures were being determined, 2012 and 2018.

The community exhibited a marginally enhanced community flood disaster resilience index (CFDRI) in 2018 that was not statistically significant at the $\alpha = 0.05$ level. It was found that the resilience coefficient for the institutional indicator was lowest for the two years (2012 and 2018); and further still, that it was lower in 2018 than in 2012, indicating that the institutions of government were not responsive to the yearnings and aspirations of the community. Additional results show that certain variables can indeed be used effectively to capture community resilience

in a survey and that experiences from past flood events do not count towards appropriately determining whether a community has developed or will develop resilience to future flood disasters.

6.2 Relevance of the Study and Contribution to Knowledge

Very few studies on measuring disaster resilience have been conducted (see Mayunga, 2009; Cutter et al., 2010). Most of the existing studies have been carried out using coarse County and State data that may not necessarily apply to all communities within their boundaries in equal measures. In understanding the real dynamics of recovery from natural disasters or resilience to natural disasters, it is therefore imperative to obtain grassroots data, most of which cannot be captured in databases, and transform them into metrics to obtain quantitative measures of disaster resilience. This is what this dissertation set out to achieve and has achieved.

This work holds the potential to monitor the recovery or lack of it of communities that have been victimized by a flood disaster (or any other disaster for that matter) over time using primary data with great promise of their applicability in developing countries where data acquisition and storage often present a challenge. Indices were developed for social, economic, institutional, infrastructural, and community capital for the community under study. These indicators reflect the multi-dimensional nature of resilience. It will, therefore, be useful for monitoring the most underdeveloped indicators of resilience in concrete terms, that is, the sector where the community is lagging the most. For example, in this study, the institutional indicator was found to lag the most and should be a reminder to authorities of their failings.

Again, it will form the basis for comparing the disaster resilience of communities. With the metrics being updated regularly, it will be possible to maintain the records of communities and assess their level of disaster resilience accurately over time. Thus, the recovery or development level for different communities within the same geo-political zone can be monitored. This ultimately will provide a context for the action to reduce vulnerability further through decision-making, policy formulation, planning, and management.

6.3 Recommendation for Future Research

Future studies could aim to conduct comparative studies between communities in a third-world environment and a developed economy to develop standard questions that may be deployed everywhere in determining disaster resilience. This will eliminate recourse to trial-and-error techniques every time a study of this nature is undertaken.

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APPENDICES

APPENDIX A: Survey Questionnaire

Research Assistant's Name_____ Respondent ID #_____

THE QUESTIONNAIRE

Before administering the questions to the respondents, please carefully explain to them that the purpose of the survey is purely for university research, with the assurance that no personal information or markers like name or address will be used in the research. It will also be necessary to tell them that the research team members are not agents of the government nor are they working for them, and that they should be free to bare their minds regarding any opinion they hold, as this will not be traceable to them or used against them in any way conceivable.

1. Respondent ID#: _____
2. Sex of respondent: MALE___ or FEMALE_____(Code Female as '**0'**; Male as '**1'**)
3. How many years have you lived here? _____
4. Take note of the type of house: (a) old and weak (b) Modern but weak (c) Old but strong (c) Modern and strong (Code a & b as '**0'**; c & d as '**1'**)
5. Take note of the distance in Km of the house from the arterial (main) road leading out of Town in case of need for evacuation (a) ≥ 4 (b) 3 (c) 2 (d) ≤ 1 (Code a, b, & c as '**0'**; d as '**1'**)
6. Of what tribe are you, please? _____ (Code Tiv/Idoma/Igede as "0" Jukun & others as "1")
7. Religion_____

8. **Educational Equity sub-indicator**
   (i) What was your highest level of education at the time of the flood?
   (a) No education
   (b) Primary/Secondary education
   (c) National Diploma (ND)/College of Education
   (d) HND/Bachelor's/Master's/PhD
   (Code a & b as "**0**"; c & d as "**1**")
   (ii) What is your highest level of education now?
   (a) No education
   (b) Primary/Secondary education
   (c) National Diploma (ND)/College of education
   (d) HND/Bachelor's/Master's/PhD
   (Code a & b as "**0**"; c & d as "**1**")

9. **Age sub-indicator**
   (i) Determine "age at time of flood" from (b) below ____
   (ii) How old are you now? ____ (or 20-29, 30-39, 40-49, 50-59, 60-69, 70-79, 80-89yrs)
   NB: Only ques. "ii" will be asked (Enter the raw age)

10. Transportation access sub-indicator

(i) Did you own a car before or at the time of the flood? YES___ NO __ (Code NO as "**0**"; Yes as "**1**")

(ii) Do you own a car now? YES___ NO ____ (Code NO as "**0**"; Yes as "**1**")

11. Communication Capacity sub-indicator

(i) Did you own a telephone line before or at the time of the flood? YES ___ NO ___ (Code NO as "**0**"; Yes as "**1**")

(ii) Do you have a telephone line now? YES ___ NO ___ (Code NO as "**0**"; Yes as "**1**")

12. Language competency sub-indicator

(i) Did you speak at least pidgin English before or at the time of the flood?
- (a) Not at all
- (b) Not so well
- (c) well
- (d) Very well

(Code a & b as "**0**"; c & d as "**1**")

(ii) Can you speak the pidgin English now?
- (a) Not at all
- (b) Not so well
- (c) well
- (d) Very well

(Code a & b as "**0**"; c & d as "**1**")

13. Special needs sub-indicator

(i) Did you or a family member have any physical or mental health challenges at the time of the flood?
- (a) Physically disabled and needed help evacuating
- (b) Physically disabled but did not need help evacuating
- (c) Not disabled but needed help due to chronic illness or old age
- (d) None of the above

(Code a & b as "**0**"; c & d as "**1**")

(ii) Do you or a family member have any physical or mental health challenges now as a result of trauma from the flood event?
- (a) Physically disabled and will need help evacuating
- (b) Physically disabled but will not need help evacuating
- (c) Not disabled but need help due to chronic illness or old age

(d) None of the above

(Code a & b as "**0**"; c & d as "**1**")

14. Insurance sub-indicator

(i) Before the flood did you have health insurance?
- (a) I had none and I cannot pay heavy medical bills
- (b) I had none, but I could pay for all my medical bills
- (c) I had insurance, but the company only paid a few medical bills
- (d) I had insurance and they could pay most medical bills

(Code a & b as "**0**"; c & d as "**1**")

(ii) Do you have health insurance now?

(a) I have none and I cannot pay heavy medical bills
(b) I have none, but I can pay for all my medical bills
(c) I have insurance, but the company pays only few medical bills
(d) I have insurance and they can pay most of my medical bills

(Code a & b as "**0**"; c & d as "**1**")

15. Housing capital sub-sector

(i) Before the flood did you own or rent the house you lived in? RENT __ OWN __
(Code RENT as 0 & OWN as 1)

(ii) Are you a renter or landlord now? RENTER ____ OWNER/LANDLORD____
(Code RENTER as 0 & OWNER as 1)

16. Employment sub-sector**

(i) Were you employed at the time of the flood? NO ___ YES ___
(Code NO as 0 & YES as 1)

(ii) Are you employed now? NO __ YES__
(Code NO as 0 & YES as 1)

17. Income and equity sub-sector

(i) What was your monthly income before the flood? _____
(or N0-N20K| N20-N40K| N40-N60K| N60-N80K| N80-N100K| N100-120K| etc.)
Please note that N0-N20K & N20-40K are interpreted in statistics as < N20K & < N40K respectively

***NB**: No coding is required as the exact figure is used in computing the GINI index*

(ii) How much do you earn per month now? _____
(or N0-N20K| N20-N40K| N40-N60K| N60-N80K| N80-N100K| N100-120K| etc.)

NB: The same conditions as in (i) apply.

18. Single sector employment dependence sub-indicator**

(i) In what profession were you before the flood?

(a) None/self-employed
(b) Fishing/Farming
(c) Other
(d) Civil Servant

(Code a & b as 0; c & d as 1)

(ii) In what profession are you now?

(a) None/Self-employed
(b) Fishing/Farming
(c) Other
(d) Civil Servant
(e) (Code a & b as 0; c & d as 1)

** Questions 16 and 18 should be alternatives (Ques 16 should be dropped)

19. Gender employment sub-indicator (**for female respondents only**)

(i) Were you employed at the time of the flood? NO ___ YES ___
(Code NO as 0 & YES as 1)
(ii) Are you employed now? YES, __ NO__
(Code NO as 0 & YES as 1)

20. Business size sub-indicator

(i) Before the flood did you own your own business? YES,__ NO __ If YES, how many people did you employ?
(a) None
(b) Self and/or 1 more
(c) 2
(d) 3 and above
(Code a, b, & c as 0; d as 1. NB: This criterion may change based on field assessment)

(ii) Do you run your own business now? YES, __ NO __ If YES how many people work for you?
(a) None
(b) Self and/or 1 more
(c) 2
(d) 3 and above
(Code a, b, & c as 0; d as 1. NB: This criterion may change based on field assessment)

21. Health access sub-indicator

(i) Before the great flood who did you consult first when you were sick beyond just headache or fever?
(a) None/Self-medication/Traditional doctor
(b) Chemist/Nurse
(c) Pharmacist
(d) Orthodox Medical Practitioner
(Code a & b as 0; c & d as 1)
(iii) Who do you consult now when you are sick, beyond just headache and fever?
(a) None/Self-medication/Traditional doctor
(b) Chemist/Nurse
(c) Pharmacist
(d) Orthodox Medical Practitioner
(Code a & b as 0; c & d as 1)

22. Mitigation 1 sub-indicator

(i) Before the flood, were you satisfied with all measures that the government or its agents had in place like building a sea wall, or enforcement of building codes or warnings on radio, TV, etc. to stop river overflow from causing a disaster?
(a) Not satisfied at all
(b) Not sure
(c) A little satisfied
(d) Very satisfied
(Code a &b as 0 & c & d as 1)
(ii) How about now?

(a) Not satisfied at all
(b) Not sure
(c) A little satisfied
(d) Very satisfied

(Code a &b as 0 & c & d as 1)

23. Mitigation 2 sub-indicator

(i) Before the 2012 flood were you participating in any saving scheme (like a savings account, social club, Isusu', etc.) because you were apprehensive that one day, the flood might damage your things?

(a) Not at all
(b) Not sure
(c) A little
(d) Very much so

(Code a &b as 0 & c & d as 1)

((ii) Since that flood event, have you opened additional saving schemes or increased your savings to help you against any unforeseen flood disaster?

(a) Not at all
(b) Not sure
(c) A little
(d) Very much so

(Code a &b as 0 & c & d as 1)

24. Mitigation 3 sub-indictor

(i) Before the flood did you ever think you could be affected by that level of flooding?

(a) Very much so
(b) Not sure
(c) Very little/A little
(d) Not at all

(Code a & b as 0 & c & d as 1)

(ii) Do you now think you have taken enough precautions to prevent that level of flood from affecting you again?

(a) Not at all
(b) Not sure
(c) Very little/A little
(d) Very much so

(Code a, b & c as 0; d as 1)

25. Mitigation 4 sub-indicator (additional) – Drills

(i) Before "the great flood" did you receive drills or mock exercises by authorities on what to do in the event of R. Benue overflowing its banks and posing a danger?

(a) None
(b) Not sure
(c) A few

(d) Very Much

(Code a & b as 0 & c & d as 1)

(ii) Since after the flood have you been given any drills or mock exercises regarding how to act in the event of a recurrence?

(a) None
(b) Not sure
(c) A few
(d) Very Much

(Code a & b as 0 & c & d as 1)

26. Flood coverage sub-indicator

(i) At the time the 2012 flood occurred, did you think that the losses that you or others suffered would be compensated for by the government?

(a) Not at all
(b) Not sure
(c) A little
(d) Very much so

(Code a &b as 0 & c & d as 1)

(ii) Now do you think that any similar loss in the future will be compensated for by the government?

(a) Not at all
(b) Not sure
(c) A little
(d) Very much so

(Code a &b as 0 & c & d as 1)

27. Municipal services sub-indicator

(i) Before the flood, were you ever a volunteer member of an organized group of first responders helping to evacuate people in an emergency (flood, fire, etc.)?

(a) Not at all
(b) Not sure
(c) Sometimes
(d) All the time

(Code a &b as 0 & c & d as 1)

(ii) Do you still belong to any such group now or participate in that activity now?

Not at all

(a) Not sure
(b) Sometimes
(c) All the time

(Code a &b as 0 & c & d as 1)

28. Political fragmentation sub-indicator

Of what tribe are you please? _____NOTED ABOVE_____

(a) Jukun and others
(b) Igede
(c) Idoma

(d) Tiv

Code a as 0; b, c, & d as 1;

29. Previous disaster experience sub-indicator

(i) Before the great flood, how many times did you suffer flood damage and had to rebuild?

(a) Many times,
(b) A few times
(c) Only once
(d) None
(Code a & b as 0 & c & d as 1)

(iii) Other than the damage of the 2012 flood; how many times have you had a flood damages and rebuilt?

(a) Many times
(b) A few times
(c) Only once
(d) None
(Code a & b as 0 & c & d as 1)

30. Mitigation and social connectivity program

(i) Before the great flood, how many volunteer **groups** (not persons, but groups) existed that you know that helped out in the community whenever an emergency event like a flood disaster occurred?

(a) None
(b) Only one
(c) Two
(d) Three or more
(Code a as 0 & b, c & d as 1)

(ii) How many volunteer groups that you know exist now to help out in the community in the event of another flood?

(a) None
(b) Only one
(c) Two
(d) Three or more
(Code a as 0 & b, c & d as 1)

31. Housing type sub-indicator

No Questions to be asked but a (mental) note of the type of house. A note of the type of house: Is this house a Shanty?

(a) Very much so
(b) A little
(c) Not a shanty
(d) Very modern and solid-looking
(Code a & b as 0; c & d as 1)

32. Shelter capacity sub-indicator

(i) At the time the great flood occurred did you have a place accessible to you and unaffected by the flood that you could run to immediately?

(a) None
(b) A few
(c) Many
(d) Very many
(Code a as 0; b and c & d as 1)

(ii) If a flood of that magnitude occurs now do you have a place to evacuate to?

(a) None
(b) A few
(c) Many
(d) Very many
(Code a as 0; b and c & d as 1)

33. Medical capacity sub-indicator

How many hospitals outside this area not affected by the flood do you know that have been built since the great flood (the flood of 2012).

(a) None
(b) 1
(c) 2 to 4
(d) 5 and above
(***NB: This question does not apply to the time of the flood***. Code a as 0; b, c & d as 1)

34. Access/evacuation potential sub-indicator

Take note of the distance in Km of house from the arterial (main) road leading out of Town in case of evacuation____**NOTED EARLIER**___

(a) Within 1 Km
(b) Within 2 Km
(c) Within 3 Km
(d) More than 3 Km
(Code a as 1; b, c & d as 0)

35. Housing age sub-indicator

Do you know (can estimate) when this house was built BEFORE 1990__ AFTER 1990__
(Code AFTER as "0" and BEFORE as "1")

NB: There is only one part to this question

36. Sheltering needs sub-indicator

(i) At the time the flood occurred how many evacuation shelters (hotels, motels, schools, including newly constructed temporary shelters, etc.) were closest to you?

(a) None
(b) 1
(c) 2

(d) More than 2
(Code a & b as 0; c & d as 1)

(ii) If that flood was to occur again how many public spaces (hotels, motels, schools, etc.) would be closest to you before temporary ones are erected that you can run to? ____
(a) None
(b) 1
(c) 2
(d) More than 2
(Code a & b as 0; c & d as 1)

37. Place attachment 1 sub-indicator

(i) In your opinion, before the flood do you think more people were coming into this community than the number leaving, or you think that more were leaving than coming in; or you think there is no change, or you don't know?
(a) More leaving community than coming in
(b) No change
(c) I do not know
(d) More were coming in than leaving
(Code a, b, c as 0; d as 1)

(ii) What about now, do you think more people are coming into this community than the number leaving, or you think that more have been leaving than coming in; Or you think there is no change, or you don't know?
(a) More leaving community than coming in
(b) No change
(c) I do not know
(d) More were coming in than leaving
(Code a, b, c as 0; d as 1)

38. Place attachment 2 sub-indicator

Were you born in this city or this state? NO _____ YES ____
(Code NO as 0; YES as 1)

39. Political engagement sub-indicator

Did you participate in the last (2015) election exercise? NO__ YES__
(Code NO as 0; YES as 1)

40. Social capital 1 sub-indicator – Religion

(i) Before the flood did you use to attend Mosque or church, or any other place of worship?
(a) No
(b) Rarely
(c) Occasionally
(d) Very often
(Code a & b as 0; c & d as 1)

(ii) Do you still attend a Mosque, Church or any other place of worship now?
(a) No

(b) Rarely
(c) Occasionally
(d) Very often
(Code a & b as 0; c & d as 1)

41. Social capital 2 sub-indicator: civic involvement

(i) Before the flood did you belong to a social club (including town's meeting, political party, professional body, mechanics, landlords' association, Parents'/Teachers' Association, vigilante, rotary, Knighthood, etc.?) NO _YES_
(Code NO as 0; YES as 1)
(ii) Do you belong to any of those now? NO __YES__
(Code NO as 0; YES as 1)

42. Social capital advocacy sub-indicator

(i) At the time of the flood did you know of any advocacy group(s) that helped in raising money for Victims of disaster besides the Church or Mosque?
(a) None
(b) 1
(c) 2
(d) More than 2
(Code a as 0; b, c, & d as 1)

(ii) At this present time, do you know any group(s) that could help raise money for victims of disaster? _____

(a) None
(b) 1
(c) 2
(d) More than 2

43. Innovation sub-indicator

QUESTIONS (**NB**: Response to this question can be extracted from Ques.1 of Social resilience and does not need to be asked again. However, the coding is different).

(i) What was your level of education by the time of the flood in 2012?
(a) No education
(b) Primary/Secondary education
(c) National Diploma (ND)/College of education
(d) HND/Bachelor's/Master's/PhD
(Code a, b, & c as 0; d as 1)

(ii) What is your level of education now?
(a) No education
(b) Primary/Secondary education
(c) National Diploma (ND)/College of education
(d) HND/Bachelor's/Master's/PhD
(Code a, b, & c as 0; d as 1)

SUPPLEMENTARY QUESTIONS

1. Can you say that the community will cope better this time if that level of flood ever occurs again? YES____ NO___
2. Do you think that your answer is due to the number of years you have lived here, in other words, your experience with floods? YES___ NO ____

SUGGESTED FOR INCLUSION IN FUTURE RESEARCH ON THE SAME OR SIMILAR SUBJECT.

1. Before the flood, were you (or your house) served with any notification by the government or its agents to do any work on the property to help against flood?
2. Have the authorities ever asked you to consider moving away to a safer zone?
3. How would you describe the crime rate before the flood?
4. How many people were in your household at the time of the flood/disaster?
5. What's your marital status?
6. Media: How quickly can the community get to the frontline media – newspapers, TV, social media, etc., to attract a quick response?
7. Have any physical changes been made to your building to make it stronger against flood/disaster?
8. What is the rent inequality index within the community

APPENDIX B: Statistical Results – Research Question 1 (RQ1)

Since the mean Community Flood Disaster Resilience Index (CFDRI) for the community over two time periods are μ1 and μ2, we conduct Paired Sample t-tests to determine whether there is a statistically significant difference in resilience between the means of the resilience indicators of the same sample.

STEP 1: We define the hypotheses

Null Hypothesis (H_0): There is no significant difference between the two Means.

Thus, H_0: $D_\mu = 0$

Alternative Hypothesis (H_1): There is a significant difference between the two Means.

$H_1 = D_\mu \neq 0$

Where D_μ is the mean of the differences

STEP 2: We compute the differences

For each indicator, compute the difference between the two years:

D_i = Difference of each indicator ($X_{2012} - X_{2018}$)

X_{2012} = Indicator for 2012 and,

X_{2018} = Indicator for 2018

STEP 3: We compute the Mean and the standard deviation of the differences

The Mean of the differences (D) is given

$$D_\mu = \frac{\sum D_i}{n}$$

The standard deviation of the differences (δ) is:

$$\delta = \sqrt{\frac{(D_i - D_\mu)^2}{n-1}}$$

where:

D_i = Individual differences or differences for each indicator ($X_{2012} - X_{2018}$)

n = number of paired observations (same for both conditions)

n-1 = Degrees of freedom

STEP 4: We Compute the Test Statistic:

The paired t-test statistic is computed using:

$$t = \frac{D_\mu}{\delta/\sqrt{n}}$$

t = test statistic

D_μ = mean of the differences between paired observations

δ = standard deviation of the differences

STEP 5: We determine the critical value or p-value

We use a t-distribution table or a p-value

The degree of freedom (df) is calculated as df = n-1

Using a significant level of $\alpha = 0.05$, we compare the calculated t-value to the critical t-value from the table for df = 4

STEP 6: We make a decision

If $|t| > t_{critical}$, OR $p < 0.05$, we reject H_0 and conclude that there is a significant difference; but were $|t| \leq 0.05$ OR $p > 0.05$ we fail to reject H_0 and conclude that the difference is not statistically significant.

$|t| = 0.5915$, and $t_{critical} = 2.776$

Since < 2.776, we fail to reject H_0

Again, the p-value for t = -0.5915 for df = 4 is greater than 0.05 further confirming that the difference is not statistically significant.

APPENDIX C: Statistical Results – Research Question 2 (RQ2)

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	Anchor for judgment	1.923	.635	9.180	1	.002	6.842
	Experience	.004	.011	.119	1	.730	1.004
	Male or Female	-.229	.307	.555	1	.456	.796
	Constant	-2.049	.687	8.887	1	.003	.129

a. Variable(s) entered on step 1: Anchor for judgment, Experience, Male or Female.

From the Table, the Logistic regression is given by:

$Log_e = -2.049 + 1.923x_1 + 0.004x_2 – 0.229x_3$

From the Table:

(i) The odds of perceived resilience are 6.842 times higher for the "thinking or opinion or judgment" of the respondent when the years of living in the community (experience) and gender are kept constant.

(ii) For every one-year increase in living in the community (experience), the odds of perceived resilience increase by 1.004-1 or 0.4% when the "thinking or opinion or judgment" and gender are kept constant.

(iii) The odds of perceived resilience are 0.796 lower for a male respondent than for a female when the "thinking or opinion or judgment" of the respondent and the years of living in the community (experience) are held constant.

Hypothesis testing

H_0: $\beta i = 0$

H_a: $\beta i \neq 0$

Anchor for judgment (thinking/opinion): Wald's chi-square statistic = 9.180(p-value = 0.002 < 0.10). So, reject the null hypothesis at $\alpha = 0.10$ (as well as at $\alpha = 0.05$). The sample evidence indicates that the "Thinking or Opinion or judgment" is a "useful" predictor of Resilience perception when the number of years of residence in the community (a proxy for experience) and the gender are held constant.

Experience: The Wald's chi-square statistic = 0.119(p-value = 0.730 > 0.10). So, we fail to reject the null hypothesis at $\alpha = 0.10$ (and at $\alpha = 0.05$). The sample evidence indicates that the "experience" is NOT a useful predictor of Resilience perception when the thinking or opinion and the gender are held constant.

Gender (male or female): The Wald's chi-square statistic = 0.555(p-value = 0.456 > 0.10). So, we fail to reject the null hypothesis also at $\alpha = 0.10$ (and at $\alpha = 0.05$). Thus, the sample evidence also indicates that "gender" is NOT a useful predictor of Resilience perception when the thinking or opinion and the experience are held constant.

Likelihood ratio test

$H_0 = \beta_1 = \beta_2 = \beta_3 = 0$

H_a = At least one of the 3 model parameters differs from zero

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	14.138	3	.003
	Block	14.138	3	.003
	Model	14.138	3	.003

Likelihood ratio test: Chi-square statistic = 14.138(p-value = 0.003 < 0.01) falls in the rejection region. So, reject the null hypothesis at $\alpha = 0.01$. At least one of the model parameters is non-zero. Thus, the logistic regression model appears to provide more useful predictions of resilience perception than the Null model.

Strength of association test

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	240.303[a]	.072	.098

a. Estimation terminated at iteration number 5 because parameter estimates changed by less than .001.

The Nagelkerke R-Square ranges from 0 to 1 and is used to measure the strength of association. Nagelkerke R^2 value of 0.098 suggests a very poor goodness-of-fit, indicative of the degree to which the model parameters improve upon the prediction of the null model.

Classification test table

Classification Table[a]

			Predicted Perception		
	Observed		0	1	Percentage Correct
Step 1	Perception	0	103	8	92.8
		1	71	6	7.8
	Overall Percentage				58.0

a. The cut value is .500

The table indicates that 92.8% of the respondents who think the community cannot cope better if the level of flooding witnessed in 2012 occurs again are correctly classified, while only 7.8% of those who think the community can were classified correctly by this logistic model. The overall percentage of respondents classified correctly and who think the community is less resilient/more resilient is only 58%, leaving those who were incorrectly classified by the model to be 52% (100-58%).

APPENDIX D: Institutional Review Board (IRB) Approval of Field Survey.

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RESEARCH INTEGRITY AND COMPLIANCE
Institutional Review Boards, FWA No. 00001669
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5/1/2018

Augustine Israel
School of Geosciences
11328 Winter Ct
Apt. C
Tampa, FL 33612

RE: **Exempt Certification**
IRB#: Pro00032860
Title: Measuring resilience to natural disaster: A case study of a Nigerian community after The Great Flood of 2012

Dear Mr. Israel:

On 5/1/2018, the Institutional Review Board (IRB) determined that your research meets criteria for exemption from the federal regulations as outlined by 45CFR46.101(b):

(2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless:
(i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation.

As the principal investigator for this study, it is your responsibility to ensure that this research is conducted as outlined in your application and consistent with the ethical principles outlined in the Belmont Report and with USF HRPP policies and procedures.

Please note, as per USF HRPP Policy, once the Exempt determination is made, the application is closed in ARC. Any proposed or anticipated changes to the study design that was previously declared exempt from IRB review must be submitted to the IRB as a new study prior to initiation of the change. However, administrative changes, including changes in research personnel, do not warrant an amendment or new application.

Given the determination of exemption, this application is being closed in ARC. This does not limit your ability to conduct your research project.

We appreciate your dedication to the ethical conduct of human subject research at the University of South Florida and your continued commitment to human research protections. If you have any questions regarding this matter, please call 813-974-5638.

Sincerely,

John Schinka, Ph.D., Chairperson
USF Institutional Review Board