

**RESILIENCE OF RIVER BASED LIVELIHOODS ON
FLOOD-PRONE AREA COVERING THE LOWER
NIGER RIVER IN NIGERIA**

BY

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Abstract

Climate change exerts direct and indirect impacts on the livelihoods of local communities, fundamentally altering the behaviour of farmers and fishers reliant on natural resources. Shifts in climatic factors, notably temperature variations, significantly affect crop yields, thereby influencing the behaviour of communities relying on these resources. Adverse climate events, including floods and droughts, disrupt the economic stability of farmers and fishers, causing varying repercussions across global regions. The escalating frequency and severity of floods pose substantial challenges, impeding agricultural activities, damaging infrastructure, and displacing communities. This leads to income loss, food insecurity, and heightened vulnerability, necessitating resilient measures for river-based livelihoods to withstand and recover from severe flood events. This research employs a comprehensive methodology that integrates physical and human geography to explore the impact of changing climatic factors on floodplain communities' livelihoods. Adopting a mixed-methods approach, the study combines a household survey, key stakeholder interviews, and the analysis of climatic data covering a 30-year period (1991-2021) to provide a nuanced understanding of the vulnerabilities faced by communities along the Lower Niger River.

The primary data collection involved surveying 198 households, selected through a stratified sampling method, capturing diverse perspectives from small, medium, and large farmers, as well as fishers. Additionally, 24 key stakeholder interviews were conducted, identified in collaboration with the All-Farmers Association of Nigeria, ensuring a comprehensive representation of community voices. The use of both quantitative and qualitative methods enhances the robustness of the research, allowing for a multifaceted exploration of the challenges and adaptive strategies employed by these communities.

To analyse climatic trends, open-source terra climate data from the Climate Research Unit (CRU) dataset covering precipitation, runoff, and temperature trends from 1991 to 2021 were utilized. The examination of these climatic variables aims to unravel the intricate relationship between changing environmental conditions and the vulnerability of floodplain communities. Concurrently, a land use land cover change analysis spanning the same period was conducted, providing insights into alterations in the physical landscape.

The participatory approach in this research extends beyond traditional data collection methods, delving into the behavioural dynamics of farmers and fishers during extreme weather events. By assessing the risks posed by flooding and revealing coping strategies employed by these communities, the study goes beyond statistical analysis, providing a deeper understanding of the lived experiences of those directly impacted. The synthesis of quantitative and qualitative data allows for a holistic exploration of the interconnected factors shaping vulnerability. This research not only identifies the climatic stressors affecting floodplain communities but also examines the social, economic, and cultural dimensions that mediate their adaptive capacity. The research reveals multifaceted findings that intricately dissect the vulnerability of floodplain communities along the Lower Niger River. The climatic analysis spanning 1991 to 2021 uncovers alarming trends in precipitation, runoff, and temperature, underscoring the intensification of climatic stressors. Concurrently, the land use land cover change analysis exposes significant alterations in the physical landscape, pointing to the dynamic environmental shifts in the region. The findings highlight disparities in vulnerability, with small farmers facing heightened risks due to individual land ownership constraints and limited resources. Medium farmers, primarily family landowners, exhibit a slightly lower vulnerability, while large farmers demonstrate comparatively lower vulnerability, leveraging diversified land ownership.

The participatory approach delves into the behavioural dynamics of communities during extreme weather events. The study identifies significant risks posed by flooding, affecting

agricultural operations, damaging infrastructure, and uprooting communities. Coping strategies employed by these communities range from traditional practices to innovative adaptations. The study recommends the implement community-based climate education programs to enhance awareness and understanding of climate risks which can empower farmers and fishers to make informed decisions and adopt adaptive strategies. Furthermore, the study prioritizes infrastructure investments that bolster flood resilience, particularly for small farmers. This includes the development of flood-resistant agricultural practices, early warning systems, and improved transportation infrastructure.

DEDICATION

This research is dedicated to the Almighty God whose wondrous creation has provided a source of livelihood to mankind. Also, we dedicate this work to resilient communities along the Niger River in Nigeria whose strength and perseverance in the face of recurrent flooding has inspired this study.

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CHAPTER ONE – INTRODUCTION

1.0 Background of The Study

The world is faced with an interconnected crisis that is linked with climate change, biodiversity loss and poverty entrenchment(Allam et al., 2020). The recent COVID-19 pandemic has added to the repository of disasters in the world, thus making less developed countries more vulnerable. Studies have indicated that river-dependent communities worldwide are facing growing vulnerability due to the combined pressures of climate change and human activities(Allam et al., 2020). These communities face a number of difficulties, such as unchecked urbanization along river beaches, unsustainable farming methods, the degradation of coastal vegetation systems, sand mining, oil pollution, and unlawful dumping of solid wastes (Zabbey et al., 2019).

The adverse effects of climate change have already become evident in river-dependent communities globally, and developing countries are particularly vulnerable. The frequency and intensity of natural disasters have exceeded expectations, leading to detrimental consequences for livelihoods and socio-economic development (King and Brown, 2021). As a result, it is crucial for governments and policymakers to take action to address the common goal of river-dependent communities and mitigate the impacts of natural hazards such as coastal erosion and inundation.

In the African context, the vulnerability of river-dependent communities to the impacts of climate change is particularly pronounced(Field et al., 2012). This implies that African

communities, especially those relying on river resource for their livelihoods, are at high risk of experiencing significant disruptions and challenges because of changing climatic conditions.

These changes manifest in various ways and increased frequency and intensity of extreme weather events, such as floods which have severe implications for agriculture, water availability, and overall community well-being. Changes in precipitation patterns and rising temperatures can disrupt traditional farming practices, threaten food security, and contribute to increased poverty and vulnerability (Effiong et al., 2024b). The increasing global incidence of water-induced disasters, such as floods, is a critical issue that demands urgent attention. Additionally, examining the role of land tenure inequalities provides deeper insight into the vulnerabilities and responses to flooding (Chopra, 2016, Steenwerth et al., 2014, Adebo and Ayelari, 2011).

The Lower Niger River in Nigeria is home to numerous communities that rely on river-based livelihoods, including fishing, farming, and other related activities. However, the area is faced with several difficulties that exacerbate communities' vulnerability to flooding. Flooding is a recurrent challenge in this region, with the 2012 flood event serving as a poignant example of the devastating impact on local communities and their means of subsistence (Mmom and Aifesehi, 2013). The low-lying nature of the area, coupled with rapid population growth, poor governance, and inadequate infrastructure, has exacerbated the vulnerability of the local population to flood-related hazards. One of such challenges is the increasing frequency and intensity of floods, which disrupt agricultural cycles, destroy crops, and deplete fish stocks (Muruganandam et al., 2023). These changes undermine the economic stability of the communities, making it difficult for them to sustain their traditional livelihoods. The resulting economic strain often force individuals and families to migrate, either temporarily or permanently, in search of more stable opportunities.

Geospatial analysis has revealed that several local government areas along the Lower Niger River are at a high risk of flooding, with factors such as elevation, slope, rainfall intensity, and proximity to the river contributing to this vulnerability (Njoku et al., 2020). The impact of these floods is particularly pronounced in low-lying areas, where the combination of rapid urbanization and lack of proper environmental planning has forced many to settle in unsafe areas (Odufuwa Bashir et al., 2012). The consequences of these flood events include loss of life and property, the spread of diseases, disruption of livelihoods, and the depletion of assets and infrastructure(Odufuwa Bashir et al., 2012).

In response to these challenges, households in flood-prone areas have employed various coping strategies, such as temporary relocation, reduced household expenditures, engagement in supplementary income-generating activities, and the sale of property (Opondo, 2013). However, these coping mechanisms are often considered "erosive" in nature, as they can further undermine the resilience of communities in the long term.

Another underlying response is the inequality rooted in land tenure systems, which is often characterized by a lack of formal land rights, especially for marginalized groups such as women, non-indigenes, and people with disabilities (Bhanye, 2023, Salmerón-Manzano and Manzano-Agugliaro, 2023). These groups frequently face barriers to securing land, relying on family or relative land or purchasing land from individuals without formal titles. Consequently, this insecure land tenure exacerbates their vulnerability to floods, as they are less likely to invest in long-term resilience measures.

Additionally, land tenure inequalities exacerbate these difficulties, with many community members, particularly women, non-indigenes and marginalized groups, facing significant

barriers to securing land ownership(Loh, 2023). These inequalities often leave them without the legal rights or resources needed to invest in flood-resilient infrastructure or adaptive farming techniques, perpetuating a cycle of vulnerability and marginalization. During floods, those lacking secure land rights are typically the first to be affected and the last to receive assistance. This unequal access to resources and support not only hinders immediate flood response efforts but also obstructs long-term recovery and adaptation strategies(Tamuno, 2005, Musa et al., 2016, Sallu et al., 2010, Barbier and Thompson, 1998).

This study aims to investigate the resilience of such livelihoods in the floodplains of the Lower Niger River in Nigeria. By examining the complex interactions between climate change, human activities, and the vulnerability of river-dependent communities, this research seeks to identify strategies and interventions that can enhance the resilience of these communities and contribute to their sustainable development. The findings of this study will be invaluable for policymakers, community leaders, and other stakeholders as they develop and implement effective adaptation strategies to protect livelihoods and promote the long-term wellbeing of river-dependent communities.

1.1 Statement of Problem

River-dependent ecosystems exhibit intricate connections between social, economic, and physical elements, intensifying the challenges posed by climate change in coastal communities (Hodobod et al., 2021). The floodplains along the Lower Niger River play a pivotal role in supporting local livelihoods, with communities relying heavily on the river for activities like fishing, farming, and transportation. However, recurrent flooding in the area threatens the adaptability of these livelihoods. Despite the escalating frequency and severity of floods, there is a substantial research gap in understanding the comprehensive dimensions of vulnerability

in these communities. This study aims to fill this gap by examining the socio-economic and environmental factors influencing the vulnerability of diverse farming groups, considering variations in landholding, income, ethnicity, and educational background. The research also focuses on assessing the impact of flooding on different livelihood sectors, particularly agriculture and fisheries.

Environmental changes in the floodplains, including urbanization, deforestation, and alterations in land use, further compound the challenges. These changes not only disrupt natural ecosystems but also compromise the resilience of river-based livelihoods. Despite the critical role of floodplains in supporting local livelihoods, there is limited research on the dynamics of these ecosystems. This lack of knowledge hinders the development of effective policies and interventions to enhance regional resilience and sustainable development. The socioeconomic and cultural dynamics of local communities also significantly influence the resilience of river-based livelihoods.

Gender inequality, poverty, limited resource access, and inadequate governance structures can exacerbate vulnerability to floods and impede recovery efforts. Moreover, adaptation strategies, such as the widespread phenomenon of 'Japa' (mass migration for improved opportunities), present unique challenges. While migration offers individuals a chance to escape hardships, it raises concerns about its consequences for agricultural productivity and the sustainability of rural communities in Nigeria. Therefore, this research seeks to provide a comprehensive understanding of the interconnected factors contributing to vulnerability in the Lower Niger River region, addressing critical gaps and informing targeted strategies for building resilience and sustainable development.

1.2 Aim and Objectives

The primary aim of this research is to apply a sustainable livelihoods approach, tailored to the unique context of the Lower Niger Basin, to assess and understand the socioeconomic vulnerabilities to flooding of farming and fishing households. The study seeks to explore how these vulnerabilities are shaped by livelihood strategies, the impacts of recurrent floods, and how households adapt to mitigate flood-related risks in this highly vulnerable region.

Objectives and Research Questions

To achieve this aim, the study will focus on the following objectives and research questions:

1. Assess the socioeconomic vulnerabilities of farming and fishing households in the Lower Niger Basin to recurrent flooding, focusing on how these vulnerabilities affect their livelihoods.
2. Examine the role of land tenure inequalities in shaping households' capacity to respond to and recover from flood-related risks.
3. Analyse the livelihood strategies employed by different groups (e.g., gender, socioeconomic status) to adapt to flood impacts, and assess their long-term sustainability.
4. Explore how community perceptions of flood risks influence adaptation decisions and socioeconomic resilience.
5. Propose targeted interventions that can strengthen the resilience of farming and fishing communities in the Lower Niger Basin.

1.3 Research Questions

1. What are the specific socioeconomic vulnerabilities of farming and fishing households in the Lower Niger Basin in the context of recurrent flooding?
2. How do land tenure inequalities exacerbate the vulnerabilities of certain households, and which groups are most affected by these inequalities?
3. What livelihood strategies and coping mechanisms are adopted by farming and fishing households to mitigate the impacts of flooding, and how effective are these strategies in building long-term resilience?
4. How do local communities perceive and assess the risks of flooding, and how do these perceptions influence their decisions regarding livelihood adaptations?
5. What interventions or policies can be introduced to enhance the flood resilience of river-dependent communities, particularly in farming and fishing sectors?

1.4 Justification of The Study

The Lower Niger region has witnessed a significant population increase of approximately 50% between 2019 and 2021, as reported by the National Bureau of Statistics in 2021. With the global and Nigerian urbanization rates on the rise, it is anticipated that regions such as the Lower Niger will experience significant population growth over the next decade. Based on current trends, it is possible that the population of the Lower Niger region could increase substantially, potentially approaching a million by 2026 (DESA, 2011, Potts, 2012). If these projections hold true, the region could be considered for metropolitan status, reflecting its urban expansion and increased density. However, this demographic surge raises concerns about the increased vulnerability to man-made urban disasters and the potential impact on livelihood of farmers and fishers alongside other shocks, and stresses.

The Lower Niger River in Nigeria is home to numerous communities that rely heavily on river-based livelihoods, such as fishing, farming, and related activities. However, these communities face increasing challenges due to climate change, particularly the rising frequency and severity of floods. For instance, in 2017, heavy rains in the region and its surroundings left nearly 3,000 homes submerged, displacing an estimated 100,000 people, as reported by (Mashi et al., 2019, KURANGA, 2021).

While there has been some research on the region Umar and Gray (2023), (Ikuemonisan et al., 2023, Tran et al., 2022, Warner and Van der Geest, 2013), there is a pressing need for a comprehensive study that specifically focuses on the resilience of river-based livelihoods in floodplains. As observed by Hurlimann et al. (2021), sustainable community must proactively address the challenges posed by a changing climate, including extreme weather events.

The Lower Niger region is particularly vulnerable to these risks and should be a focal point for enhanced disaster management and resilience efforts. Therefore, this study is crucial for several reasons: Firstly, the study aims to explore the complex interactions between climate change, human activities, and the vulnerabilities of river-dependent communities. By doing so, it seeks to identify strategies and interventions that can enhance the resilience of these communities, ensuring their sustainable development in the face of increasing climate variability.

Secondly, the findings of this study will provide valuable insights for policymakers, community leaders, and other stakeholders. Effective adaptation strategies require a deep understanding of local conditions and vulnerabilities. This research will equip decision-makers with the evidence-based knowledge needed to develop and implement measures that protect livelihoods and promote long-term wellbeing.

Thirdly, the study will shed light on how inequalities, particularly those rooted in land tenure, influence vulnerability and responses to flooding. Understanding these dynamics is essential for creating equitable and effective flood management and adaptation policies.

Fourthly, the study will be enhancing community engagement and empowerment by fostering a sense of ownership and empowerment among residents. Through their insights and experiences the study designs interventions that are not only effective but also culturally and socially appropriate. Also, the research will fill a significant gap in the literature by providing a focused analysis of river-based livelihoods in the floodplains of the Lower Niger River and will contribute to the broader field of climate adaptation research and offer practical recommendations that can be applied in similar contexts globally.

1.5 Structure of The Thesis

The structure of the thesis consists of several chapters that provide a comprehensive framework for the research as shown in Fig.1.1

Chapter Two is after the introduction and concentrates on the conceptual framework and literature review. The purpose of this chapter is to lay the theoretical groundwork and explain the motivation for the study. It starts off by defining the idea of sustainable livelihoods and examining how they might be achieved. The five different livelihoods that the sustainability idea depends on are thoroughly investigated. Additionally, the concept of resilience, borrowed from psychology, is discussed in the context of vulnerable environments, particularly in relation to the poor and their ability to build resilience. The chapter also provides an overview of vulnerability, including different models used to predict vulnerability, and attempts to classify the most affected groups.

Chapter Three delves into the study area and the methodology employed in the research. The chapter explains the characteristics and geographic setting of the study area. It also discusses the reasons for adopting an interpretivist approach in the research. The sources of data, which primarily consist of primary and secondary data, are outlined, and their utilization for identifying hydrological changes in the study area is explained. The chapter further elucidates the community-based participatory technique employed for data collection, including the administration of questionnaires, conducting focus group discussions, and interviews. The sampling technique, sample size, and methods of data analysis are also described. The researcher's positionality, including their perspective and biases, and how it may influence the data collection process, are addressed. Ethical considerations and the utilization of ethical values during data collection are thoroughly discussed.

Chapter Four of the thesis delve into the hydrological changes in the study area establishing the fact that the impacts of hydrological changes in the Lower Niger region on people's livelihoods have been significant and wide-ranging. These changes affect water availability, flood hazards, and all other aspects of water management techniques which increase the vulnerability of people.

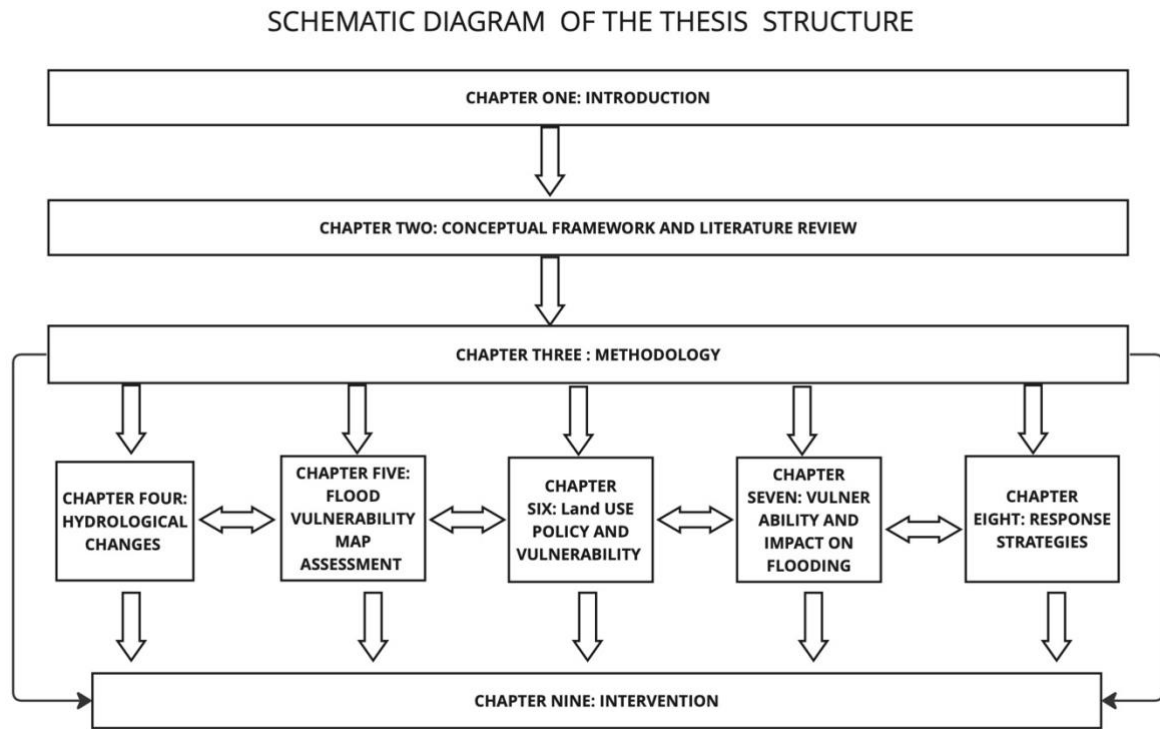


Fig 1.1 Schematic Diagram of the Thesis Structure

Source: Author, 2023.

Chapter Five uses different indicators in GIS to examine and produce flood vulnerability assessment map. These indicators help individuals and communities understand the likelihood and severity of flooding and the most affected area. Through this map, it's easy for policy makers, people, and community to make informed decisions regarding their safety, livelihoods, and property.

In chapter Six, the research discusses the land use policy and its effect on the livelihood of people. The chapter covers land policy from pre-colonial era, colonial era and post-colonial era and examine how the different eras affected the livelihood of farmers.

Chapter Seven discusses factors that contribute to vulnerability of livelihood in the region. The chapter identify both climate and non-climate factors which includes among other things

temperature, changes in rainfall, changes in runoff, gender inequality, post-harvest infrastructure, insecurity etc. Furthermore, the chapter delves into examining different social groups and how they are affected. The study concludes that certain groups are more vulnerable to the impacts of flood risks and the most affected are women, people with disability because they have limited access to resources, information, and services.

Chapter eight examines the response mechanism and how adaptation fits into the context of vulnerability. One key finding in this chapter is the significant migration of people, commonly referred to as 'Japa,' to local and western countries for greater opportunities. In addition, the chapter discusses migration decision and driving factors of migration in the study area.

Chapter Nine is followed by conclusions and recommendations based on the study's outcomes. The interventions needed are based on the study's findings which underscore the need for a sophisticated approach that goes beyond only economic factors but addresses the context of vulnerability in the study area. The structure of the thesis aims to provide a clear and logical progression of the research process, ensuring that each chapter contributes to a comprehensive understanding of the topic and its implications.

In the next chapter, we will discuss the conceptual framework and the literature underpinning this study, providing a theoretical basis for our analysis. By exploring existing theories and research, we aim to contextualize our findings within the broader academic discourse on climate change, land tenure, and community resilience. This will help us to better understand the mechanisms driving the observed impacts and to identify potential strategies for mitigating these challenges.

CHAPTER TWO

CONCEPTUAL FRAMEWORK AND LITERATURE REVIEW

2.0 Introduction

In the previous chapter, we examined the vulnerabilities exacerbated by uncontrolled urbanization, unsustainable farming practices, and inadequate environmental management in the Lower Niger River region. These challenges significantly heighten the region's susceptibility to natural hazards, particularly flooding, which disrupts agricultural cycles, displaces populations, and threatens livelihoods.

In this chapter, we employ Natarajan et al.'s Sustainable Livelihood Framework (SLF) to analyse adaptation strategies at the micro, meso, and macro scales. Alongside this, a political economy (PE) perspective is utilized to explore how systemic inequalities influence access to resources and adaptive capacities. By integrating these frameworks, the research not only investigates the coping strategies employed by farmers in the region but also critically examines the socio-political and economic structures that facilitate or constrain resilience-building efforts.

The PE framework complements the SLF by uncovering the governance structures, power relations, and systemic inequalities that shape resource distribution and adaptation outcomes. Together, these frameworks provide a comprehensive approach to understanding the multi-scalar factors that influence resilience and vulnerability.

Throughout this thesis, these frameworks are revisited and applied to analyse the adaptation practices of farming communities in the Lower Niger River region. In this chapter, concepts such as vulnerability, resilience, and social sustainability are examined, with a focus on the

intersection of power dynamics and resource access. This integrated perspective lays the foundation for the analyses presented in the subsequent chapters.

2.1 Concept of Vulnerability

Vulnerability encompasses the extent to which a system, population, or infrastructure is open to harm or impairment resulting from the impact of hazards or stressors. It is a central concept in disaster risk, climate change adaptation, and livelihood studies, particularly in contexts where environmental and socio-economic risks are intertwined. Vulnerability refers to the degree to which a system, community, or individual is susceptible to harm due to exposure to hazards, sensitivity to those hazards, and their ability or inability to cope with or recover from their effects (Adger, 2006). It is inherently a multidimensional concept, shaped by socio-economic factors, environmental conditions, governance systems, and institutional responses. In development studies, vulnerability is crucial for understanding poverty, inequality, and exposure to climate risks (Biswas and Nautiyal, 2023).

Vulnerability consists of three interconnected components: exposure, sensitivity, and adaptive capacity of which exposure refers to the presence of individuals or communities in hazard-prone areas, such as floodplains or coastal regions (Adger, 2006; IPCC, 2018). See Fig 2.1

Sensitivity relates to how severely a hazard can affect a system or population, influenced by factors like livelihood dependence on climate-sensitive resources, socio-economic inequalities, and lack of infrastructure. Adaptive capacity is the ability to anticipate, respond, and recover from shocks or stresses, shaped by access to assets, institutions, governance, and knowledge systems.

In the Sustainable Livelihoods Approach (SLA), vulnerability is framed through the vulnerability context, which includes shocks, trends, and seasonality that affect livelihoods (Chambers and Conway, 1992). However, political economy perspectives challenge this narrow framing by emphasizing how structural inequalities—such as land ownership, governance failures, and market access—compound vulnerability (Scoones, 2013).

Vulnerability, in disaster risk studies, refers to the susceptibility of a system, community, or individual to harm due to hazards and their capacity to cope (Adger, 2006). However, understanding vulnerability in the context of Political Economy requires deeper analysis of the socio-political structures that create and perpetuate unequal distributions of resources, power, and opportunities. Vulnerability is not just a product of environmental exposure but also a consequence of structural inequalities, such as governance failures, unequal land ownership, and restricted market access (Scoones, 2013). This view helps us understand how certain communities or groups are more vulnerable due to their limited access to decision-making processes and critical resources. For instance, Political Economy perspectives argue that vulnerabilities are socially constructed and are often the result of unequal power dynamics that leave marginalized groups—such as women, the poor, or ethnic minorities—more susceptible to (True, 2012). This understanding of vulnerability considers how socio-economic systems (e.g., wealth inequality, gender norms, and institutional inefficiencies) interact with environmental hazards to exacerbate the risks faced by certain populations.

In the Nigerian context, these inequalities manifest in the form of poor urban planning, inadequate infrastructure, and weak governance. Vulnerability to flooding, for example, disproportionately affects low-income communities, women, and rural populations who have limited access to resources and institutions that could help them adapt (Adelekan, 2011, Ndimele et al., 2024). Therefore, PE approaches are crucial in understanding the vulnerability

in these communities, as they stress that access to power and resources is often governed by political, social, and economic structures that limit adaptive capacities.

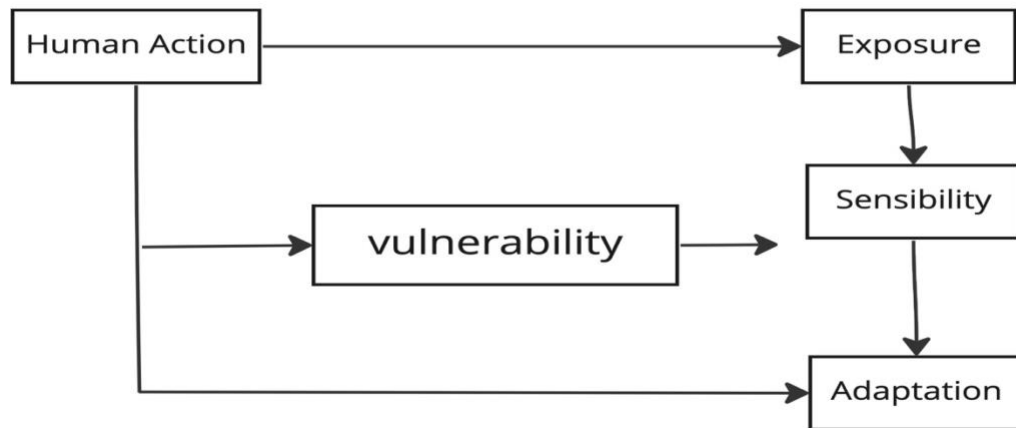


Fig2.1: Demonstrating the Concept of Vulnerability

Source: Author 2023.

2.1.1 Political Economy and Vulnerability

The Political Economy approach employed in this study involves a critical analysis of capitalist systems, delving into issues of inequality, exploitation, and the distribution of economic benefits (Phillips, 2017). It serves to understand the role of states, markets, and institutions in shaping economic outcomes. From a Political Economy perspective, vulnerability is not simply a product of environmental exposure; it is also shaped by social, economic, and political inequalities that structure how different groups experience and respond to hazards. For example, vulnerability to flooding is heightened by land ownership disparities, governance failures, and institutional weaknesses (De Haan and Zoomers, 2006). In contexts like Nigeria, marginalized communities often lack the political power to advocate for better flood

management systems or access to financial resources for recovery, making them more vulnerable than more privileged groups (Scoones, 2013).

Political Economy perspectives on vulnerability also focus on the role of power relations in creating and sustaining inequalities. In flood-prone areas of Nigeria, poor governance and corruption often result in poorly maintained infrastructure and inadequate disaster preparedness systems. These issues disproportionately affect vulnerable populations, such as the urban poor and rural dwellers, whose limited access to decision-making processes leaves them exposed to hazards without adequate support systems (Audu and Aye, 2014).

Additionally, PE approaches emphasise the importance of understanding how global economic systems interact with local vulnerabilities. For instance, global market dynamics can exacerbate vulnerabilities by creating economic dependencies that limit a community's ability to adapt to environmental changes. In Nigeria, the reliance on agricultural exports and global commodity prices can increase rural communities' vulnerability to climate-related shocks like flooding, as these events disrupt agricultural productivity and livelihoods.

2.1.2 Resilience in Political Economy

Resilience, often defined as the ability to recover from shocks, is also closely linked to political and economic factors. A Political Economy approach emphasizes that resilience is not just a matter of environmental adaptation but is influenced by social justice, governance, and equitable access to resources (Béné et al., 2014). Communities with greater access to political power and financial resources are better positioned to implement adaptation measures and recover from disasters.

In Nigeria, for example, resilience to floods is unevenly distributed across socio-economic groups. Wealthier populations in urban centres can often afford to relocate or build more flood-

resistant homes, while poorer communities are forced to remain in flood-prone areas without the means to recover after disaster strikes (Adelekan, 2011). A Political Economy lens shows that resilience is not just an outcome of adaptive strategies but is deeply tied to the distribution of wealth and power.

2.1.3 Concept of Sustainable Livelihood

The Sustainable Livelihoods Approach (SLA) emerged in the early 1990s, most notably through the work of Chambers and Conway (1992), as a way to understand how people secure and sustain their livelihoods in contexts of vulnerability and uncertainty. The approach was initially developed as part of efforts to combat poverty and promote sustainable development by focusing on the diverse ways in which individuals and communities manage their resources and navigate external stresses. They emphasized that a livelihood is sustainable when it can cope with and recover from stresses and shocks, maintain or enhance its capabilities and assets, and provide sustainable livelihood opportunities for future generations (Chambers and Conway, 1992).

The SLA was quickly adopted in development policy, most notably by organizations like Dfid (1999), where it emerged as key framework for understanding how livelihoods are shaped by access to five forms of capital:

- Human capital: skills, education, and health.
- Natural capital: access to natural resources.
- Social capital: relationships and networks that provide support.
- Physical capital: infrastructure and tools.
- Financial capital: income, savings, and credit.

Through this framework, development agencies sought to develop policies that improve livelihoods by enhancing access to these forms of capital, while considering the vulnerability context of communities, such as shocks, seasonal trends, and external stresses like climate change and environmental degradation.

2.1.4 Policy Applications and Critiques

The Sustainable Livelihoods Approach (SLA) has faced significant critiques over time. Critics contend that, despite its widespread influence, the framework places excessive emphasis on local livelihoods and household-level analysis, often neglecting the broader macro-political and economic structures that govern access to resources. This narrow focus can overlook systemic inequalities and larger power dynamics that critically shape the livelihoods of vulnerable communities. For example, Scoones (2013), (De Haan and Zoomers, 2006) highlight how SLA may downplay the importance of power relations, market dynamics, and governance failures that limit livelihood opportunities for the most vulnerable populations.

Recent scholarship has addressed these critiques by proposing ways to make the SLA more dynamic and responsive to larger-scale socio-political forces (Natarajan et al., 2022). This brings in the importance of linking local-level analysis to broader political and economic contexts, often referred to as a political economy (PE) approach. Scholars argue that SLA needs to better account for how unequal power relations, elite capture, and institutional failures shape who has access to resources and whose livelihoods are protected or undermined (Scoones, 2015).

The SLA framework was widely adopted by development agencies such as the UK Department for International Development (DFID), particularly in its 1999 guidelines. DFID's application of SLA was intended to guide poverty alleviation programs by focusing on five key types of

capital assets—human, social, natural, physical, and financial—and how these assets interact within vulnerability contexts, influenced by social, economic, and environmental factors. SLA was seen as a tool for promoting people-centred development, placing the priorities and voices of the poor at the centre of analysis and policymaking (Solesbury, 2003).

Despite its widespread use, the Sustainable Livelihoods Approach (SLA) has faced significant critiques, particularly for its oversimplification of complex socio-political dynamics and its limited focus on power relations. One of the primary criticisms is that SLA tends to focus heavily on local livelihoods and household-level analysis, often failing to consider the broader macro-political and economic structures that shape access to resources and opportunities. For instance, De Haan and Zoomers (2006), (Scoones, 2013) argue that SLA underemphasises the importance of power relations, governance failures, and market dynamics, all of which can significantly restrict livelihood opportunities for vulnerable populations. . By neglecting these macro-level processes, the framework can inadvertently obscure the systemic barriers that constrain people's livelihood opportunities.

A significant critique of the Sustainable Livelihoods Approach (SLA) is its predominant focus on micro-level dynamics, emphasising individual and household coping strategies. This narrow perspective has been criticized for failing to adequately incorporate macro-level political and economic processes, which are essential for understanding the broader structural factors that shape livelihoods (Burawoy, 1998, Challies and Murray, 2011). For example, globalization, land reforms, and neoliberal economic policies have profound effects on poverty and livelihoods, yet traditional SLA frameworks rarely address these dynamics (De Haan and Zoomers, 2006). By focusing predominantly on localized strategies, SLA falls short in addressing the structural determinants of poverty, such as unequal land distribution, labour

market exclusions, and trade policies, thereby limiting its effectiveness in promoting long-term, sustainable development (Johnson and Schaltegger, 2020).

Additionally, SLA has been critiqued for its inadequate attention to gendered labour and the social reproduction of livelihoods (Sugden and De Silva, 2014). Gender roles, particularly unpaid and often invisible work carried out by women in households and communities, are critical to sustaining livelihoods, yet they are frequently overlooked in SLA's emphasis on income-generating activities. Gender inequalities in access to resources, decision-making power, and social roles significantly shape livelihood outcomes (Prosperity, 2016). By not addressing these, SLA fails to capture how gender intersects with other vulnerabilities, such as class and ethnicity, affecting livelihood resilience and overall sustainability.

From a spatial perspective, geographers have pointed out that SLA assumes households are co-residential, unified entities (Carney, 1999). Many households adopt trans local and multi-located livelihood strategies, with family members dispersed across different geographic regions to diversify income sources. These strategies, such as migration and remittances, reflect adaptations to globalized labour markets (Scoones, 2013). However, SLA inadequately accounts for these spatially dispersed strategies, as it tends to focus on localized livelihoods tied to specific places, failing to recognize the complexities of household networks that extend across regions or even countries.

Moreover, critiques from decolonial perspectives challenge SLA's underlying assumptions about knowledge production and application (Joseph Mbembe, 2016). Decolonial scholars argue that, like many development frameworks, SLA is rooted in Western-centric notions of development, which often disregard or marginalize indigenous knowledge systems and culturally specific practices (Curley, 2021, Noxolo, 2017). The tendency of SLA to impose

external solutions, rather than recognizing and valuing local strategies for livelihood sustainability, limits its inclusivity. Decolonial critiques call for an approach that integrates diverse epistemologies and empowers marginalized communities to define their own development pathways, rather than conforming to externally imposed models of progress (Curley, 2021).

In summary, while SLA offers a valuable framework for understanding livelihoods, its limitations—particularly its micro-level focus, neglect of power relations, inadequate attention to gender, and spatial oversimplifications—restrict its capacity to address the complexities of poverty and development in a globalized, unequal world. These critiques highlight the need for a more nuanced and inclusive framework that incorporates macro-political dynamics, gendered experiences, and diverse knowledge systems to promote truly sustainable livelihoods.

2.1.5 Revisions and Contemporary Approaches

In response to these critiques, Natarajan et al. (2022), propose a revised framework that integrates SLA with Political Economy (PE), offering a more holistic view of how livelihoods are shaped at multiple geographic scales, from the local to the global. Their framework bridges the gap between micro-level livelihood strategies and macro-level structural factors, such as global trade, national governance, and regional political dynamics. This integrative framework helps to address the limitations of traditional SLA by incorporating:

1. Power relations: How access to livelihood resources is shaped by power asymmetries between different actors at local, national, and global scales.
2. Institutional structures: The role of governance systems and policies in shaping vulnerability and resilience.

3. Environmental change: How livelihoods are impacted by climate change and other long-term environmental shifts.

By incorporating these elements, Natarajan et al. (2022), provide a multi-scalar analytical framework that emphasizes how vulnerability and resilience are produced through interactions between different actors (e.g., governments, NGOs, local communities) across geographic scales. This approach is particularly relevant to the present study, as it allows for the exploration of how local communities in the Lower Niger River region navigate flood vulnerability within the broader political and economic context of Nigeria.

2.2 Integrative Frameworks: Linking SLA and Political Economy

The integration of the Sustainable Livelihoods Approach (SLA) with Political Economy (PE) provides a comprehensive framework for understanding vulnerability and resilience in the Lower Niger River Basin. While SLA helps us explore the strategies communities use to sustain their livelihoods, PE deepens our understanding by highlighting the structural factors that shape access to resources and opportunities.

2.2.1 The Natarajan et al. (2022) Framework: A Multi-Scalar Approach

In examining the vulnerability and resilience of communities in the Lower Niger River Basin, integrating the Sustainable Livelihoods Approach (SLA) with a Political Economy (PE) perspective is essential. The SLA focuses on understanding the strategies local communities use to sustain their livelihoods amidst environmental challenges such as flooding. In contrast, the PE framework uncovers the structural forces—such as governance, power dynamics, and economic inequalities—that shape access to resources and adaptive capacities. Together, these

frameworks provide a comprehensive view of how vulnerability is locally experienced but globally driven, offering a nuanced understanding of resilience in the region.

The Natarajan et al. (2022) framework adopts a multi-scalar approach, analysing the interactions of local practices, institutional dynamics, and broader political-economic systems at three levels: local actor-based analysis, meso-level institutional dynamics, and macro-level political economy.

1. **Local Actor-Based Analysis:** At the community and household levels, this research examines how people manage their livelihoods using available resources, such as human, natural, social, physical, and financial capital, in response to floods and other environmental shocks (Nkonya et al., 2015). In the Lower Niger River Basin, natural capital plays a pivotal role. Resources such as farmlands, fisheries, and water bodies are central to livelihoods but are highly vulnerable to flood damage, which can lead to significant declines in food production and income. Communities adopt various coping mechanisms to manage these shocks, including planting a mix of fast-growing and staple crops to ensure some harvest before floodwaters arrive, relying on informal support systems for financial and material aid during crises, diversifying into non-farm (Nelson et al., 2007). These strategies highlight the resourcefulness of local actors in adapting to environmental challenges. However, their effectiveness is often constrained by limited access to resources and systemic inequalities.
2. **Meso-Level Institutional Dynamics:** At the regional level, institutions such as local governments, non-governmental organizations (NGOs), and development agencies play a significant role in mediating access to resources and shaping community resilience. For instance, inadequate flood management systems and the lack of infrastructure, such as proper drainage, exacerbate flood risks in the Lower Niger River

Basin. Moreover, institutional failures in implementing disaster risk reduction (DRR) policies leave many communities exposed to recurrent floods (Nur and Shrestha, 2017). Policies and initiatives aimed at reducing vulnerability are often hampered by corruption, mismanagement, and a lack of coordination between regional and local authorities. Thus, the meso-level perspective reveals how institutional dynamics either mitigate or amplify flood risks.

3. **Macro-Level Political Economy:** The broader political-economic context at the national and global levels significantly shapes vulnerability in the Lower Niger River region. For example, governance failures at the national level—such as poor land tenure policies, weak disaster preparedness, and inadequate public investment in flood management—aggravate the vulnerabilities faced by local communities. Furthermore, global economic forces, including trade policies and market dynamics, influence the availability of financial capital and agricultural inputs, making it harder for communities to recover from flood impacts (Fieldman, 2011). The macro-level analysis also uncovers how social inequalities, such as gender-based barriers and economic disparities, are embedded in the political-economic structures, disproportionately affecting marginalized groups.

2.3 Sustainable Livelihoods, Vulnerability, and Flooding

In the context of this research, the Sustainable Livelihoods Approach (SLA) is used to understand how flooding in the Lower Niger River region disrupts livelihoods by damaging key assets such as natural capital (e.g., farmlands and fisheries) and physical capital (e.g., homes and infrastructure). This damage weakens people's financial capital, leaving them more vulnerable to future shocks and increasing the likelihood of falling deeper into poverty (Hynes et al., 2020). Additionally, flooding affects human capital by displacing people, causing health

problems, and disrupting education, further eroding the capacity of households to rebuild their livelihoods (Echendu, 2022b). The SLA framework shows that resilience to such hazards depends on how well communities can manage their assets in the face of shocks. Communities that have more diversified and robust assets are better equipped to cope with and recover from disasters. However, Political Economy (PE) approaches reveal that many of the most vulnerable communities in Nigeria are those with limited access to these critical assets due to systemic barriers such as corruption, poor governance, and social exclusion (Adelekan, 2011). These barriers not only restrict people's ability to accumulate assets but also weaken their resilience, making it hard for them to recover from shocks like flooding.

Political Economy approaches complement the SLA by highlighting the structural factors—such as power dynamics, resource allocation, and institutional failures—that compound vulnerability. The work of Adger (2006), contributes to this understanding by introducing the concept of a social-ecological system, emphasizing the interconnectedness of social and natural structures. This perspective underscores that vulnerability is not just a product of environmental hazards but is also shaped by social inequalities and governance failures. Similarly, Bohle (2002), identifies three key components of vulnerability:

1. The risk of exposure to crises, stresses, and shocks (e.g., floods, droughts, unpredictable rainfall patterns).
2. The risk of inadequate capacities (e.g., lack of entitlements or assets) to cope with these stresses.
3. The risk of severe consequences resulting from crises and shocks.

By integrating the SLA and Political Economy frameworks, this research provides a more comprehensive understanding of flood vulnerability in the Lower Niger River region. While

the SLA identifies local livelihood strategies and coping mechanisms, Political economy examines why certain groups are more vulnerable—often due to issues like land tenure problems, unequal access to resources, and gender-based restrictions on resource use. For instance, the SLA might show that a community relies heavily on farming for its livelihood, but PE would reveal that women in this community are more vulnerable because they are systematically excluded from land ownership or access to agricultural inputs. Therefore, while SLA provides insight into how people cope with floods, PE explains why those strategies may be inadequate, especially for marginalized groups. This combined approach highlights the need for more inclusive policies and interventions that address both the immediate impacts of flooding on livelihoods and the deeper structural issues that perpetuate vulnerability in the region.

2.4 Flood Vulnerability Studies in Nigeria

In Nigeria, vulnerability to environmental hazards—especially flooding—has been extensively studied due to the country’s frequent flood disasters, which are often driven by a combination of poor urban planning, deforestation, and inadequate drainage systems. Nigeria’s vulnerability to flooding is compounded by the socio-economic context, where poverty, weak institutions, and poor infrastructure exacerbate exposure and limit coping capacities (Adelekan, 2011, Echendu, 2022a)

Flooding, particularly in regions like the Lower Niger River Basin, has had devastating effects on livelihoods, displacing populations, disrupting agricultural cycles, and destroying infrastructure (ADEOYE, 2019). Studies by Nigerian researchers have identified the main drivers of vulnerability as a combination of natural hazards, such as heavy rainfall and overflowing rivers, and human-induced factors, such as urbanization, deforestation, and poor

flood management (Amadi and Mac Ogonor, 2015, Nsorfon, 2015, Cirella and Iyalomhe, 2018).

Additionally, gendered dimensions of vulnerability are significant in Nigeria. Women, particularly those in rural areas, tend to be more vulnerable to climate-related hazards due to their disproportionate reliance on natural resources for their livelihoods, restricted access to decision-making processes, and lower levels of education (Chidakwa et al., 2020). Studies have also shown that women in flood-affected areas experience greater livelihood losses and slower recovery compared to their male counterparts, largely due to socio-cultural barriers that limit their resource access and mobility.

Several studies have applied vulnerability frameworks to analyse flood risks in Nigeria. For instance, Adelekan (2011) utilized a vulnerability assessment approach to examine flood impacts in Lagos and found that urban poor communities living in informal settlements are disproportionately exposed to flood risks due to inadequate infrastructure and lack of government support. Similarly, Aiyewunmi (2023) examined flood vulnerability in the Lower Niger Basin, highlighting the role of local governance failures and underscoring the need for improved institutional frameworks to mitigate risks.

Moreover, scholars like Madu and Nwankwo (2021) have used the concept of climate vulnerability to explain how both climatic and socio-political factors shape the vulnerability of different groups in Nigeria, stressing the importance of building adaptive capacities at both the community and institutional levels.

2.4.1 Application of Vulnerability Frameworks in Nigeria

The application of vulnerability frameworks in Nigerian research underscores the importance of multi-scalar approaches that consider both micro-level community dynamics and macro-level structural influences (Irbik, 2022). Vulnerability assessments in Nigeria often combine environmental and social dimensions, examining not only physical exposure to hazards such as floods but also the social, economic, and political factors that exacerbate the impacts of these hazards. This integrated approach helps to reveal how natural and human factors intersect, creating and perpetuating vulnerability in complex ways (Awolala et al., 2022).

Environmental vulnerability in Nigeria typically focuses on physical risks—such as the increased frequency and severity of flooding due to climate change and poor infrastructure (Komolafe et al., 2015). However, social vulnerability, which encompasses poverty, governance failures, and social inequalities, often amplifies the consequences of these environmental risks. For example, inadequate flood management systems, corruption, and lack of political will to invest in resilient infrastructure leave marginalized communities disproportionately exposed to climate-related hazards. Poverty and inequality further limit the ability of these communities to cope with or recover from disasters, thereby intensifying their vulnerability (Ajibade et al., 2013).

In conclusion, vulnerability in the Nigerian context is a multi-dimensional concept influenced by a combination of environmental, socio-economic, and political factors. Research highlights that vulnerability to flooding is driven not only by natural hazards but also by structural inequalities, including poor governance, inadequate social protection systems, and exclusionary policies. Therefore, it is essential to adopt integrated approaches that address both environmental risks and the socio-political determinants of vulnerability. Therefore, adopting

an integrated approach that incorporates both SLA and political economy perspectives allows for a more comprehensive analysis of vulnerability, offering pathways to enhance community resilience and promote sustainable development in flood-prone areas of Nigeria.

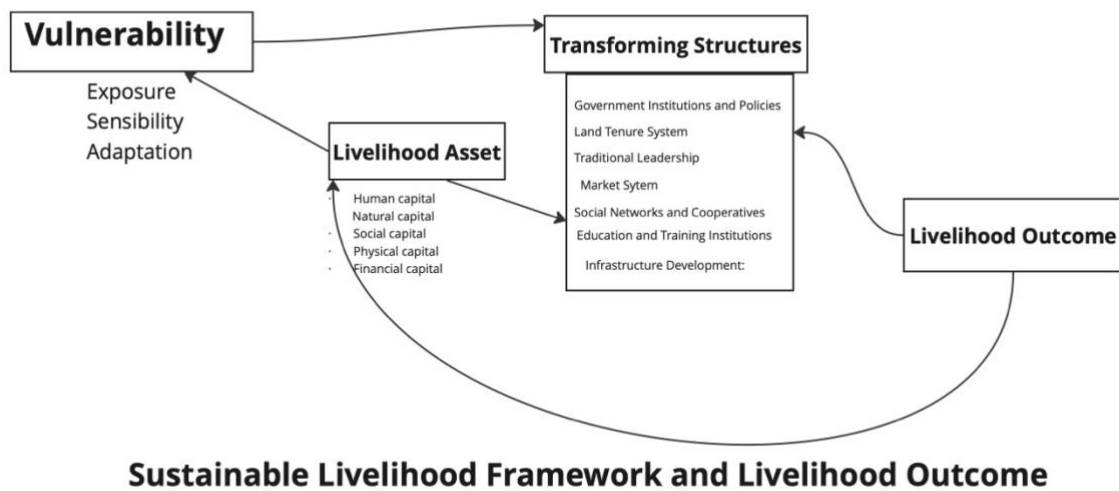


Fig2.2. Sustainable Livelihood Framework

Source: Author, 2023.

2.5 Understanding Livelihood Vulnerability to Climate Change

Vulnerability has often been regarded either due to the harm caused by a particular environmental stressor or because of the situation before a danger strikes (Brooks, 2003). Livelihood vulnerability to climate change denotes the susceptibility of households and farming communities to the ramifications of climate change on their means of sustenance. Numerous factors contribute to livelihood vulnerability, encompassing geographical location, economic status, gender dynamics, and access to resources and services. Various methodologies, such as the Livelihood Vulnerability Index (LVI), have been employed in studies to assess and quantify vulnerability. Therefore, livelihood vulnerability can be understood as a product of biophysical and social factors (Cardona et al., 2012, Cutter et al.,

2012). Biophysical vulnerability refers to the degree of exposure faced by communities from climate induced variability in form of sea level rise, coastal erosion, temperature variability and pollution. This increase household vulnerability and reduce their ability to deal with stress and shock arising from climate hazards(Nyahunda et al., 2021).

Research findings suggest that households situated on the periphery, especially those recently integrated, face heightened vulnerability to climate change and natural disasters (Ngu et al., 2023). For instance, farming households in Southeast Asia, especially in the Mekong region, experience substantial exposure to climate change impacts, affecting their livelihoods and adaptive capacity (Minh et al., 2023). Similarly, smallholder farmers in developing nations encounter diverse levels of vulnerability, with lowland ecological zones demonstrating heightened susceptibility (Zelege et al., 2023).

In addition, studies have shown that salinity levels and increase in temperature due to carbon emission will impact on farmers and limit crop productivity (Tompkins et al., 2018). The interplay of human activities and climate have exacerbated environmental consequences. For example, sand mining has distorted the river flow regime while farming and fishing systems have constructive consequence on the ecological landscape of the region. Similarly, shrimp farming, coastal embarkment, population growth, use of chemicals have significant effect on soil salinity and degradation thereby limiting people's involvement in other livelihoods opportunities (Miah et al., 2010). Climate change will increase environmental hazards in numerous ways which will make the people of the lower Niger river vulnerable(Thomas, 2010). The most recent research suggest that global warming will increase ocean heat leading to intense tidal wave and increase the occurrence of coastal erosion(Hoque et al., 2018, Mukherjee et al., 2019, Rahman, 2009, Juza et al., 2022). Furthermore, extreme weather which is associated with human activity is unleashing unprecedented effect on the earth, which is the

reason Mukherjee et al. (2019), concluded that climate is an extreme driver for the freshwater ecosystem. Also, increase in precipitation will alter rainfall pattern causing flooding in the region (Short, 2022, Kuecker and Hartley, 2021, Ahmad and Ma, 2020). Low flow regime with impact negatively on agriculture productivity and increase salinity intrusion in rivers especially during drought and dry season (Tran Anh et al., 2018, Eslami et al., 2019). The combination of these facts makes communities in the Lower Niger river highly vulnerable as their livelihood depends on natural resources which is sensitive to climate variability (Brown et al., 2018, Tompkins et al., 2018).

Methods for vulnerability assessment, such as the LVI and SIDIK, have proven instrumental in identifying pivotal indicators driving vulnerability and informing policy interventions aimed at mitigating vulnerability (Iliyyan et al., 2022). In rural farming communities within Ethiopia, livelihood vulnerability to climate change is assessed to be moderate, with factors such as access to resources and services exerting considerable influence on vulnerability (Adzawla and Baumüller, 2021). Therefore, this work will explore the intersectionality among diverse demographic groups and their susceptibility to livelihood vulnerabilities, while also elucidating the requisite policy actions essential for fostering resilience.

2.6 Hydrological Changes

Floodplains, as well as river hydrology and biodiversity, are being impacted by climate change. The amount and sources of water in floodplains are changing due to changes in temperature and precipitation patterns, which is causing changes in water balance, chemistry, and biology (Berezowski and Partington, 2023, Ferencz et al., 2023). Floodplain lakes and their ecosystems are being impacted by human activities that further disrupt the natural cycles of inundation, such as dam construction and changes in land use (Siddha and Sahu, 2022). River flows are

also fluctuating due to climate change; lower flows are anticipated in the future, which would enhance habitat degradation and erosion and pose hazards to freshwater and estuarine ecosystems downstream (Berezowski and Partington, 2023).

Furthermore, the hydrological features of floods are being impacted by climate change. Increased flood volume and duration are anticipated, which will have an impact on floodplain ecosystems through changes in vegetation types, increased nutrient availability, and higher rates of peat accumulation (Miroslaw-Świątek et al., 2020). In general, river hydrology and biodiversity are being greatly impacted by climate change, which emphasises the necessity of water management and restoration techniques to prevent the loss and deterioration of these ecosystems.

Studies have revealed that human activities altered the hydrology through the construction of dams, dikes dredging. Similarly, the temperature has a strong impact in determining the rate of increase and decrease of foraging behaviour. Temperature has increase significantly in many parts of the world in the last 30years causing a major alteration in the flow regime and water quality of a region(Montagna et al., 2012, Arnell and Gosling, 2013). For example, a less river flow rate due to low precipitation can lead to increase in pollutant concentration because less water cannot dilute the pollutant. More so, the rising temperature may shift the focus of local communities into reliance on the smaller organism which will pose serious implication for freshwater, livelihood, and food security.

In the work of Badou et al. (2017), the study provides valuable insights into the changes in the hydrology of the Lower Niger River basin during the period from 1970 to 2010. To evaluate the hydrological changes in the area, the study primarily looked at rainfall and runoff patterns in four sub-basins of the Niger River Basin. According to the study's findings, the Lower Niger River basin has seen an overall rise in rainfall and runoff. This indicates that over the provided

period, there has likely been an overall rising trend in the region's precipitation and associated water flow. The observed increase in rainfall and runoff could have important implications for water resource management and ecosystem dynamics within the basin (Shen and Chen, 2010). Furthermore, the study drew attention to the possibility of drought cessation around 1992. This suggests that the lower Niger River basin may have experienced a significant change in its climatic conditions, leading to the cessation of drought events that were previously affecting the region. The identification of this potential turning point in drought occurrence can contribute to a better understanding of the hydrological dynamics and long-term climate trends in the area. However, it is worth noting that the study in Badou et al. (2017) did not provide a clear determination regarding the direction of changes in runoff, and the area that are most susceptible to flooding. This highlights the need for further research and investigation comprehensively assess the hydrological changes within the Lower Niger River basin.

Similarly, the study of Babatolu and Akinnubi (2014) contributes valuable insight into the long-term and recent trends of Niger River runoff, shedding light on the hydrological changes within the Lower Niger River basin. To evaluate the trends in Niger river discharge, the study conducted a thorough investigation spanning the years 1955 to 2010. The study found a negligible rising trend in runoff during this extended time. Although the observed increase in runoff was not statistically significant, it does indicate that the amount of water flowing down the Niger river may have been trending slightly upward over this time.

This finding indicates that there has likely been a notable increase in the volume of water flowing through the Niger river in the more recent years. The significant trend during this period suggests that the hydrological changes within the lower Niger river basin may have intensified in recent decades.

Ologhadien (2019), conducted a study to analyse the trends in annual maximum streamflow, which represents the peak flow events in the Lower Niger river. The findings indicate that there was a negative trend in annual maximum streamflow within the lower Niger river basin which suggests a potential decrease in the overall volume of water during peak flow events. This observed negative trends in maximum streamflow is in line with Ayeni et al. (2015) which averred that the negative trends in streamflow have implications for water availability, flood management, and ecological processes in the region.

Similarly, Ologhadien (2019) also assessed the trends in annual minimum streamflow and observed a mixed trends which indicates a decreasing and increasing trends. These contrasting trends in minimum streamflow suggest variability in the low-flow conditions of the river which suggests the complex impacts of climate change on the hydrology of the lower Niger River basin. It is important to note that these contradictory trends may have a variety of underlying causes, such as changes in rainfall patterns, adjustments to land use, or adjustments to water management procedures.

The study by Descroix et al. (2012), focuses on the potential impact of human activities, particularly intensive cropping and land clearing, may affect the hydrology cycle of the Niger river. The study highlights the role of anthropogenic factors in shaping the hydrology of the lower Niger river basin. Descroix et al. (2012) maintains that human actions, particularly the rise in farming and land clearance activities. These practices not only alter natural landscapes but also contribute to issues such as soil erosion, loss of biodiversity, and disruptions to local ecosystems. Their findings highlight the need for more sustainable land management practices that consider both human needs and environmental protection in the face of climate change which aligns with the work of Marlier et al. (2015), who emphasise the importance of considering the influence of human activities when assessing the hydrological changes in the

lower Niger River basin. By highlighting the potential role of intensive cropping and land clearing, the study calls attention to the need for sustainable land management practices and the consideration of land-use changes in water resource planning and management strategies.

2.7 Impact of Hydrological Changes on Livelihood in the Lower Niger River Basin

Hydrological changes in the lower Niger region have exerted profound impacts on the livelihoods of its inhabitants. Observable declines in both rainfall and river discharge have precipitated numerous challenges, including flash floods and diminished water availability. These changes have especially affected agrarian communities, encompassing crop cultivators, livestock farmers and fishermen, all of whom depend on water for their agricultural pursuits.

The effect of these are manifest in many spectrum which include crop failures resulting from drought, exacerbation of conflicts between farmers and herders, dwindling water resources from well depletion, food scarcity and insecurity, degradation of soil fertility, diminished livestock yields, and proliferation of weed and invasive species (Issaharou-Matchi et al., 2019). In addition, vulnerability to these impacts varies across different demographic groups, influenced by factors such as geographical location and socioeconomic status. For instance, the Kebbi and Niger states, located in the northwestern part of Nigeria, often experience flooding and soil erosion due to changes in water availability and agricultural practices (Audu et al., 2013). Similarly, the Borno State, located in the northeastern part, faces climate impacts, including desertification, exacerbated by both natural and human factors (ETIM, 2024). These areas are not only prone to flooding but also to droughts and resource scarcity, further compounding socio-economic challenges.

Natural and anthropogenic stressors have long been at risk to river because of human induced impacts. Communities that depend on rivers are thought to be more susceptible to climate change due to the combined impact of human-induced stress, which has affected over 75% of the hydrologic changes (Yin et al., 2022). River-dependent communities, particularly those relying heavily on natural resources for their livelihoods, can be particularly vulnerable to the impacts of climate change. These communities' reliance on ecosystem services, water availability, and agricultural output can be greatly impacted by changes in river flows, precipitation patterns, and temperature. This vulnerability can be further exacerbated by limited access to resources, infrastructure, and adaptive capacity in low-income countries. The primary types of disasters in Nigeria encompass floods, droughts, oil spills, bush fires, landslides, and disease outbreaks.

Human-induced stressors can contribute to the alteration of hydrological patterns which includes anthropogenic stressors like water abstraction, dam construction, land-use changes, and pollution which can disrupt the natural flow regime and overall hydrological balance of a river system (Gunawardana et al., 2021). These stressors can negatively impact river-dependent communities by reducing water availability, degrading water quality, altering aquatic ecosystems, and affecting the productivity of agricultural lands. Moreover, the burgeoning population has emerged as a pivotal factor exacerbating vulnerability at the national level, compounding the challenges posed by hydrological shifts and amplifying their socio-economic ramifications.

Due to the cumulative effect of human-induced stress on hydrological changes, the river system has undergone major changes because of many stressors working together. For example, freshwater resources which are relied on to protect natural habitats and to provide for human needs are irretrievably destroyed at substantial cost to the survival of both nature and human

habitation. These alterations can intensify the vulnerability of river-dependent communities to climate change impacts. In addition, limited access to resources, infrastructure, and adaptive capacity in low-income countries can exacerbate this vulnerability, making it challenging for communities to cope with or adapt to hydrological changes and associated climate risks.

The work of Oyerinde et al. (2015), study the hydro-climatic changes in the Niger basin and their consequences for water availability, particularly for farmers and fishermen. The study sheds light on the challenges posed by decreasing water availability and the subsequent implications for livelihoods in the region.

The study's conclusions point to a decline in water availability, which is a major worry for farmers and fishers. Their capacity to carry out beneficial actions like irrigating their crops is directly impacted by the reduced supply of water. As a result, there is a reduction in agricultural productivity, which can have a serious impact on food production and the overall well-being of farming communities. The study highlights the potential threat to food security in the region due to these hydrological changes.

For farmers, the decrease in water availability can hinder their ability to irrigate their crops adequately, leading to water stress and reduced yields. Such changes may have a significant impact on the way of life of farming communities in areas where irrigation is essential for supporting agriculture. Crop failures decreased agricultural productivity, and limited income opportunities can further exacerbate poverty and food insecurity.

Similarly, the reduced water availability also impacts the livelihoods of fishermen in the Niger basin. For fish populations to flourish, there must be enough water movement and suitable habitats. The ecological circumstances for fish populations can suffer with a reduction in water availability. This can result in declining fish populations, reduced catches, and diminished

income for fishermen who rely on fishing activities for their livelihoods. The challenges posed by decreased water availability have direct and tangible consequences for the livelihoods of both farmers and fishermen.

Maintaining a reliable and sufficient water supply is essential for economic stability, food security, and overall quality of life (Capone et al., 2014). This report emphasizes the critical role that water availability plays in sustaining agricultural productivity and supporting livelihoods in vulnerable regions, particularly in areas prone to environmental stressors such as recurrent flooding. Adequate water resources are not only vital for farming and fishing activities but also for ensuring the resilience of communities in the face of climate variability and other socio-economic challenges.

In examining the hydrological changes in the Lower Niger River Basin, Ologhadien (2019), analyses streamflow trends, providing valuable insights into the ongoing hydrological shifts in the region. The study highlights the need for adaptable strategies to address the challenges posed by these changes, particularly concerning water availability, irrigation practices, and fish habitats. The findings from Ologhadien (2019), underscores the importance of developing responsive and sustainable approaches to manage water resources effectively in the context of evolving environmental conditions. The study reveals negative trends in streamflow over the analysed period, indicating a potential decrease in the overall volume of water flowing through the Lower Niger River. This decrease in streamflow can have significant implications for various aspects of human activities in the region, especially for farmers and fishermen who heavily rely on water resources for their livelihoods (Dube et al., 2016). For example, a decrease in streamflow, directly affects water availability for farmers and poses significant challenges for irrigation farming practices thereby leading to reduced crop yields and income for farming communities.

Furthermore, the decrease in streamflow, coupled with a decrease in rainfall is an indication of climate which have far-reaching consequences for water availability, irrigation practices, and fish habitats. Firstly, it disrupts the natural balance and ecological conditions required for sustaining fish populations. Secondly, the impacts on fish habitats can be significant, as reduced streamflow alters the quality and quantity of water in the river (Postel and Richter, 2012). Thirdly, changes in water flow patterns and ecological conditions directly affect the survival, reproduction, and distribution of fish species. This poses challenges for fishermen who rely on fish populations for their income and livelihoods.

Similarly, van Beukering et al. (2005) study underscores the significance of sustainable development strategies in the lower Niger region. The research emphasises the importance of improving the performance of existing infrastructure and economic activities in the Inner Niger Delta as an efficient approach to stimulate economic growth, reduce poverty, and safeguard the environment. Instead of relying on the construction of new dams and hydropower plants, this sustainable development strategy considers the potential negative socio-economic and ecological impacts associated with large-scale infrastructure projects.

By focusing on optimizing the utilization of existing infrastructure, the study recognizes the importance of considering both the short-term and long-term implications of development interventions. It emphasises the significance of striking a balance between economic development, environmental protection, and community welfare.

The work of Oyerinde et al. (2017), provides valuable insights into the adaptive measures adopted by farmers in the Niger Basin parts of Benin to cope with changing hydrological trends. The research identifies various adaptation strategies employed by farmers in response to fluctuating water availability and changing hydrological conditions.

The study emphasises the significance of irrigation techniques as a crucial adaptive mechanism for farmers in effectively managing water supplies. Farmers can make up for decreased water availability and preserve agricultural yield by using irrigation systems. Another adaptive method used by farmers to reduce their sensitivity to hydrological changes is diversifying their crop and income sources. Farmers can reduce the risks associated with varying water supply and guarantee their livelihoods more adaptable to change by increasing their agricultural production and revenue streams.

2.8 Floodplain Farming

Floodplain farming remains most common despite the risk associated with vulnerability to flooding and maladaptive (Ning and Nielsen, 2011). It offers fertile land and regular crop plantation attracting farmers from different locations practicing different livelihood strategies utilizing the diversity of floodplains (Gebrekidan et al., 2020). Generally, floodplains are described as area adjacent to river or stream and are inundated by flood. They are naturally flat valley bottom, and periodically flood because of stream or river overflowing its bank. Studies have shown that many flood plains around the world are used for agriculture because of its natural fertility (Nguyen et al., 2021, Jakubínský et al., 2021). For instance, In the Kilombero Valley Floodplain, three types of farmers were identified: monocrop rice producers, diversifiers, and agropastoral (Tariq et al., 2021). Floodplain ecosystems are among the most quickly declining natural systems of all (Nyantakyi-Frimpong et al., 2023). In the Tobol River floodplain, the degradation and disappearance of floodplain fields are due to lack of haymaking and insufficient pasture load (Liman Harou et al., 2020).

Environments in the floodplain system vary ranging from large rivers, such as the Paraná River main channel, to tributaries such as the Colastiné River, to smaller low-flow rivers such as the

Santa in northeastern Argentina. Some of these environments especially those with lower flow or size, tend to fluctuate over time or disappear. The diversity of aquatic and terrestrial floodplain ecosystems is regulated and sustained by variations that affect the distribution and turnover of habitats within the hydrological regime. However, the detrimental impact of the use of floodplains for agricultural development and human settlements has become all too evident today, exacerbated in many instances by weather events linked to global warming.

Human activities which include draining of wetlands and floodplains for agriculture, enabling continuous invasion of settlements into floodplains and expanding impermeable surfaces within urban areas have increase flood risk in floodplains(Douglas, 2018). Farming is one of the characteristics associated with floodplains. Throughout the year, floodplain wetlands have continuously provided food for small scale farmers as there is access to water and the nature of soil encourages all year farming. The cultivated crops in the region consist of cassava, yam, maize, and guinea corn, with the soil demonstrating strong potential for agricultural production(Morgan, 1959, Nanbol and Namo, 2019). However, human activities—such as changes in land use, fossil fuel combustion, deforestation, and population growth—are contributing to rising greenhouse gas emissions, which in turn lead to global warming. Conversely, the farming systems, technologies, cultural values, and norms prevalent among coastal communities positively influence the coastal landscape, fostering sustainable practices and enhancing environmental resilience.

In Nigeria, floodplain farming is influence by physicochemical properties of the soil, which directly affect crop productivity(Ononogbo et al., 2024). Climate change forecasts suggest an increase in the frequency and intensity of flooding, which negatively impacts farming activities and food production including fish production in aquaculture and fisheries, leading to output

loss (Akukwe, 2019). Furthermore, the absence of effective communication has exacerbated the decline in agricultural production. Despite receiving early warnings, indigenous farmers who lack proper information continue to suffer losses in agricultural production because of the impacts of climate change (Nnadi et al., 2019a). Moreso, human developments have expanded to the flood plains thereby reducing the size of land for cultivation. In most flood plains, housing construction has increased the risk of people living in the region. The exploitation of resources could also render ecosystems more vulnerable to climate change. This aligns with Amedie (2013), who noted that forest over-harvesting has a two-fold impact: firstly, it causes local environmental harm by reducing an ecosystem's resistance to climate change, and secondly, it potentially compounds the severity of climate change itself by releasing stored carbon into the atmosphere.

2.9 Fishing

Throughout the world, rivers have played a pivotal role in sustaining the livelihoods of fishermen and have made substantial contributions to human diets. However, it is crucial not to overlook the impact of climate variability and change on fisheries in coastal and estuarine waters (Salagrama, 2012). These vulnerabilities can exert significant impacts on food security, livelihoods, and overall well-being. Water quality emerges as a critical factor influencing the vulnerability of small-scale fisheries (Onyenekwe et al., 2022). Changes in water quality, such as pollution and contamination, can precipitate declines in fish populations, diminished income, and heightened poverty among fishers (Islam and Chuenpagdee, 2022).

In Nigeria, fishing households are vulnerable to multiple stressors such as climate shocks, environmental degradation, and resource conflicts. These stressors, known as the "triple challenge," collectively impact the livelihoods, sustainability, and resilience of fishing

communities. Climate shocks, including unpredictable weather patterns, extreme events like storms and floods, and temperature changes, disrupt fishing activities, damage infrastructure, and alter fish migration patterns, making fish less available(ESCAP and HIV/AIDS, 2024). Environmental degradation exacerbates these challenges through pollution, habitat destruction, and overfishing. Industrial waste, agricultural runoff, and urban pollution contaminate water bodies, leading to poor water quality and unhealthy fish stocks(Adeyemo, 2003). Deforestation, destruction of mangroves, and wetland loss reduce essential habitats and breeding grounds for fish, decreasing their populations. For instance, overfishing depletes fish stocks faster than they can replenish, threatening long-term viability(Paruž et al., 2024). Additionally, resource conflicts emerge from competition over limited fish stocks, access challenges, and regulatory disagreements. Increased competition among local fishers, commercial enterprises, and other industries that rely on water resources can lead to disputes over fishing grounds and access rights. This heightened rivalry often results in restricted access to fishing areas, legal battles, and, in some cases, violent confrontations.

Differences in regulations and enforcement present significant challenges for fishing communities, leading to confusion and inequities among fishers(Bavinck et al., 2018). The inconsistent application of fishing regulations across various jurisdictions can create an uneven playing field, resulting in unfair competition and unequal access to vital resources. Furthermore, inadequate enforcement of existing laws often allows illegal fishing practices to thrive, depleting fish stocks and jeopardizing the sustainability of local fisheries. This lack of regulatory uniformity can heighten tensions among different fishing groups and impede efforts to implement cooperative management practices. Collectively, these challenges create a complex and precarious landscape for fishing households, highlighting the urgent need for integrated and sustainable solutions to enhance their resilience and secure the long-term sustainability of their livelihoods (Onyenekwe et al., 2022, Onyenekwe et al., 2024).

Vulnerability is influenced by several factors, including sensitivity, exposure, and adaptive capacity. In this context, farming households are generally more exposed to the triple stressors affecting their livelihoods, while fishing households exhibit heightened sensitivity due to their limited asset base (Chukwuone et al., 2022). The decline in fish biomass significantly exacerbates the vulnerability of fishing households, undermining their livelihoods and increasing their financial insecurity. As a result, these households face greater challenges in coping with the impacts of environmental changes and resource scarcity.

Additionally, it is important to note that alongside climatic factors, non-climatic factors such as overfishing, and the loss and degradation of habitats have already led to a reduction in fish stocks. According to Fisheries (2011), fisheries are estimated to contribute 5 million tons to global fish production. However, the production of fisheries is facing significant threats due to natural environmental changes exacerbated by anthropogenic activities (Brander, 2010). For instance, the practice of sand mining in many rivers can alter the hydrological flow of river channels, resulting in shallow and unnatural flows that are detrimental to fish habitats and can pose topographical challenges for fish migration. Additionally, long-term dredging issues are emerging in the Niger River, with one of the most notable effects being the alteration of discharge distribution, leading to flooding in certain regions. Furthermore, population growth and the necessity to meet the growing demand for food are exerting pressure on the natural environment. This is reflected in the cultivation methods adopted by many fishers, who resort to the use of chemicals to meet the high demands of fisheries. Unfortunately, this practice has adverse consequences, including altering the physical composition of water bodies. These unsustainable cultivation methods have resulted in the annual destruction of soil, fish, and wildlife, while valuable vegetation is indiscriminately harvested or destroyed, to the detriment of both present and future generations. Moreover, the increase in runoff volume, brought about by river channel dredging and alterations in impermeable surfaces along major rivers of high

stream order, has led to significant changes. Concurrently, lower stream order tributaries have been progressively narrowed or, in some cases, entirely eradicated due to sedimentation in river channels and the encroachment of urban development (Gaeuman et al., 2005, Ashmore et al., 2023). This has had dire consequences, including overfishing in rivers and the transformation of floodplains in lowland rivers.

Additionally, the convergence of climatic and human pressures has significantly heightened the vulnerability of coastal communities. Research indicates that modifications to floodplains lead to the loss of fish guilds, which in turn diminishes the survival prospects of various fish species and disrupts the fish supply chain. Unsustainable agricultural practices, particularly the use of chemicals in fishing, pose unprecedented threats to both farming and aquatic ecosystems, contributing to the decline and extinction of numerous fish species. This intersection of environmental degradation and unsustainable practices ultimately jeopardizes the livelihoods of those reliant on these vital resources. This observation aligns with the assertion made by Gao et al. (2018), that flood disasters are often more a consequence of anthropogenic factors and human interventions than solely the result of heavy rainfall associated with climate change. In many cases, alterations to river channels, urban development in flood-prone areas, and unsustainable agricultural practices can exacerbate the impacts of heavy rains and contribute to the occurrence of flood disasters. This underscores the importance of addressing human-induced factors in flood risk management and disaster mitigation efforts. Understanding and addressing these vulnerabilities is crucial for supporting the viability and sustainability of Small-Scale Fisheries (SSFs). Efforts should be made to develop climate change adaptation plans specific to fisheries, improve access to natural resources, and align fishing payment policies to ensure the sustainable use of fisheries as a livelihood strategy. By considering the multidimensional nature of vulnerability and implementing tailored management strategies,

Small-Scale Fisheries can be better supported, and marginalized populations can be empowered.

2.10 The Role of Livelihood Stress and Income Disparities in Flood Risk

We synthesize findings from key studies examining the relationship between livelihood stress, income disparities, and flood risk. Our review highlights the vulnerability of low-income households and emphasizes the necessity of supporting these communities in building long-term disaster resilience. In their comprehensive study, De Silva and Kawasaki (2018), assessed the impacts of floods and droughts on households, with a particular focus on income levels. Their research indicates that low-income households experience significantly greater losses from these natural disasters compared to their higher-income counterparts. This disparity can be attributed to the limited financial resources and economic hardships faced by low-income households, which render them more susceptible to the damaging effects of floods and droughts. Moreover, the study identified households heavily reliant on natural resources for their livelihood as particularly vulnerable to flood events. These households are especially vulnerable to the effects of climate-related disasters since they frequently rely on agriculture, forestry, or fishing as their main sources of income. The stability of these households' finances and well-being are greatly impacted by crop loss, infrastructure damage, and disruption of customary ways of life.

Brouwer et al. (2007), conducted a comprehensive study to examine the relationship between flood risk and income disparities, with a focus on the vulnerability of low-income households. The study's findings showed that households with lower income levels and less access to useful natural resources are more vulnerable to flooding. This shows that these households' increased sensitivity to flooding occurrences is significantly influenced by their economic vulnerability

and limited resource availability. The study also made clear that low-income households frequently lack the funds and resources required to put in place efficient flood mitigation measures or relocate to safer places. The physical effects of floods, such as property destruction, loss of livelihoods, and displacement, are therefore more likely to affect them. Their susceptibility is further increased by the limited access to resources, which makes it difficult for them to deal with and recover from flood disasters.

Moreover, the study shed light on the collective vulnerability of low-income households within entire communities and emphasized that when communities are composed predominantly of poor households, the overall vulnerability to flood risk is heightened. This collective vulnerability arises from shared challenges such as limited resources, inadequate infrastructure, and restricted access to information and support systems. These factors increase the community's overall exposure and decrease its capacity to withstand and recover from flood events.

Deria et al. (2020), conducted a comprehensive study that examined the role of income as a significant indicator of adaptive capacity in the face of natural disasters, with a particular focus on flood events. The results of this study show that communities' capacity for adaptation and resilience-building in the face of floods is strongly influenced by their financial level.

The study found that due to financial limitations, low-income communities encounter major difficulties in coping with and recovering from flood occurrences. These limitations prevent them from having access to the tools, funding, and infrastructure they need to respond to floods and lessen their effects. Low-income areas consequently frequently have less resiliency, which indicates a diminished ability to absorb and recover from the negative effects of flood disasters. Furthermore, the study emphasized the importance of promoting inclusive and participatory approaches in resilience-building efforts. Engaging low-income communities in decision-

making processes and empowering them to actively contribute to planning and implementation can enhance their ownership and effectiveness of resilience strategies (Cai and Marks, 2021).

It is crucial to consider the unique social, economic, and cultural contexts of low-income communities and tailor interventions accordingly to ensure their relevance and effectiveness. By recognizing the role of income as a key determinant of adaptive capacity, policymakers and stakeholders can prioritize the support and empowerment of low-income communities in developing long-term disaster resilience strategies. Additionally, making investments in their financial stability, resource accessibility, and capacity-building programmes can lessen their vulnerability to flooding and improve their capability to endure, adapt to, and recover from flooding occurrences. Such activities can help build more just and environmentally friendly communities that are better equipped to lessen the effects of upcoming flood occurrences.

2.11 Perception of Adaptation to Flooding

Perception of adaptation to flooding varies among different regions and communities. For instance, in South Asia, the increase in global surface temperature and change in rainfall patterns have led to an increase in flood frequency and severity. Additionally, the lack of risk perception and vulnerability, as well as the lack of proper architectural adaptations, contribute to the negative consequences of floods which affect people and community (Weerasuriya and Rajapaksha, 2023). Adaptation is a critical element in coping with community's shock and shift associated with climate variability. According Sharifi et al. (2021), adaptation is the ability for a system to respond to potential impact associated with change from climate condition in ways that moderate effect at the same time take good advantage of any opportunity that climate may afford. Adaptation includes policies and actions aimed at reducing exposures to climate

extremes, strengthening vulnerability and build capacity to handle climatic hazards. Moreso, adaptation strategies are to reduce vulnerability to climate change and to sustain and enhance the livelihood of the poor people. This is the reason in many coastal flood zones around the world, individual households make migration and adaptation decisions based on their subjective risk assessments, such as their perception of flood risk. However, there is a need for additional data to address the heterogeneity of risk perceptions across different global coastal households(Kim et al., 2023).

Perceptions of adaptation to flooding exhibit considerable variation across different regions and communities. In South Asia, for example, the escalation in global surface temperature and alterations in rainfall patterns have resulted in heightened flood frequency and severity. Furthermore, the absence of risk perception and vulnerability, coupled with inadequate architectural adaptations, exacerbates the adverse impacts of floods on individuals and communities (Weerasuriya and Rajapaksha, 2023).

Adaptation stands as a crucial element in managing communities' responses to shocks and shifts associated with climate variability. According Sharifi et al. (2021), adaptation denotes a system's capacity to address potential impacts stemming from climate change in ways that mitigate adverse effects while capitalizing on any opportunities that may arise. This encompasses policies and initiatives aimed at diminishing exposure to climate extremes, fortifying vulnerability, and enhancing the capacity to withstand climatic hazards.

Moreover, adaptation strategies are designed to diminish vulnerability to climate change and bolster the sustainability and improvement of livelihoods, particularly among impoverished populations. Consequently, in numerous coastal flood-prone areas worldwide, individual households base their migration and adaptation decisions on subjective risk assessments,

including their perception of flood risk. Nonetheless, addressing the heterogeneity of risk perceptions across diverse global coastal households necessitates additional data (Kim et al., 2023). In tropical flood-prone regions such as the Mayurkashi River Basin in India, the perception of flood management strategies varies across different initiatives. Particularly, there are higher levels of perception variations observed for indicators associated with government initiatives (Islam et al., 2023). The risk perception and adaptation behaviour of residents in areas with diverse flooding characteristics have been extensively investigated. For instance, in rural communities, there tend to be low awareness of flood risk coupled with limited adaptive capacity, underscoring the necessity for heightened public awareness and support for preventive and management measures. Conversely, in urban communities, awareness of flood risk tends to be moderate, indicating its presence among both educated and uneducated individuals, with varying levels of adaptation observed among these groups (Elum and Lawal, 2022).

The work of Alfieri et al. (2016), examined the implementation of adaptation strategies to mitigate the impact of river flooding on population and assets. The study emphasized the importance of developing and implementing effective adaptation measures to reduce future damage and limit the number of people affected by river floods. It highlighted the need for different configurations of adaptation measures tailored to local contexts, considering factors such as flood severity, geographical characteristics, and socio-economic conditions. The study underscored the significance of proactive planning and investment in adaptation to build resilience and minimize the vulnerability of communities to river flooding.

Similarly, the work of Wannewitz and Garschagen (2021), focus on the perception of adaptation options in Jakarta, specifically in relation to flood risk. The study found that there is a bias towards protection-based measures, such as constructing flood defences, while

alternative strategies like soft adaptation options and measures to live with or retreat from flood-prone areas are less commonly considered. The research highlighted the importance of broadening the range of adaptation options and encouraging a more comprehensive approach to flood risk management. It emphasized the need for promoting a shift in perceptions towards a more diverse and inclusive set of adaptation strategies that better reflect the complex nature of flood risk and its management in urban areas.

Song et al. (2019), conducted a study that focuses on assessing the effectiveness of low-impact development (LID) initiatives in mitigating urban flooding risks. The study places a strong emphasis on how adaptation functions as an indicator for gauging the success of LID therapies. The study's conclusions show that LID treatments have the potential to improve resilience to urban flooding by strengthening adaptation capability. The results of the LID initiatives show that they can significantly reduce the harmful effects of urban flooding by improving the social-ecological system's capacity to adapt to flooding occurrences and absorb their negative effects. The study carryout by Nasrin et al. (2022), explores the concept of migration as an adaptation strategy in the context of climate and environmental vulnerabilities. The study provides a thorough review of the ways in which migration is viewed and investigated as an adaptive response to these difficulties. The study acknowledges that migration might not always be a free option, but rather one that is compelled by external factors.

Climate change and environmental vulnerabilities, such as extreme weather events, sea-level rise, or prolonged droughts, can have significant impacts on people's living conditions and livelihoods. These challenges can drive individuals and communities to seek alternative options for survival and adaptation, including migration.

By delving into the understanding that migration can be a response to environmental pressures and the loss of capabilities, the study contributes to a broader discussion on climate change adaptation and the role of migration in enhancing resilience. It clarifies the intricate connections among migration, adaptation, vulnerability, and climate change and offers insightful information on how to interpret migration as an adaptation strategy and its effects on vulnerable groups.

The study carryout by Vinke et al. (2022), examines the notion of migration as an effective adaptation strategy for people in climate-vulnerable settings, particularly in relation to agricultural distress in sub-Saharan Africa. The study questions the dominant narrative by investigating whether migration can truly provide a viable solution for vulnerable populations facing climate-related challenges in the agricultural sector. We argue sequel to Dambeebo et al. (2022), that while migration can be a potential coping mechanism for individuals in the face of climate-related agricultural distress, its effectiveness as an adaptation strategy is not universally applicable or guaranteed. We emphasise that the ability to migrate and the outcomes of migration are influenced by a range of factors, including socio-economic conditions, access to resources, and the availability of supportive infrastructure and services. We then proposed that adaptation strategies should include the evaluation of flood hazards based on available information and climate change impact predictions; the preparation of flood hazard and flood risk maps; and the development of risk management plans based on the outcomes of relevant studies.

2.12 Summary

This chapter has provided a robust theoretical framework by grounding our study in key concepts such as Sustainable Livelihood, Resilience, and Vulnerability. These concepts serve

as a foundation for interpreting our empirical findings, offering a structured approach to understanding the complex dynamics of flood vulnerability in the Lower Niger River region. Furthermore, the chapter has identified gaps and limitations in current research, highlighting areas where new insights can be generated. By synthesizing relevant literature, we have pinpointed areas requiring further investigation, which will contribute to advancing knowledge and understanding in the field of climate adaptation and community resilience. Moreover, this theoretical grounding has informed the development of targeted policies and interventions tailored to address the specific needs and vulnerabilities of communities in the Lower Niger River region. By aligning our study with practical implications, we aim to support decision-makers, community leaders, and stakeholders in implementing effective strategies that strengthen resilience and foster sustainable development amid environmental challenges.

CHAPTER THREE

METHODOLOGY

3.0 Introduction

In the previous chapter, we established the conceptual framework and reviewed the relevant literature to understand the dynamics of sustainable livelihood, resilience, and vulnerability among floodplain farmers in the Lower Niger River region. This foundational understanding highlights the need to apply the concept of sustainable livelihood to explore the risks and adaptive strategies of these communities.

Building on this groundwork, this chapter delves into the methodology employed in this study. Here, I present a detailed account of the research design used to collect and analyse data, ensuring that our approach is robust and reliable. Additionally, I will discuss the ethical considerations and positionality issues that are crucial to conducting this research responsibly and transparently. These aspects were not elaborated on in the previous chapter but are vital for ensuring the integrity and credibility of the study.

As emphasized by Yin et al. (2014), (Yin, 2012, Yin, 2003) research design is an essential outline of a study which seeks to address logical problems of a study thereby providing the right questions to study. Similarly, De Vaus (2001) avers that with the research question, research design can give what data is needed to answer question or test theory realistically. This observation suggests the need for research design which will enhance the coherency of the research and offers strong support to all part of the study. This is the reason I have devoted this chapter to describe the research design showing how data was collected to support all components of this work. I have addressed the research design under the following sub-headings: Research design, Research Philosophy, Research Type, Time Horizon, sampling technique, sample size, Data Collection and Data Analysis.

3.1 Location

The Lower Niger River is in Nigeria, the most populous nation in west Africa with the population of over 216million people (Commission, 2022). Nigeria lies on longitude $2^{\circ}14'30''$ E and latitude $4^{\circ}14'0''$ N of the equator. It is bounded in the North by Niger Republic and Chad, in the South by Atlantic Ocean and in the West by Cameroon and Benin Republic. It has a total land area of 923,768sq.km and water area of 13,000sq.km (Eludoyin et al., 2023). The Nigerian territory encompasses a substantial portion of the Niger Basin, comprising 28.3 percent of its total area, equivalent to 424,500 square kilometres. Within this expansive region, the Lower Niger Basin extends across 20 of Nigeria's 36 states, delineated by the intricate network of waterways that include the Niger and Benue rivers, along with 20 tributaries. Notably, most Nigeria's major rivers find their origins within the Niger River Basin, collectively contributing to nearly 60 percent of the cumulative length of all significant rivers in the country.

The Niger River Basin holds even greater significance in terms of human habitation, as it serves as a home to a substantial portion of Nigeria's population. Approximately 60 percent of Nigeria's total population, comprising roughly 67.6 million inhabitants, have established their lives within the boundaries of the Basin. This substantial demographic presence is emblematic of the fundamental role that Nigeria plays in the larger context of the Niger River Basin, encompassing as much as 80 percent of the entire Basin's population.

Map of Nigeria Showing the Study Area

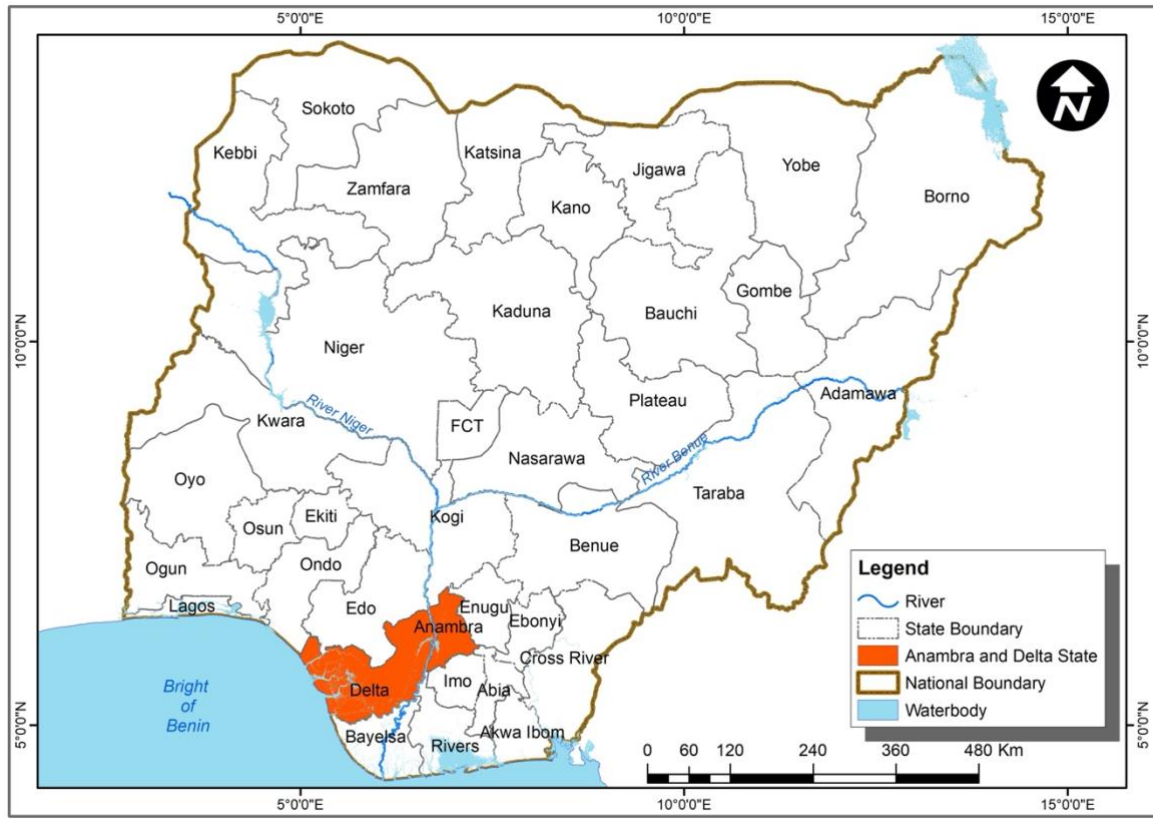


Fig 3.1: Map of Nigeria Showing the Study Area

Source: Author, 2023.

The case study for this research focused on the Lower Niger River, a crucial source of livelihood for the community, depicted in Fig. 3.1 and Fig. 3.2. The Lower Niger River stretches 450 km from Delta to Lokoja, Kanji to its discharge point into the sea. Geographically, it is situated at approximately longitude 7°03'N and latitude 7°03'E in Asaba, and longitude 6°02'52"N and latitude 6°04'18"E in Anambra State. The region is bordered by Anambra West Local Government Area to the north, Ihiala LGA to the south, Anioch LGA in Delta to the west, and Onitsha South to the East. It is approximately 75 km downstream from the Nigerian border while joining from the Sokoto River (Eludoyin et al., 2023). The characteristic of the lower reach of the Niger River can be described with a broad floodplain which is seen in the South of Idah in Delta State except in Onitsha, Anambra State (Udo, 1970).

Furthermore, there are sand and clay which promote sand mining activities as livelihood by residents of the communities bordering the river. Studies have shown that island of sand is following the direction of the flow of the river which is estimated to be around forty-three islands per 100miles in the middle of the Niger valley (Laë et al., 2004, Adeaga et al., 2017). In the Lower Niger River, there are many major tributaries which include the Anambra, Sokoto, Rima, Kaduna, Gbako and Gurara rivers up to the confluence with the Benue at Lokoja. There are also important tributaries of the Benue River, the Gongola, Taraba, Donga, Katsina-Ala and Mada Rivers. The flow of the river is still adequate in the dry season (November-March) to sustain agricultural activities with maximum salinity at 280/00. According to Eruola et al. (2021), the annual rainfall in Nigeria varies from a little 1000mm to 1500mm depending on the region. More so, the region is affected by monsoon rainfall and contributes to the rainfall runoff which brings a discharge of about 158 million cubic meter of water annually in addition to the groundwater of the main aquifer (Eruola et al., 2021). Around July, there is flash flood in the basin due to torrential rainfall and during December the basin witness Black flood which occurs due to international flood though not every year. In the region, water coarse are re-vitalized through runoff and groundwater inflows and the rainfall in the catchment brings a discharge of million cubic water annually.

The Guinea Savanna Belt dominates the Lower Reaches of Niger River which showcase the flourish nature and appearance of plants in coastal communities. The area is known for an extensive forest reserved with notable plant species like Mahogany, Iroko, Obeche tress which are good materials for furniture and building construction. The region comprises essentially of basement complex which is composed of igneous and metamorphic rocks. The major rocks in the area are the surrounding mountains which are hilly and composed of mica-schist, gneisses, and Meta sediments. It exhibits high relief pattern with weathering materials which gives a thin

soil that is eroded by rainfall water and give fine aggregated that can be used for building construction. The soil in the region is loamy with a mixture of clay and silt and promotes farming activities.

Human activities in the Lower Niger River are expressed in form of farming, fishing which is a source of livelihood and development system for the people of the region. The urban centre in the region is in the floodplains and rural settlement exists as traditional communities with pronounced rural-urban migration. There is a mixed farming activity in the form of mixed cropping and livestock farming. Economic activities thrive in the region and include sand mining, lumbering, timber logging, hunting, forest exploitation, fishing, boat making, oil exploration, commerce, and industrial activities. Fishery production is done in the basin by artisan in the brackish water, coastal water, lakes, and inland rivers. Also, the Basin is prominent for timber logging which constitutes the major occupation of the people of Kogi, Anambra, rivers, and Bayelsa States. Oil and mineral exploitation are mainly in the Delta area of the basin while industrial activities like mining, construction and processing are major livelihood activities that dominate the study area. Studies have shown that human activities have altered the natural vegetation of the area especially the rate of urbanisation which encourages housing development. Furthermore, sand mining has distorted the river flow regime, farming and fishing systems have constructive consequence on the ecological landscape of the region. For example, in the work of Alaci et al. (2011), the vegetative cover of Kogi in 1987 was 42.21km² and has reduced to 8.41km² in 2005 because of the land use land cover change because of human activities.

Map Showing the Study Area

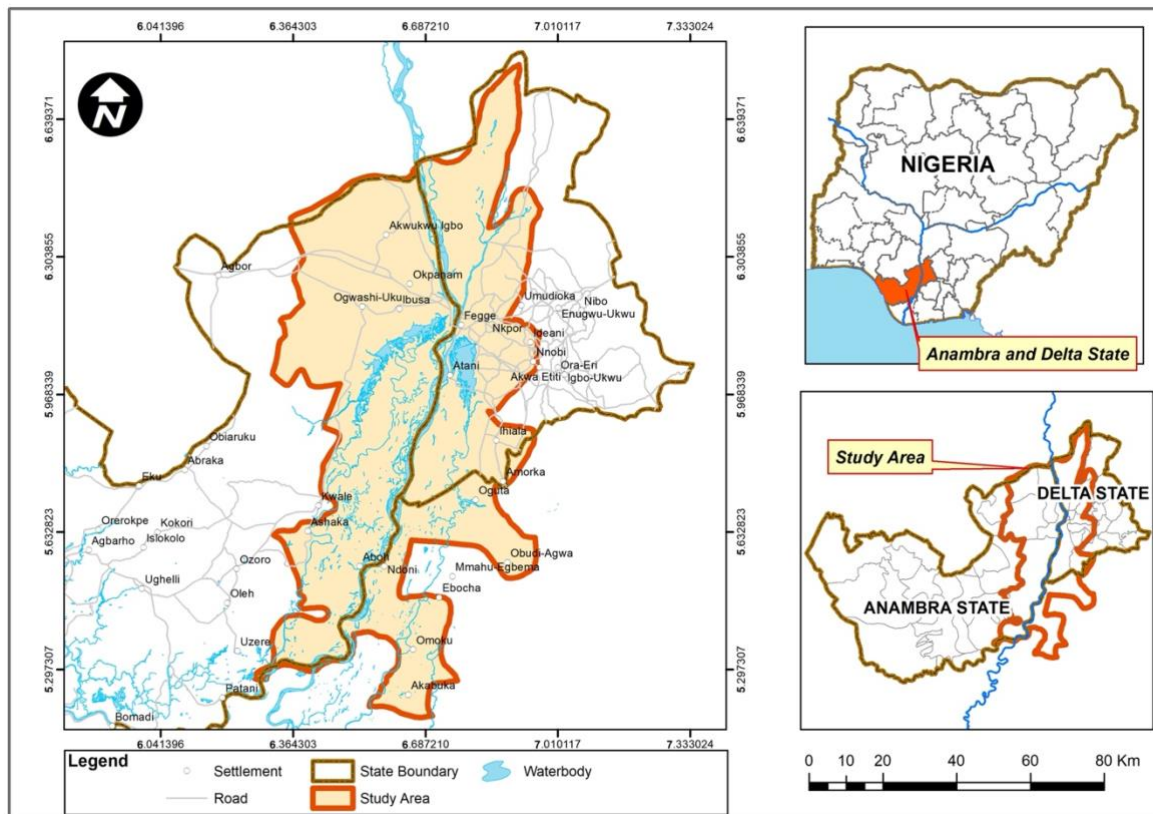


Fig 3.2: Study Area
Source: Author, 2023.

3.2 Research Philosophy

This research adopts a positivist philosophy, which is closely associated with deductive reasoning and quantitative research methods. Positivism emphasizes the testing of theories and hypotheses through observable, measurable data. Unlike interpretivism, which seeks to understand the subjective meaning of human experiences, positivism focuses on identifying causal relationships and generalizable patterns in objective reality (Alharahsheh and Pius, 2020).

In line with the positivist approach, this research starts with the formulation of clear hypotheses based on existing theory, which are then tested using structured, quantitative methods. Positivism supports the view that knowledge is derived from empirical observation and

objective measurements. It emphasises the validity and reliability of data and promotes scientific inquiry aimed at uncovering general laws that explain patterns or behaviours (Weber, 2004). This approach prioritises rigour in data collection and analysis, focusing on quantifiable variables and statistical tests to validate or invalidate hypotheses. Although interpretivism is frequently used in qualitative research for understanding the complexities of human behaviour, this research aligns with a positivist methodology to ensure the objective testing of theoretical propositions. While pragmatism, as discussed by Strübing (2007), emphasises practical verification of truths, it does not override the primary aim of this research to test hypotheses using systematic and quantifiable methods rooted in positivist principles.

By adopting positivism, this research employs a deductive approach, which begins with a theoretical framework and seeks to test its applicability through empirical data. The research will rely on data collection techniques such as structured surveys and experiments to gather numerical data that will be analysed using statistical methods. This approach aims to uncover broad patterns or relationships between variables and to contribute to theory-building through objective, verifiable results.

In summary, positivism guides this research, emphasising the measurement of variables in an objective manner, and the deductive approach ensures that hypotheses are tested in a systematic, controlled manner. Through this approach, the study aims to uncover causal relationships and contribute to the scientific understanding of the vulnerability in the Lower Niger Region.

3.3 Research Type- Deductive Approach

This research adopts a deductive approach, which begins with established theories or frameworks and tests them through the collection of empirical data (Ali and Birley, 1999). A deductive approach, typically associated with hypothesis testing, moves from the general to the

specific. It starts with a theoretical premise or hypothesis and proceeds to observations to confirm or reject the hypothesis, maintaining a structured and systematic methodology.

As Clark et al. (2021), explain, deductive reasoning uses existing theories to develop hypotheses that can be empirically tested. This contrasts with inductive approaches, where theory emerges from the data. In deductive research, a conceptual or theoretical framework guides the study, setting expectations for relationships between variables before data collection. These hypotheses are then tested using collected data to verify the relevance of theoretical assumptions.

This approach is particularly suitable for the current study as it allows for the application of established frameworks—such as the Sustainable Livelihoods Approach (SLA) and Political Economy (PE) theories—to evaluate their relevance in assessing vulnerability and resilience in flood-prone communities (Natarajan et al., 2022). By testing the applicability of these theories in the Nigerian context, the research seeks to analyse how well they explain resilience strategies of affected populations (Béné et al., 2011).

3.3.1 Application to the Research Framework: Integrating SLA and Political Economy (SLA-PE)

The revised **SLA-PE framework** Natarajan et al. (2022), provides a valuable lens for organizing the research framework in this study. This approach aligns with the research objective of understanding how macro-political economy forces, such as government policies and market structures, intersect with local, actor-based livelihood strategies in the flood-prone Lower Niger River region. By integrating these perspectives, the research explores both the structural constraints that shape vulnerability, and the adaptive strategies employed by individuals and communities to enhance resilience. In this study, I apply a three-tiered analytical framework across micro, meso, and macro levels to examine the multifaceted impact of flooding on communities in the Lower Niger River region. This framework allows for an

integrated analysis, encompassing individual and household responses (micro), community and institutional interactions (meso), and broader policy and economic influences (macro). By analysing these interconnected levels, the research design aims to capture the complexities of vulnerability and resilience in flood-affected communities comprehensively.

3.3.2 Deductive Process in this Research

In this study, the deductive process follows a structured sequence:

1. **Theoretical Frameworks:** Drawing from the existing literature on vulnerability, resilience, and livelihood strategies.
2. **Hypothesis Formulation:** Proposing specific hypotheses based on these frameworks, such as the relationship between asset access and community resilience.
3. **Data Collection:** Gathering qualitative and quantitative data from flood-prone areas to test the hypotheses.

3.3.3 Research Design Informed by SLA-PE

The research design follows a structured approach based on the SLA-PE framework:

Macro-level analysis: At the macro-level, data collection will involve conducting policy analysis, reviewing government documents, and conducting key informant interviews with national policymakers and experts in agriculture and environmental management. The primary focus at this level is to understand how national policies and global economic trends influence and shape vulnerabilities in the Lower Niger River region. By examining these broader systemic factors, the research aims to uncover how top-down governance and international market dynamics affect the livelihoods of local communities, particularly in relation to flood vulnerabilities and resilience.

Meso-level analysis: At the **meso-level**, data collection will involve interviews with local institutions, government officials, NGOs, and civil society organizations. The focus of this analysis is to examine how regional and local actors play a crucial role in mediating flood

vulnerabilities and supporting community resilience. By exploring the actions and interventions of these organizations, the research aims to understand how resources are managed and allocated, how adaptation strategies are implemented, and how local governance structures contribute to building resilience against environmental hazards in the Lower Niger River region.

Micro-level analysis: At the micro-level, data collection will involve household surveys, focus groups, and participatory rural appraisal methods to gain insights into livelihood strategies and vulnerabilities at the community level. The focus of this analysis is to assess how households and individuals navigate socio-political constraints and environmental hazards to sustain their livelihoods. By examining their coping mechanisms, access to resources, and community-based adaptation strategies, the study seeks to understand how local actors respond to flooding and other environmental challenges in the Lower Niger River region.

Analysis: The analysis will utilize deductive reasoning to confirm or refute the proposed hypotheses, employing techniques such as thematic analysis for qualitative data and statistical tests for quantitative data where appropriate. This deductive approach ensures the research remains focused on testing established theories, while the empirical findings help to refine or challenge these theoretical frameworks (Casula et al., 2021). The structured design promotes objectivity by adhering to predefined procedures and maintaining consistency throughout the study. By adopting this deductive approach, the research not only evaluates existing theories but also contributes to the broader literature by potentially extending or refining current knowledge on resilience and vulnerability in flood-prone regions.

SLA-PE Research Framework Diagram for Farmers and Fishers in the Lower Niger River Region

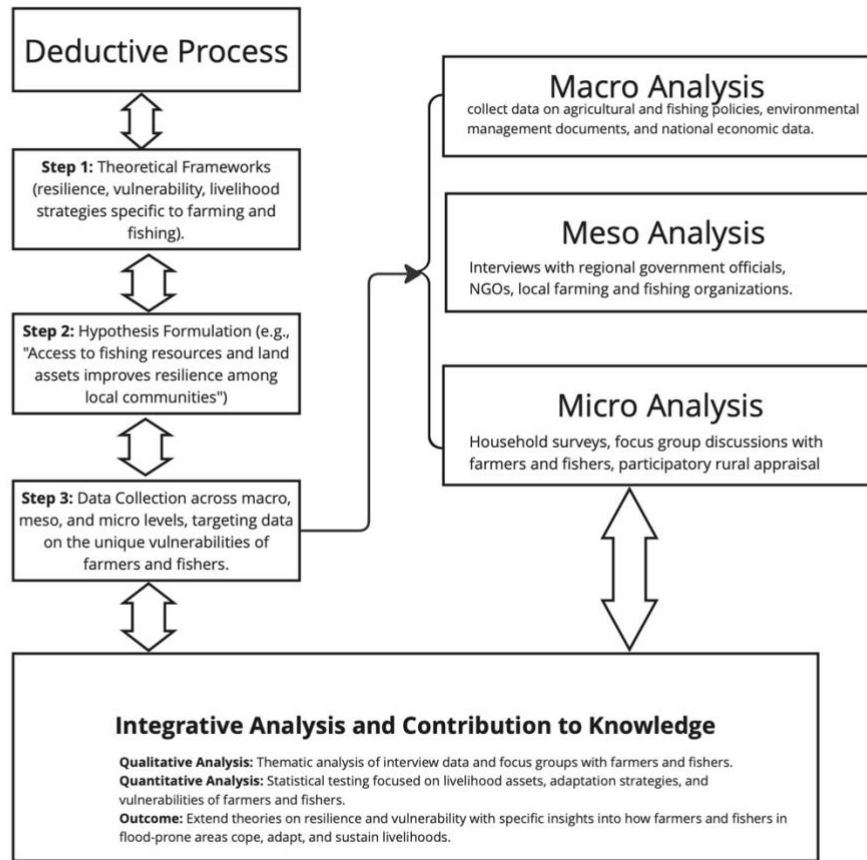


Fig 3.3: SLA-PE Framework.
Source: Author, 2023.

3.4 Time Horizon

Case study approach emphasizes “why” questions more than “what” which informs the choice of this approach. It helps to explore the complexities of issues relating to flood vulnerabilities and resilience (Yin, 2012, Yin et al., 2014). As described by Creswell (2015), case study approach are explored through in-depth data collection and other sources of information gathering. The approach of this research is focus on achieving resilience in flood-prone areas and typically relies on both quantitative and qualitative assumptions to obtain awareness of the

issues in accordance with the approach of interpretivism investigation. To achieve this, a cross-sectional assessment was conducted to rapidly establish the prevalence and relationship between variables at a specific point in time (Mann, 2003). The cross-sectional approach was chosen for several reasons which among other things includes the validity of the results it guarantees, and the fact that it is flexible enough to provide access to a variety of data. More so, it helps in generating systematic observation and analysis of a phenomenon. It is also reasonably descriptive and representative.

3.5 Sampling Technique

The selection of an appropriate sampling technique is a pivotal aspect of any research study, particularly when dealing with a dynamic and multifaceted subject like climate change impacts and resilience-building strategies in flood-prone areas along the Lower Niger River in Nigeria. To capture a holistic understanding of this complex issue, a multistage sampling approach is meticulously designed to ensure the research's validity and representativeness.

The multistage sampling technique adopted in this research is characterized by its thoroughness and commitment to capturing a comprehensive view of the research subject. This multistage approach is designed to enhance the validity, representativeness, and depth of the research findings.

Stage 1: Selection of States The first stage involves a purposive delineation and selection of states that intersect with the Lower Niger River, a geographical boundary crucial for this study. Based on the research's geographical scope, which focuses on specific areas along the Lower Niger River, two states within the south-eastern region were chosen. This selection follows a convenience sampling process to enhance the impartiality of the research.

Stage 2: Selection of Local Government Areas (LGAs) and Communities The second stage of the sampling process entails the purposive selection of two local government areas (LGAs)

and two communities within the identified states. These selections were guided by a series of carefully considered criteria:

1. **River Dependence:** The chosen LGAs must demonstrate a significant economic and livelihood dependency on a river, aligning with the research's focus on river-based vulnerabilities and resilience-building.
2. **Proximity to the River:** Selection favours communities and LGAs located near the Lower Niger River, as their geographical proximity is often correlated with higher flood risks.
3. **Historical Flooding:** Priority is given to villages with a documented history of flooding, as this is a key indicator of the communities' vulnerability to climate-related hazards.
4. **Main Occupations:** Communities whose primary livelihoods are based on farming and fishing, two activities susceptible to climate change impacts, are included in the sample.
5. **Accessibility:** For practicality and cost-effectiveness, all selected communities should be accessible during the sampling periods, allowing researchers to conduct thorough fieldwork.

Stage 3: Selection of Communities: The third stage involves the careful identification and selection of two local communities located near the riverbank. These communities meet the established criteria, ensuring they are well-suited to provide relevant insights into the research's subject matter.

Stage 4: Sampling the Population: The fourth stage is the heart of the data collection process. Here, a combination of instruments, including questionnaires and interview guides, were employed to gather both quantitative and qualitative data. To ensure a fair and unbiased representation of the population, a systematic random sampling technique was utilized for selecting interview respondents.

In the case of the questionnaire administration, heads of households were randomly selected from the communities within the sample. This approach allows for a diverse range of perspectives and experiences to be included in the data collection process.

A team of researchers compiled a list of households residing in the selected communities along the Lower Niger River, assigning each household a unique identification number for reference. Employing a systematic random sampling approach, the researchers selected households at regular intervals from this list, ensuring a representative sample for the study.

3.6 Sample Size

To calculate the sample size, an online sample size calculator (<http://www.raosoft.com/samplesize.html>) was employed. The calculation was performed with a predefined error margin of 5% and a confidence level of 95%, considering the disaster and vulnerability-related focus of the research.

From a household population of 87,177, encompassing the selected LGAs in two states, the online sample size calculator determined that a sample size of 383 was sufficient to achieve the research objectives at the chosen confidence level. This 95% confidence level was selected due to the research's emphasis on disaster and vulnerability-related experiences.

The calculated sample size of 383 participants constitutes approximately 0.4496% of the total household population. This sample size was then equitably distributed among the purposively selected communities to ensure an even representation and minimize potential sample bias.

To select participants for the sample, a systematic random sampling method was employed. Firstly, a list of households within the selected LGAs across two states was obtained from local authorities. Then, using a random starting point, households were systematically chosen at regular intervals from this list until the desired sample size of 383 was achieved. This approach ensured a representative sample from the target population, allowing for diverse perspectives and experiences to be included in the study. However, out of the initially intended sample size of 383, only 198 questionnaires were successfully collected and utilized for the research. This

highlights the deviation from the planned sample size and indicates the actual number of responses obtained for the study.

The meticulous process employed in determining the sample size underscores the research's commitment to statistical rigor and the validity of the findings. The process of selecting an appropriate sample size for the study, was to ensure that the data collected accurately reflects the experiences, perspectives, and vulnerabilities of the population residing in flood-prone areas along the Lower Niger River.

Table 3.1 - Selected Communities and Sample Size

| State | LGA | LGA Household Population | Sample Size (0.4496%) | Purposively Selected communities | Household size (0.4496%) |
|--------------|----------------|--------------------------|-----------------------|----------------------------------|--------------------------|
| Delta | Oshimili South | 34,938 | 88 | Okwe | 78 |
| | | | | Oko | 79 |
| Anambra | Ogbaru | 50,239 | 226 | Odekpe | 113 |
| | | | | Umunankwo | 113 |
| Total | 4 LGAs | 85,177 | 383 | 4 communities | 383 |

Source: NPC, 2006 and Author, 2023

3.7 Focal Villages: Odekpe, Umunankwo, Oko, And Okwe

To contextualize the study of flood vulnerability and resilience, it is essential to introduce and characterize the four focal villages—**Odekpe, Umunankwo, Oko, and Okwe**—which are situated along the Lower Niger River in Anambra State, Nigeria. These villages have been selected based on their geographical locations, socio-economic activities, and frequent exposure to flooding, offering a representative sample of flood-prone communities in the region (Adeoye et al., 2023).

Odekpe

Odekpe is a riverside community located along the eastern bank of the Niger River. It is part of the Ogbaru Local Government Area (LGA) and is predominantly an agrarian village, with

most residents engaged in subsistence farming and fishing. The village is home to approximately 8,000 inhabitants Commission (2013), with farming being the primary economic activity (Anugwom and Anugwom, 2022). Crops like cassava, yam, maize, and rice are widely cultivated. Due to its proximity to the river, the community experiences regular flooding during the rainy season, which disrupts agricultural activities and damages infrastructure. The floods also bring health risks, such as waterborne diseases, which significantly affect the well-being of the residents(Louw et al., 2019).

Umunankwo

Umunankwo, another village in the Ogbaru LGA, lies downstream from Odekpe. With an estimated population of 7,500, this village also relies heavily on agriculture and fishing for its livelihood (Adeoye et al., 2023, Commission, 2013). The community is known for its fishing culture, with the Niger River providing a vital source of fish for both consumption and trade. In addition to farming and fishing, small-scale trading and craft-making contribute to household incomes. However, Umunankwo is highly vulnerable to flooding, as the village is situated on low-lying land that is frequently inundated during heavy rains. The floods erode farmlands and sweep away crops, reducing agricultural productivity and food security(Afolabi et al., 2022). The village also faces challenges in accessing clean drinking water during floods, increasing the risk of diseases.

Okò

Okò, located further inland but still close to the Niger River, has a population of around 10,000 people(Commission, 2013). The socio-economic activities in Okò are more diversified compared to the other focal villages. In addition to agriculture and fishing, Okò is known for small-scale commercial activities and artisanal craftsmanship. The community is involved in trading agricultural produce and handicrafts with neighbouring villages and towns. While Okò

is not as directly exposed to river flooding as the riverside villages, it still experiences significant flood-related challenges, particularly from excessive rainfall and poor drainage systems(Ajeigbe et al., 2024). Floods in Oko often result in infrastructural damage, particularly to roads and schools, making it difficult for residents to access basic services and markets.

Okwe

Okwe is a small but densely populated village situated near the confluence of the Niger and Anambra Rivers. According to Commission (2013), the village has an estimated population of 6,500 people with agriculture, fishing, and trade being the primary economic activities. Okwe is highly vulnerable to both riverine and flash floods. The village's location at the confluence makes it particularly susceptible to seasonal flooding, which disrupts both agricultural productivity and fishing activities. The floods in Okwe tends to be more severe, with greater risks of displacement and damage to homes and community infrastructure(Effiong et al., 2024a). Flooding in the area has also led to the erosion of farmlands, reducing crop yields and further threatening the livelihoods of residents(Oranye, 2020).

3.7.1 Types of Flood Vulnerabilities Experienced

Across all four villages—Odekpe, Umunankwo, Oko, and Okwe—the communities face several types of flood vulnerabilities, including:

1. **Agricultural Vulnerability:** Flooding during the growing season destroys crops and erodes farmlands, leading to reduced agricultural productivity and food insecurity (Idoko, 2016).
2. **Infrastructure Damage:** Floodwaters frequently damage roads, homes, schools, and health facilities, limiting access to essential services(Louw et al., 2019).
3. **Health Risks:** Stagnant floodwaters contribute to the spread of waterborne diseases such as cholera and typhoid, particularly in areas with inadequate sanitation(Ajaero and Mozie, 2010).

4. **Displacement:** Seasonal floods often force residents to evacuate their homes, leading to temporary or permanent displacement and loss of livelihoods(Oranye, 2020)
5. **Economic Vulnerability:** The destruction of crops, livestock, and fishing gear reduces income levels, exacerbating poverty and making it difficult for families to recover from flood impacts(Elisha and Felix, 2021).

These focal villages offer a diverse range of socio-economic and environmental conditions, providing valuable insights into the localized experiences of flood vulnerability and resilience strategies in the Lower Niger River region. Through the study of these communities, this research aims to explore how different geographic, social, and economic factors influence the capacity to cope with and recover from flooding events.

3.8 Data Collection

The collected data underwent a comprehensive analysis, which included assessing the trends and patterns in the hydrology dataset, evaluating the extent of land use and land cover change, and conducting thematic analysis of the qualitative data. Thematic analysis is a flexible method that offers various approaches to interpreting research topics, ensuring that the dataset is condensed without sacrificing its underlying meaning in alignment with predefined themes. Moreover, as Braun and Clarke (2006), have argued, thematic analysis is a valuable technique for providing detailed explanations of a dataset while simultaneously offering insights that can shed new light on a subject matter.

3.8.1 Land Use Land Cover Change (1991-2021)

Geographic Information System (GIS) and remote sensing techniques were employed to assess changes in land cover and land use between 1991 and 2021. Time series data on land use and land cover change in the research area were obtained from the United States Geological Survey

(USGS, <https://www.usgs.gov/>), utilizing Landsat images (TM, ETM+, OLIS/TIRS). Cloud-free images from 1991, 2001, 2011, and 2021 were selected and geographically projected onto UTM 32N WGS84 coordinate system. The raw imagery underwent conversion to Top of Atmosphere (TOA) reflectance values following the methodology outlined by Chander et al. (2009) and Dark Object Subtraction was used to rectify the data, as suggested by Zhang et al. (2010). Following the processing step, the processed image was aligned with the ArcGIS 10.4 research area border shapefile. An image enhancement procedure was then used to categorise the land cover into four groups: vegetation, built-up areas, floodplains, and waterbodies. The Random Forest image classification method, which was first presented by Breiman (2001), served as the foundation for this classification because of its excellent classification accuracy and robustness in comparison to other conventional image classification techniques. The integration of both primary and secondary data sources has played a critical role in this study, leveraging their complementary strengths to provide a holistic understanding of the research topic. Primary data, collected through interviews, enabled respondents to share personal experiences and insights into life in the flood-affected region. These narratives offer a rich and nuanced foundation for shaping policies aimed at building resilience to flooding, aligning with the principles of qualitative research highlighted by Silverman (2013).

Although it is acknowledged that the subjective nature of respondents' accounts in household surveys may not offer an entirely objective or value-free perspective, these narratives are invaluable in validating and contextualizing broader themes related to the research. As Flick (2004) asserts, such experiential data contribute meaningfully to understanding complex social phenomena, emphasizing the importance of integrating diverse perspectives to inform robust policy recommendations. On the other hand, secondary data sources such as hydrology data and satellite imagery enhance the credibility of the study by providing insights into the

dynamics of events and guiding what should be investigated through primary surveys, as outlined in the works of Silverman (2002), (Yin, 2003). The combination of these data sources adds rigor to substantiating academic knowledge concerning the complexities of climate policy actions and their connections to livelihood and sustainable development.

3.8.2 Questionnaire

A questionnaire survey of household heads shall be carried out in the selected communities. The questionnaire was designed based on knowledge from literature review. The questions covered background of respondents; hydrological changes that are observed in the study area which affect livelihood, duration of flooding, other questions are designed based on Likert scales.

In-person research assistants with training distributed the survey questionnaire to participants after explaining the goal of the investigation and obtaining their informed consent. Refer to Plate 3.1. The questionnaire is divided into three main sections. The first section serves as the entry point and includes the participant information sheet along with the participation consent form. Here, participants receive essential information about the study's objectives, potential risks and benefits, and their rights as research subjects. They are provided with a consent form to review and sign, ensuring their informed consent to participate in the research.

Following the initial section, the second part of the questionnaire is designed to capture the respondents' sociodemographic details. This section gathers crucial demographic information such as age, gender, marital status, educational background, types of agricultural products cultivated, farm size, employment history, ownership status of the farm, and monthly income. These details offer valuable context for examining potential variations in how different participant groups perceive and adapt to climate change challenges.

The final portion explores farmers' assessments of the magnitude of flooding damage and their adaptation and reaction strategies to climate change. In this section, participants are invited to share their perspectives on how flooding has affected their farming and fishing activities, considering things like crop loss, property damage, and interruption of livelihood. Additionally, this section explores respondents' strategies and how they adapt to the challenges posed by climate change. Using the technique of Katirtzidou et al. (2023), who examined how stakeholders perceived several climate-related phenomena, we asked respondents if they had seen or expected periodic coastal flooding, water scarcity, or temperature changes.

The final section of the questionnaire is dedicated to exploring land policy and nature-based solutions, with the goal of understanding how farmers in the study area have demonstrated or complied with nature-based solutions as a measure to reduce the impact of flooding. This section plays a crucial role in assessing the participants' awareness, engagement, and practices related to nature-based solutions for flood mitigation and sustainable land management.

Here, respondents will be asked a series of questions aimed at gauging their familiarity with nature-based solutions, such as the use of natural ecosystems like wetlands, forests, and vegetation to reduce flooding risks. Specifically, the questionnaire will seek to understand if the respondents have incorporated nature-based strategies into their farming practices or land management activities. This may include inquiries about activities like reforestation, wetland restoration, or sustainable agricultural practices that align with nature-based principles.

Moreover, the questionnaire assesses the participants' perception of the effectiveness of these nature-based solutions in mitigating flooding and enhancing their resilience to climate change impacts. Their feedback will provide valuable insights into the practicality and acceptance of nature-based solutions in the study area and how these strategies are viewed by local farmers as potential tools for reducing flooding events.

By gathering this information, the study aims to shed light on the extent to which nature-based solutions have been integrated into local land policies and farming practices. It will also help identify any challenges or barriers faced by farmers when trying to implement these solutions. This data is essential for understanding the potential for nature-based strategies to contribute to reducing the impact of flooding and enhancing the overall resilience of the study area's agricultural and fishing communities in the face of climate change.

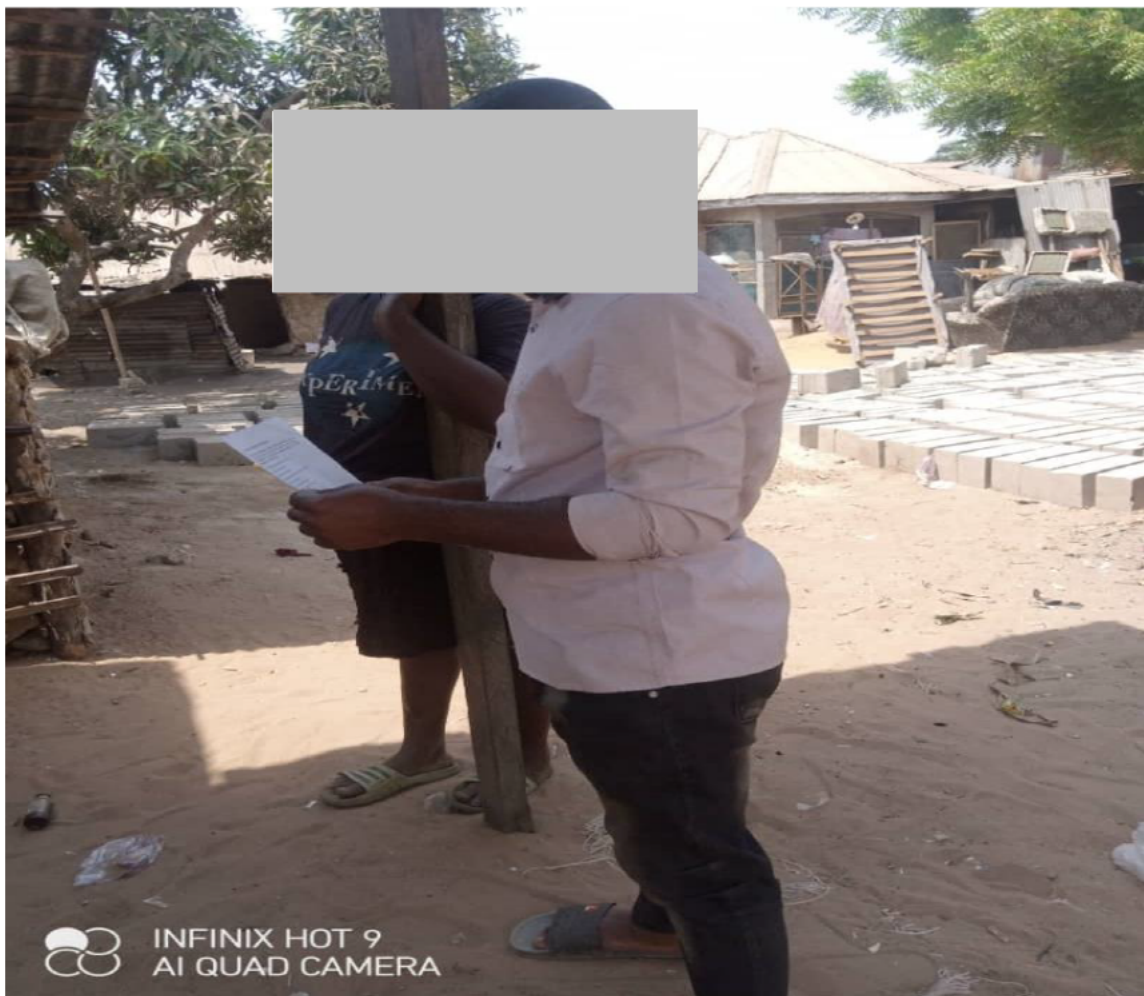


Plate 3.1: Questionnaire Administration During Field Study

Source: Author, 2023

3.8.3 Key Informant Interview

A total of 40 participants engaged in fishing or farming activities were initially identified in from All Farmers Association of Nigeria (AFAN). However, despite three attempts to schedule and conduct interviews, 16 participants declined to participate. Ultimately, 24 participants, comprising 60% of the initially identified individuals, were successfully interviewed across all four communities.

The first stage of interviews involved five participants, of which two were fishers and three were farmers. In the second stage, a total of 11 fishers (16.9% of participants) and 20 farmers (30.8% of participants) were interviewed across the four communities. This distribution reflects the need to explore livelihood risks in the study area, with a greater emphasis on farmers due to their prevalence in the region. By involving a higher number of farmer participants, the study aimed to capture a richer diversity of information from the dominant livelihood source in the area, thereby addressing data saturation concerns (Flick, 2004, Staller, 2021).

To initiate the interviews, I collaborated with a research assistant who was already in Nigeria before the fieldwork began. The research assistant used participant consent forms to secure informed consent from the interviewees as shown in Fig3.2. Following this, we scheduled appointments for the interviews, ensuring compliance with the ethical considerations of the University of Birmingham. Most of the key informant interviews were conducted in the local language, while some were conducted in West African Pidgin. To ensure comprehensive data capture, I recorded each interview to avoid missing any important points.

The interview questions were open-ended, fostering dynamic interactions with the participants and allowing for discussions that naturally extended into various aspects of livelihoods. The duration of the interviews ranged from 20 to 40 minutes per participant.

Despite the overall success of the interviews, several challenges were encountered. The volatile environment of South-Eastern Nigeria, with its recurring "sit at home" orders imposed by non-state actors every Monday, significantly disrupted social and economic activities in the region. This instilled fear in the minds of potential interviewees, making them reluctant to participate. Financial constraints also posed a challenge, as many participants requested some form of compensation in exchange for their involvement. While I was able to provide refreshments after the interviews, this was not always sufficient to persuade more participants to take part.

Key informant interviews were conducted either in person or via phone, with responses meticulously recorded and subsequently transcribed for detailed analysis. Stakeholders were tasked with evaluating distinct hazards and decision-making processes associated with flood risks, fluctuating temperatures, and other notable challenges observed in the study area. Throughout these discussions, we examined the impact of global perspectives on loss and damage within the Lower Niger River Region, aiming to achieve a thorough understanding of the region's strategies and responses to climate change impacts.



Plate 3.2 During Field Study Interview

Source: Author, 2023

3.8.4 Climate Data

An extensive analysis of climate data was conducted, utilizing an open-source terra climate dataset encompassing key parameters such as precipitation, runoff, and temperature. This dataset covered a substantial 30-year period, ranging from 1991 to 2021. The data source for this critical analysis was the Climate Research Unit (CRU) dataset, a widely recognized and respected repository for climate information.

The selection of the CRU dataset was underpinned by several strategic considerations. Firstly, its long-term coverage harmonized seamlessly with the comprehensive 30-year scope of this study. This temporal alignment was essential to capture and evaluate climate trends and patterns over an extended period accurately.

Furthermore, the CRU dataset earned its place as the preferred data source due to its well-established reputation for data quality and consistency. The data within this repository undergoes stringent quality control procedures, ensuring that it remains dependable and robust for research and analytical purposes. Researchers and climatologists worldwide rely on the CRU dataset for its high standard of data quality and the credibility it lends to research findings. The data analysis process leveraged the power of R programming, a versatile and widely used tool for statistical and data analysis. Through this analytical framework, the study sought to unearth insightful trends and patterns within the climate data, thus contributing to a deeper understanding of the environmental dynamics in the study area.

In summary, the utilization of the CRU dataset, coupled with the analytical capabilities of R programming, enabled this research to shed light on critical climate-related aspects. By examining patterns and trends in precipitation, runoff, and temperature over three decades, the study aimed to draw valuable insights that would inform discussions around climate change impacts and adaptation measures in the Lower Niger River region. The choice of a reputable data source and rigorous analytical techniques underscores the commitment to scientific rigor and the pursuit of reliable research outcomes.

3.9 Data Analysis:

3.9.1 Coding

The interview transcripts and field notes underwent a rigorous analysis using a multistep coding method, which included elements of content analysis, to uncover key patterns and themes within the data. This methodological approach, as described by Clifford et al. (2016), involved sequential stages such as open coding, category development, and thematic analysis.

In line with the principles outlined by Longhurst et al. (2008), I viewed my participants as significant agents of affective expression. As I engaged with the transcribed interviews and written field notes, I adopted a thematic analysis approach to scrutinize not only the explicit content of the data but also the subtleties of expression. This involved paying close attention to the nuances of tone of voice, patterns of speech, and the strategic placement of pauses. By incorporating thematic analysis into the coding process, I was able to delve deeper into the underlying meanings and emotional dimensions embedded within participants' narratives.

3.9.2 Analysis of Qualitative Data

The qualitative data collected in this research was analysed using NVivo, a powerful software tool designed for qualitative and mixed-methods research. NVivo facilitates the organization, coding, and analysis of large volumes of textual data, ensuring a systematic and rigorous approach to qualitative data analysis. The choice to employ computer software for the analysis of data in this study was driven by several fundamental considerations. Given the substantial volume of data at hand, the utilization of computer software offered an efficient and expedited approach to managing and structuring this extensive dataset. Moreover, the utilization of such software facilitated the critical task of data analysis in a comprehensive manner, particularly in the context of a mixed-methods research design.

It is worth noting that there is an array of software tools designed specifically for qualitative data analysis (Weitzman, 1999). The decision to utilize computer software ensured that the data could be methodically examined and structured, ultimately aiding the research process.

One of the paramount advantages of employing computer software is that it enables the researcher to maintain intellectual control throughout the analytical process. The software serves as a valuable aid, rather than a replacement, allowing the researcher to apply their

expertise and judgment in interpreting the data. This is particularly important in the context of inductive research, where the generation of themes and the subsequent data analysis demand a high level of intellectual acumen (Creswell and Poth, 2016).

3.10 Data Preparation:

Transcription: All interview recordings were transcribed verbatim to create accurate textual data for analysis. The transcribed interviews, along with other qualitative data sources such as field notes and documents, were imported into NVivo.

3.10.1 Coding:

The data was subjected to initial coding, where key themes and concepts were identified. This involved reading through the data multiple times and marking segments that were relevant to the research questions. Initial codes were reviewed and organized into broader categories and subcategories which help in identifying patterns and relationships between different themes. Finally, selective coding was performed to integrate and refine the categories into core themes that formed the basis of the research findings.

3.10.2. Theme Development:

NVivo's advanced features were used to visualize the data and identify major themes. This involved using word frequency queries, text searches, and matrix coding to explore connections within the data. The identified themes were continually refined through analysis, ensuring that they accurately represented the data and were aligned with the research objectives.

3.10.3 Data Visualization:

Mind Maps and Models: NVivo's visualization tools, such as mind maps and models, were utilized to create graphical representations of the themes and their interrelationships. These visual aids helped in understanding the data's structure and presenting the findings clearly. Furthermore, various charts and graphs were generated to provide a visual summary of the coding frequency and the distribution of themes across different data sources.

3.10.4. Interpretation:

Contextual Analysis: The themes were interpreted within the context of the research questions and the theoretical framework. This involved linking the qualitative findings to the broader literature on flood resilience and livelihoods. Nevertheless, as Conway et al. (2019), wisely cautioned, the interpretation of data of this magnitude must be conducted with a sense of circumspection. A coherent narrative was constructed to explain how the identified themes and patterns contributed to understanding the resilience of livelihoods in flood-prone areas. Direct quotes from participants were used to illustrate key points and add depth to the analysis. It is recognized that different socioeconomic groups are distributed throughout the four distinct study sites, and their perceptions of adaptation may diverge in relation to the study's context. This variance must be acknowledged and factored into the analysis, further underscoring the nuanced nature of the research findings and the significance of taking a multifaceted perspective when examining the multifarious impacts of livelihood stress in the study area.

3.11 Analysis of Quantitative Data

The quantitative data collected from primary sources were subjected to statistical analysis using the Statistical Package for the Social Sciences (SPSS). This software enabled a comprehensive analysis, allowing for the identification and examination of key variables relevant to the research. Both descriptive and inferential statistical methods were employed to analyse the data.

3.11.1 Data Preparation:

The data collected from surveys and other quantitative instruments were entered into SPSS. This included ensuring accuracy in data entry and handling any missing values appropriately. Variables were then clearly defined, including assigning appropriate labels and measurement scales (nominal, ordinal, interval, or ratio).

3.11.2 Descriptive Statistics:

Frequency distributions were calculated to understand the basic features of the data, such as the number of occurrences for each category of a variable. Histogram, bar charts, and pie charts were created to provide visual representations of the data distributions.

3.11.3 Interpretation:

The results from the descriptive and inferential statistical analyses were interpreted in the context of the research questions and objectives. Patterns and trends in the data were identified, providing insights into the relationships and differences among variables. A Spearman rank correlation was employed to assess the degree of relationship within the climate data.

3.12 Positionality

The position of the research is an important issue that affects a researcher; and must be handled in such a way that it does not compromise the data collection process. Aside from the fact that research assistants are recruited to help in research, the position of the research may skew the data collection process in return for money. According to Flick (2004), the experience of research is central to social research which guarantees valid data for analysis and interpretation, which means that every process of data collection must be documented. Furthermore, as Vannini (2015) emphasizes, understanding the role of researchers in shaping knowledge is a

critical concern within more-than-representational research. This perspective challenges traditional representational frameworks, advocating for an embodied and situated approach that acknowledges the researcher's influence in co-constructing meaning with participants. Together, these insights highlight the interplay between methodological rigor and reflexivity in producing robust and contextually grounded social research. This perspective emphasizes the importance of examining how the researcher's positionality influences research outcomes. Throughout my research, I carefully considered various aspects of my positionality, although I can only provide a limited set of reflections. Although, it is generally believed that when a researcher shares the same culture with his subject, data collection may be easy. However, this assertion may not be true especially when a researcher is affiliated with a university abroad. I am confident that my multiple positions in this study helps overcome many obstacles as I was able to seek assistance where necessary to ensure a successful data collection.

As a lecturer in a Nigerian University, my role in facilitating the data collection process involves leveraging both my academic expertise and personal background to ensure a thorough and ethical approach. Additionally, having a colleague from the community where the study takes place can further ease access to the study area and enhance the quality of interactions with the community members. The goal is not to exploit these positions to influence the data collection process but rather to build trust and confidence among participants, ensuring they feel comfortable sharing information without fear of intimidation or undue influence. In this study, my academic position provides a structured approach to research methodologies and data analysis, ensuring rigor and reliability. My Nigerian nationality enables effective communication with local communities, fostering trust and rapport.

It is important to recognize that the position of a researcher can have both advantages and disadvantage. For instance, while local knowledge and cultural familiarity can be assets, they can also lead to biases if not managed carefully. As a researcher, I was vigilant about maintaining objectivity and ensuring that my positions do not compromise the data's reliability. In this study, the combination of my researcher's academic role and personal background offers unique advantages. Being a lecturer allows for a deep understanding of research methodologies and a structured approach to data collection and analysis. The researcher's Nigerian nationality facilitates communication with local communities, as shared cultural backgrounds can build rapport and trust.

Moreover, having a colleague from the study area is a significant advantage. This person can serve as a bridge between the researcher and the community, enhancing access and ensuring that the research is conducted respectfully and ethically. However, the key is to use these positions judiciously, primarily to facilitate access, gather data, and interpret findings rather than exerting undue influence on the research subjects.

3.13 Ethical Consideration

The ethical underpinning of any research is of paramount importance as it forms the bedrock upon which the entire research process stands. Upholding ethical values is not just a requisite; it is a moral obligation that must be strictly adhered to, ensuring the integrity of the research, and protecting the dignity and rights of all participants involved. In this study, a robust ethical framework was diligently followed to safeguard the well-being of both the researcher and the respondents, acknowledging and upholding principles of honesty, fairness, objectivity, openness, respect for others, and trustworthiness as stipulated by the Committee on Science, Engineering, and Public Policy.

Ethical Review and University Approval: Prior to embarking on the fieldwork, formal ethical review and approval was sought from the University of Birmingham with approval number (ERN_21-0613). This critical step was essential to ensure that the research adheres to high academic standards, preserves the university's reputation, and demonstrates a commitment to good ethical practices. The university's approval serves as a testament to the research's credibility and adherence to ethical guidelines.

3.13.1 Informed Consent: It is fundamental that all participants, hereafter referred to as "respondents, “were fully informed of their role in the research process, including the nature of their participation and the potential implications of providing information. To ensure that respondents participate willingly and knowingly, a participant information including consent form was presented and explained to each respondent. Participant who was willing to participate in both the interview and survey signify their voluntary agreement to take part in the interview.

3.13.2 Anonymity and Confidentiality: The utmost care will be taken to protect the anonymity of the respondents. Their identities, including names, will not be disclosed in the research findings or related documents. Furthermore, the names of the towns and agencies involved in the interviews will be recorded anonymously to prevent any unintended disclosure of specific identities.

3.13.3 Recording and Transparency: During the interviews, transparency was upheld. Respondents were informed that the interview will be recorded, and their consent were sought for that purpose. The recording was intended to facilitate accurate data transcription and analysis to ensure the integrity of the research. The recorded data was securely stored in the

University of Birmingham database and used solely for the research purposes. Participants were duly informed that they retained the right to withdraw their participation at any point during or after the interview. It is important to note, however, that once the data analysis process has commenced, which began approximately four months after the interviews were conducted, participants no longer have the option to withdraw their data from the study.

3.13.4 Data Security: All data collected, including recorded interviews and survey responses, were securely stored, and protected to prevent unauthorized access or breaches of confidentiality. Measures will be put in place to ensure that data is treated with the utmost sensitivity, following ethical and legal guidelines.

3.13.5 Professional Conduct: Throughout the research process, professional conduct was maintained, and respondents were treated with respect, courtesy, and sensitivity. Any concerns or issues raised by the respondents was addressed promptly and appropriately, and every effort was made to ensure a comfortable and respectful environment for their participation.

3.13.6 Research Assistants: Two research assistants were employed and trained to understand the ethical considerations and protocols of the study. This plays an integral role in the data collection process. They follow the same ethical guidelines to ensure uniformity and consistency in approaching respondents and conducting interviews.

In summary, the ethical considerations of this research are not just a regulatory obligation; they reflect the fundamental principles of academic integrity and the respect for human dignity. These considerations are integral to the research's credibility and the rights of the respondents.

3.14 Conclusion

This chapter has provided an in-depth examination of the study's geographical context, research design, and the methodology employed in conducting the research. The research design was comprehensively outlined, emphasizing the adoption of a pragmatic cross-sectional research design. This design facilitated the simultaneous collection of data from a diverse sample and allowed for inferences to be drawn from this comprehensive dataset. Additionally, a mixed research method was incorporated, encompassing both qualitative and quantitative research methods, to address the research questions effectively. The inclusion of mixed research methods served to capture the complex interplay of human behaviour and experiences in the context of this research. Since the primary aim of this study is to gain a holistic understanding of how local actors develop resilience in flood-prone regions during periods of hydrological stress, the approach taken in this chapter aligns with the core themes and objectives of the research.

By implementing a cross-sectional research design and integrating both qualitative and quantitative research methods, this research endeavours to provide a robust and multifaceted analysis of the intricate processes involved in building resilience within flood-prone areas. This approach will yield valuable insights into the challenges faced by communities affected by flooding, as well as their adaptive strategies and resilience-building initiatives. As the research progresses, this multifaceted methodology will enable a comprehensive exploration of the interplay between socio-economic factors, environmental dynamics, and the adaptation mechanisms utilized by local actors. The amalgamation of both qualitative and quantitative data will contribute to a nuanced and thorough examination of the subject matter, and this research methodology is anticipated to generate rich and informative findings.

The subsequent chapters will build upon this foundational framework, delving into the data collection and analysis processes, while also presenting the findings, discussions, and conclusions. The adoption of a mixed research methodology reflects the multidimensional

nature of this research, encompassing both the objective and subjective dimensions of human behaviour and adaptation in the face of hydrological stress. This comprehensive approach aligns with the overarching goal of the research: to provide valuable insights into how local actors enhance their resilience in flood-prone regions and, ultimately, contribute to the sustainable development of these vulnerable communities.

CHAPTER FOUR

HYDROLOGY AND SOCIOECONOMIC CHANGES

4.0 Introduction

In the preceding chapter, we detailed the methodology of our study, covering the research design, data collection, and ethical considerations. This groundwork sets the stage for a deeper exploration of key themes identified in our conceptual framework.

This chapter delves into hydrological and socio-economic changes within the Lower Niger River region. Over recent decades, this area has experienced significant transformations in weather patterns, hydrological trends, and social dynamics, including land use changes and herding migrations. Understanding these shifts is crucial for grasping their interconnected impacts on the environment and local livelihoods.

We begin with weather patterns. The region's distinct wet and dry seasons have been increasingly influenced by global climate change, resulting in more frequent extreme weather events that affect communities in multifaceted ways. Next, we examine hydrological trends in the Lower Niger River basin, noting variations in flow patterns linked to changes in precipitation and human activities, which impact ecosystems and communities.

The chapter also explores social changes, driven by population growth, housing demands, and shifts in agriculture and livelihoods. The migration of herders adds another layer, affecting land use and resource management. This chapter aims to unravel the interactions between environmental and social factors, highlighting their impact on community resilience and adaptation in a rapidly changing world.

4.1 Weather Pattern in the Lower Niger River Region

Weather patterns are critical drivers of environmental changes, particularly in regions where agriculture and water resources are central to societal well-being. The Lower Niger River region, as a key ecological and economic zone in Nigeria, is characterized by its tropical climate and marked seasonal variations. These patterns play a pivotal role in shaping the livelihoods of local communities, where fluctuations in temperature, precipitation, and runoff directly affect agricultural productivity, food security, and the overall resilience of rural populations. However, of recent, this delicate balance has been increasingly disrupted by human activities and the far-reaching impacts of climate change.

As global temperatures rise and weather systems become more unpredictable, the Lower Niger River region has experienced significant climatic shifts. These changes manifest in altered rainfall distribution, more frequent and intense flooding, and increasing temperatures—particularly during the dry season. Such trends have profound implications for farming communities, which rely on predictable seasonal cycles for crop cultivation, livestock management, and water resources.

This research aims to analyse the climatic variables of temperature, precipitation, and runoff over a 30-year period (1991–2021) to understand the evolving weather patterns in the Lower Niger River region. By examining these variables, the study provides insights into the broader effects of climate change on local agriculture, community health, and flood risks. Understanding these shifts is crucial for developing adaptive strategies that enhance the resilience of farming communities and mitigate the adverse effects of climate change on one of Nigeria’s most important river basins.

4.1.1 Distribution of Temperature (1991-2021)

The Lower Niger River region, located within a tropical climate zone, experiences two primary seasons: a rainy season from late March to October, and a dry season from October to March. During the rainy season, temperatures typically range from 25°C to 35°C (77°F to 95°F), while the dry season sees cooler temperatures, averaging between 20°C to 30°C (68°F to 86°F). These seasonal variations significantly influence agriculture and local economic activities (Oguntunde and Abiodun, 2013).

Increased precipitation during the rainy season raises river levels and inundates floodplains, heightening the risk of flooding (Agbiji et al., 2024). Heavy rains combined with high temperatures lead to increased runoff and reduced soil absorption, exacerbating flood risks. Convective storms, caused by evaporation from high temperatures, also contribute to flash floods, especially in urban areas along the river. For instance, in cities like Onitsha and Lokoja, the combination of rising temperatures and increased urbanization has intensified the occurrence of flash floods. These storms, which result from the rapid heating of the land and water surfaces, lead to heavy rainfall within short periods, overwhelming drainage systems and causing severe flooding. The impact is often worsened by inadequate infrastructure and poor land-use planning, leading to significant property damage and disruption of livelihoods.

The dry season brings reduced rainfall and lower river levels, but the residual effects of the rainy season, such as saturated soil, can prolong flood risks into early dry periods. Additionally, climate variability and unpredictable weather patterns can extend flooding events beyond historical norms, making the region particularly vulnerable.

4.1.2 Temperature Trends

Figure 4.1 illustrates the temperature distribution from 1991 to 2021, revealing distinct seasonal variations. The warmest temperatures during the 1990–2000 decade suggest a potential upward trend that, if it persists, could pose significant challenges for farming and water resource management. Notably, the year 2020 emerged as one of the hottest in recent decades, likely leading to disruptions in agricultural activities.

During the dry season, temperatures consistently exceed 30°C, which aligns with the region's tropical climate characteristics. This extreme heat negatively impacts crop yields by hindering growth and productivity. Furthermore, the elevated temperatures contribute to water scarcity, directly affecting plant health. This observation is supported by the 2021 IPCC report, which indicates that tropical regions are particularly susceptible to the adverse effects of rising temperatures, noting an increase in the frequency and intensity of weather patterns due to climate change. Conversely, the rainy season offers cooler conditions; however, the average temperature during this period was still 0.6°C above the long-term norm. Specific years, such as 1990, 1999, 2001–2005, and 2020, were especially notable for their elevated temperatures.

4.1.3 Implications for Agriculture and Community Resilience

Temperature fluctuations directly affect agricultural productivity. Higher temperatures increase evaporation rates and the frequency of convective storms, leading to intense rainfall and heightened flood risks during the rainy season. This cycle of high temperatures and frequent flooding can disrupt crop growth, damage infrastructure, and cause economic losses for farming communities.

Interviews conducted with stakeholders from the Lower Niger River Region revealed concerns about increasing heatwaves and their impacts on agriculture. Stakeholders reported significant changes in temperature patterns, with heatwaves becoming more frequent and prolonged.

These conditions not only impact crop yields but also heighten the risk of health issues, such as heat-related illnesses and discomfort, particularly among vulnerable populations like the elderly and children.

Participants also emphasized the link between higher temperatures, increased evaporation, and more intense rainfall, which exacerbate flooding risks. This creates a feedback loop where rising temperatures lead to more extreme weather events, such as heavy rains and storms, which in turn overwhelm local infrastructure and agricultural systems.

One farmer shared how high temperatures from January to March affected his poultry: “During the months from January to March, my birds experienced high temperatures due to the corrugated zinc sheets used in roofing. This material prevents the birds from sweating, causing them to release heat primarily through their bodies. However, when temperatures drop significantly at night, the birds frequently develop coughing issues. This respiratory problem has unfortunately led to recurring instances of bird mortality.” This anecdote highlights the direct impacts of temperature fluctuations on livestock, further underscoring the need for adaptive measures.

4.1.4 Flooding and Climate Change:

The combination of rising temperatures and frequent flooding calls for robust adaptive strategies. Stakeholders emphasized the need for more effective flood management, improved infrastructure, and community-based climate education programs to build resilience. This resonates with the work of Rawlani and Sovacool (2011), which underscores the importance of integrating local knowledge and community engagement into climate adaptation strategies. Their study highlights that successful adaptation not only requires technical solutions but also community-driven approaches that enhance local capacities and promote sustainable development. By fostering greater awareness and participation at the grassroots level, such

programs can empower communities to respond more effectively to climate-induced challenges, such as flooding and extreme weather events.

Interviewees shared experiences of intense rainfall triggering severe floods, resulting in significant crop losses and financial hardships. These unpredictable weather patterns disrupt the ability of farmers to effectively plan planting and harvesting seasons, leading to reduced yields and heightened food insecurity. Through the lens of *intersectionality*, these challenges reveal how environmental factors, such as erratic weather, intersect with social and economic vulnerabilities, particularly for marginalized farming communities. The compounded effects of climate unpredictability, financial precarity, and reliance on agriculture for survival create overlapping disadvantages, intensifying the impact on these already vulnerable groups.

Stakeholders emphasized that rising temperatures lead to higher evaporation rates, which, in turn, contribute to heavier rains and more intense storms during the rainy season. This escalation in extreme weather amplifies the risk of flooding, disrupting agricultural cycles, damaging infrastructure, and displacing populations. To address these challenges, participants recommended the adoption of more resilient infrastructure, effective flood management strategies, and educational initiatives to equip communities to better cope with climate threats in the Lower Niger River region.

The findings highlight the urgent need to tackle the dual pressures of rising temperatures and increasing flood risks through sustainable development and adaptive measures. As climate change continues to fuel more frequent and severe weather events, it is critical for farming communities in the Lower Niger River region to embrace innovative strategies that protect livelihoods and enhance resilience. Without these proactive steps, the intersection of shifting temperature patterns and flooding will continue to pose significant threats to both the local economy and overall community well-being.

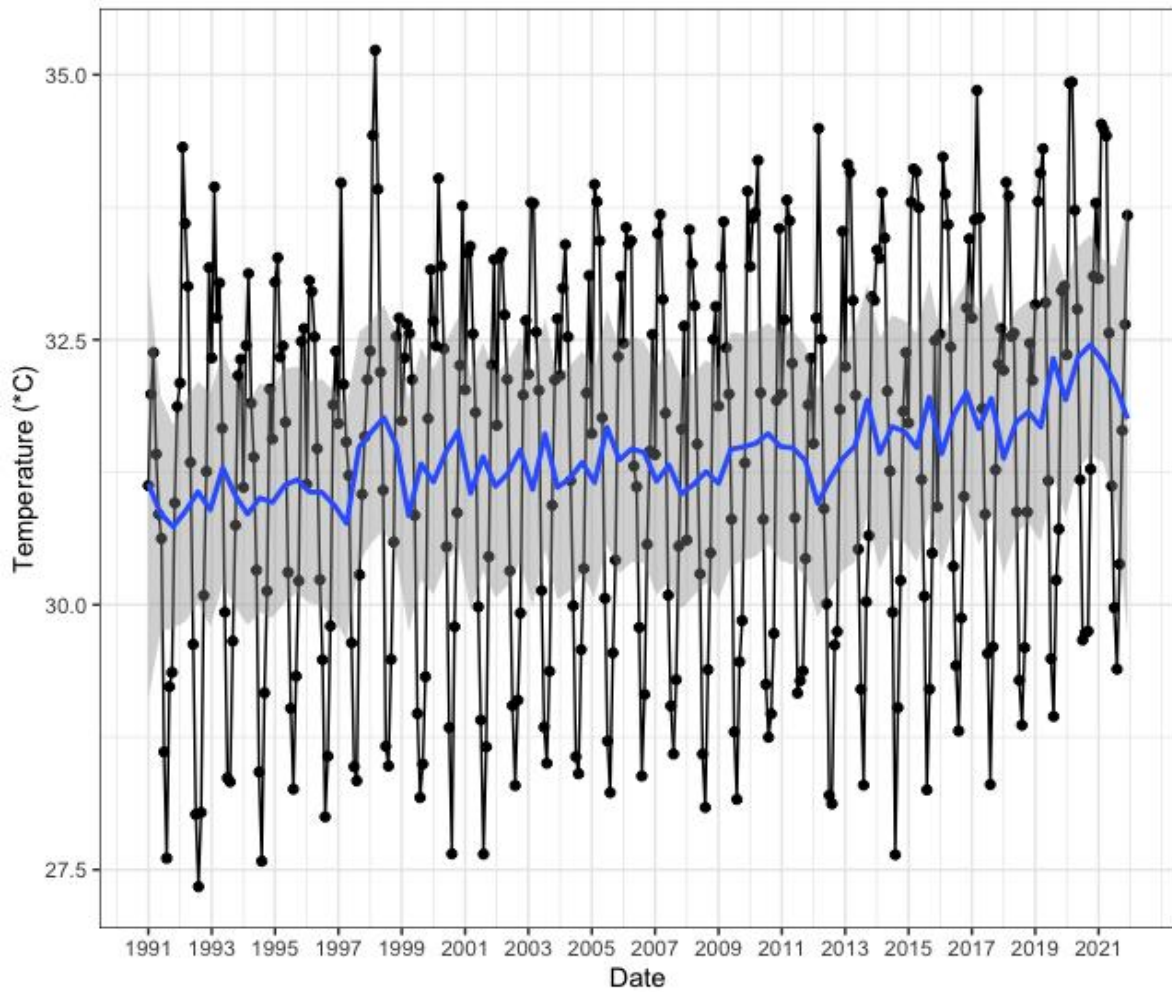


Fig 4.1: Distribution of Temperature in the Lower Niger River (1990-2020)

Source: Author, 2023.

4.2 Distribution of Precipitation and Runoff (1991-2021)

The distinctive rainfall pattern in the Lower Niger River region is crucial in shaping environmental dynamics and influencing flooding events in the area. Typically spanning from March to October, with peak intensity between June and September, this seasonal pattern directly correlates with the frequency and severity of floods experienced in the region. The onset of the rainy season in March aligns with thunderstorms and the movement of two critical meteorological phenomena: the Intertropical Convergence Zone (ITCZ) and the West African Monsoon system. As noted by Vasquez (2009), these atmospheric dynamics are essential for

understanding the regional climate. The ITCZ marks the convergence of trade winds, while the monsoon system transports moist air from the Atlantic Ocean, both significantly contributing to precipitation.

The precipitation in the Lower Niger River area is intricately linked to complex wind systems originating in the southwest and extending across West Africa. These winds, which transport moisture from the Atlantic Ocean, result in rainfall patterns that are highly dependent on the interaction of various atmospheric factors (Agbiji et al., 2024). This variability contributes to the fluctuating occurrences of extreme weather events, such as heavy rains and storms, which are key drivers of flooding in the region, as depicted in Fig 4.2.

Annual rainfall averages between 1500 mm to 2500 mm in most parts of the Lower Niger River region, while the Niger Delta zone experiences even higher levels, ranging from 2500 mm to 4000 mm annually (Oyelakin, 2021). This abundant rainfall sustains the region's diverse ecosystems, including waterways, swamps, and wetlands, which are vital for supporting local livelihoods dependent on farming, fishing, and other economic activities.

4.2.1 Intersectionality of Climate Factors

The findings from this section build upon the temperature dynamics discussed in Section 4.2, where we highlighted the adverse effects of rising temperatures on crop yields and plant health. The intersection of these climatic factors—temperature and precipitation—creates a complex web of challenges that exacerbate the vulnerabilities faced by local communities. For instance, while the warm, dry season can lead to water scarcity, the subsequent heavy rains can overwhelm agricultural systems, leading to flooding and soil erosion (IPCC, 2018).

The interplay between atmospheric processes, annual rainfall patterns, and their impacts on local communities underscores the intricate relationship between climate dynamics, environmental health, and human well-being in the Lower Niger River region. These climatic

characteristics and associated hydrological changes have significant implications for the lives and livelihoods of the local population, particularly concerning their vulnerability to flooding events (Sharma et al., 2024).

4.2.2 Intersectionality and Vulnerability:

The intensity and distribution of rainfall not only affect agricultural productivity and infrastructure integrity but also highlight the socio-economic disparities within the community. Vulnerable groups—such as smallholder farmers, women, and those with limited resources—often bear the brunt of these flooding events, revealing an intersectional dimension of climate change impacts (Rawlani and Sovacool, 2011). As flooding increases, those with fewer adaptive capacities face compounded challenges, including displacement, loss of income, and food insecurity.

Addressing these interconnected challenges requires comprehensive strategies that integrate climate adaptation measures, sustainable land use practices, and community resilience-building initiatives. By recognizing the intersectionality of climate impacts, we can develop targeted interventions that not only mitigate the adverse effects of floods but also empower marginalized communities to safeguard their livelihoods and well-being in the face of climate variability.

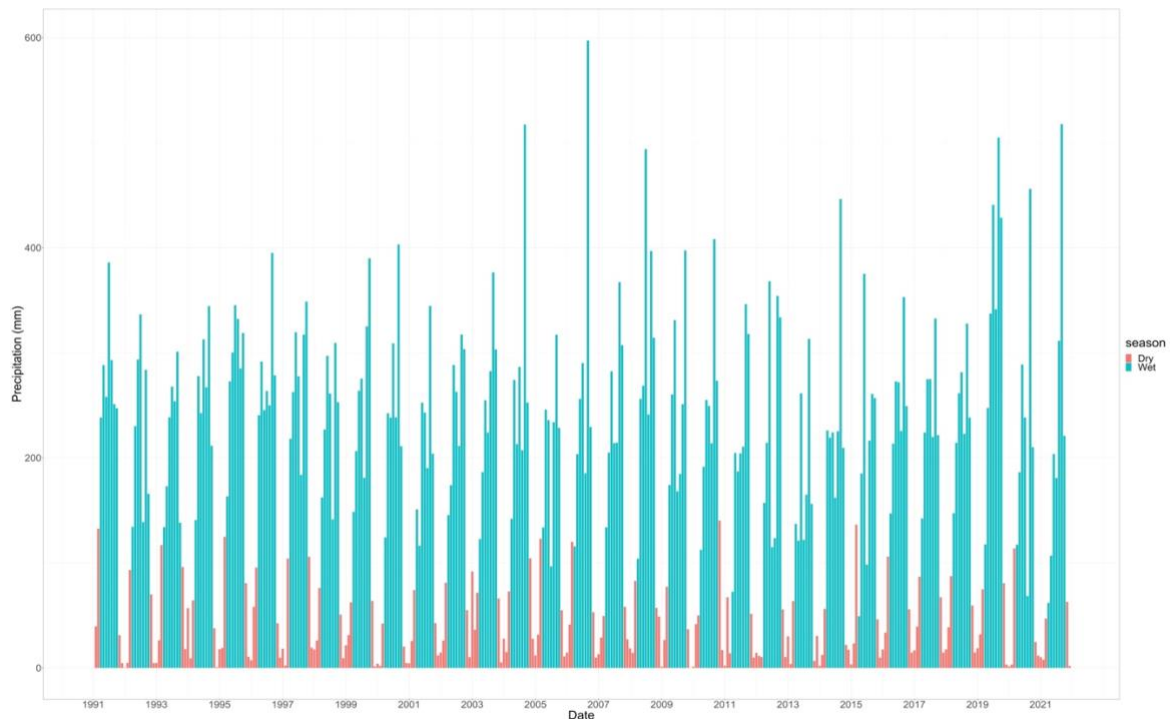


Fig 4.2- Precipitation in Dry and Wet Seasons

Source: Author, 2023.

4.3 Magnitude

Building on our earlier discussions regarding the impact of temperature fluctuations and precipitation patterns, the concept of "magnitude" in the context of hydrometeorological drivers relates to the amount or volume of precipitation received over specific periods. Precipitation is a critical factor affecting the hydrology of the Lower Niger River, and its magnitude signifies how much rainfall or water is collected, as illustrated in Fig 4.3. This aspect of magnitude directly influences water levels in the river and the potential for flooding, reinforcing the importance of understanding these dynamics as discussed previously.

During the rainy season in the Lower Niger River basin, the magnitude of precipitation is crucial for determining the volume of water that flows into the river. When rainfall is intense

and sustained over extended periods, it can lead to significantly high river levels and increased runoff. For instance, annual rainfall in the region averages between 1500 mm and 2500 mm, with particularly high precipitation levels of 2500 mm to 4000 mm observed in the Niger Delta zone (Williams, 2014). This area, as highlighted earlier, is characterized by an intricate network of waterways, swamps, and wetlands, which serve as vital resources supporting local livelihoods such as farming and fishing.

The discussion on the magnitude of precipitation is essential for understanding the risks associated with flooding. High-magnitude precipitation events—such as heavy rainfall or prolonged periods of rain—can overwhelm the river's capacity to manage the inflow, leading to flooding when riverbanks may breach, inundating adjacent areas and disrupting communities (Paron, 2023). Conversely, as noted previously, lower-magnitude precipitation events may not pose significant flood risks since the river can accommodate the water without overflowing its banks.

This dynamic nature of flooding within the Lower Niger River basin illustrates how variations in rainfall patterns directly influence flood occurrences and intensities. Understanding these rainfall patterns and flood characteristics is essential for effective flood management and resilience-building efforts, considering our earlier findings regarding community vulnerability.

Moreover, the higher precipitation levels in the Niger Delta zone contribute to increased water flow through the river system, exacerbating the risk of flooding during periods of intense rainfall (Amadi and Mac Ogonor, 2015). This reinforces the earlier discussion on the intersectionality of climate impacts, as vulnerable communities, particularly those reliant on agriculture and fishing, face compounded challenges when high-magnitude rainfall events occur.

By comprehensively analysing these climatic and hydrological dynamics, stakeholders can implement targeted strategies to mitigate flood impacts, protect infrastructure, and enhance community resilience against natural disasters in the Lower Niger River basin. This understanding of "magnitude" not only elucidates the challenges posed by flooding but also underscores the necessity of integrating this knowledge into community planning and disaster management strategies to safeguard livelihoods and enhance adaptive capacities in the face of climate variability (Filippi, 2020).

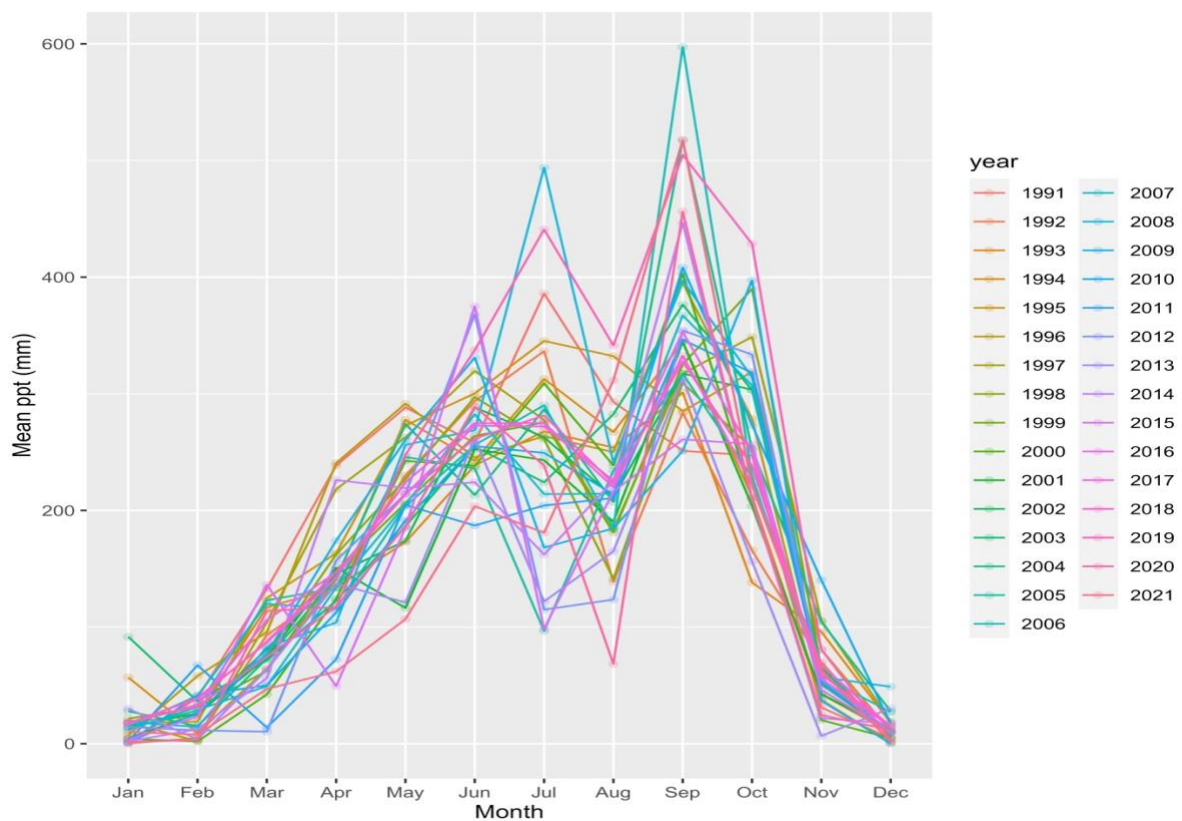


Fig 4.3- Precipitation Showing Magnitude in the Lower Niger River

Source: Author, 2023.

4.3.1 Duration of Rainfall

Building on our earlier examination of the magnitude of precipitation, the duration of rainfall is another critical factor influencing the flooding dynamics of the Lower Niger River basin. As

illustrated in Fig 4.4, the substantial variation in rainfall duration across different years underscores its crucial impact on the region's flooding patterns. The duration of rainfall refers to the length of time over which precipitation occurs, and this variability plays a significant role in determining the diverse characteristics of flooding experienced in the area.

For instance, certain years, such as 1995 and 1997, demonstrate notably longer durations of rainfall, which correlate closely with increased flooding events. In alignment with our previous discussion, the basin primarily receives its long-term average rainfall from July to September, marking the peak of the rainy season. Anomalies in rainfall duration during these months are closely associated with the occurrence and intensity of flooding in the region.

The duration of rainfall is influenced by various climatic phenomena, notably the El Niño and La Niña cycles, which can extend the length of rainfall events for weeks or even months. As mentioned earlier in our discussion on climatic variability, these natural climate patterns occur in two distinct phases in the Lower Niger region. During El Niño, the Eastern Equatorial Pacific (EEP) experiences warmer sea surface temperatures, which lead to reduced rainfall in the Western Equatorial Pacific but heightened precipitation in the Lower Niger basin. Conversely, the La Niña phase is characterized by cooler sea surface temperatures, resulting in increased rainfall in the Western Equatorial Pacific and decreased precipitation in the EEP.

These cyclical phases of the El Niño-Southern Oscillation (ENSO) play a crucial role in influencing global weather and climate patterns, with far-reaching effects on ecosystems, agriculture, and human societies across the world. Understanding the duration of rainfall is vital for effective flood forecasting, early warning systems, and developing strategies to manage and build resilience against flooding in the Lower Niger River basin.

As highlighted in our prior sections, communities can leverage this knowledge to adapt to changing climatic conditions by constructing flood-resistant infrastructure, planning agricultural activities, and implementing land-use strategies that account for the duration of

rainfall events. Such proactive measures are essential for mitigating flood risks and enhancing resilience, ultimately safeguarding livelihoods in a region vulnerable to climate variability.

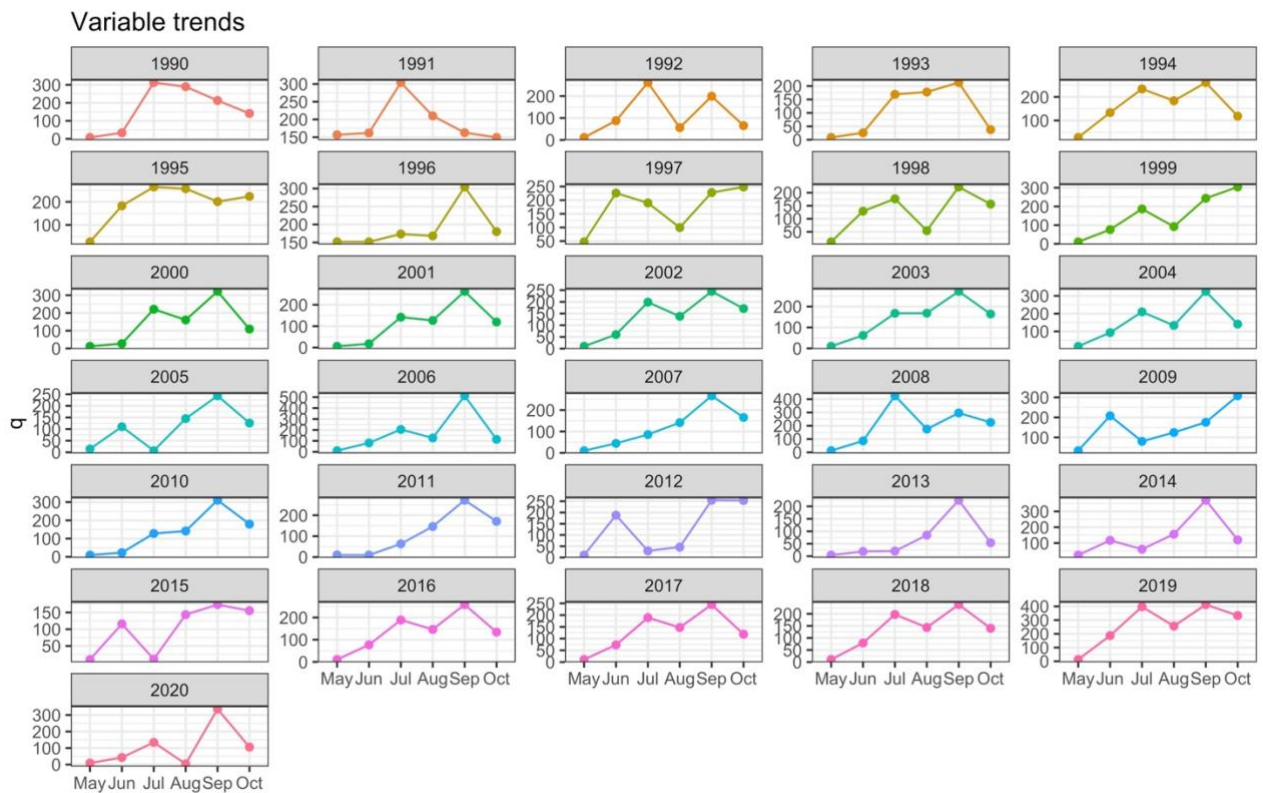


Fig 4.4 – Monthly Duration of Rainfall (1990-2021).

Source: Author, 2023.

4.3.2 Peak Water Level and Discharge

Continuing from our exploration of rainfall magnitude and duration, we now focus on the peak water level and discharge within the Lower Niger River basin, both of which are intricately linked to the intensity and volume of rainfall events. The year 2006 stands out as particularly noteworthy, as it recorded the highest mean water level of 600 mm, as illustrated in Fig 4.5. This substantial water level indicates that a significant amount of water flowed into the river during this period, likely contributing to the occurrence of flooding.

The rainy season, which extends from May to October, often aligns with the region's peak water discharge. As highlighted earlier, this period is characterized by intense rainfall, leading to significant changes in the hydrological dynamics of the river basin. The water level can rise dramatically—up to 600 mm—during intense rainfall events, signifying a considerable discharge into the river system. As we discussed in relation to magnitude, this relationship is critical, as higher volumes of rainfall directly affect river water levels and increase the potential for flooding.

The hydrograph for the study area, based on available data, further illustrates the correlation between rainfall and flow rate. Figure 4.6 demonstrates this relationship, revealing that during periods of intense rainfall, the flow rate of the river increases significantly. This reinforces our earlier discussion about the dynamic nature of flooding and the interplay between rainfall characteristics and water discharge.

Understanding these relationships is crucial for effective flood management. Recognizing the patterns in peak water levels and discharge can help stakeholders implement targeted strategies to mitigate flooding impacts and enhance community resilience. As we have seen, integrating this knowledge into planning and infrastructure development is essential to safeguarding local livelihoods, particularly in a region vulnerable to the effects of climate variability and extreme weather events.

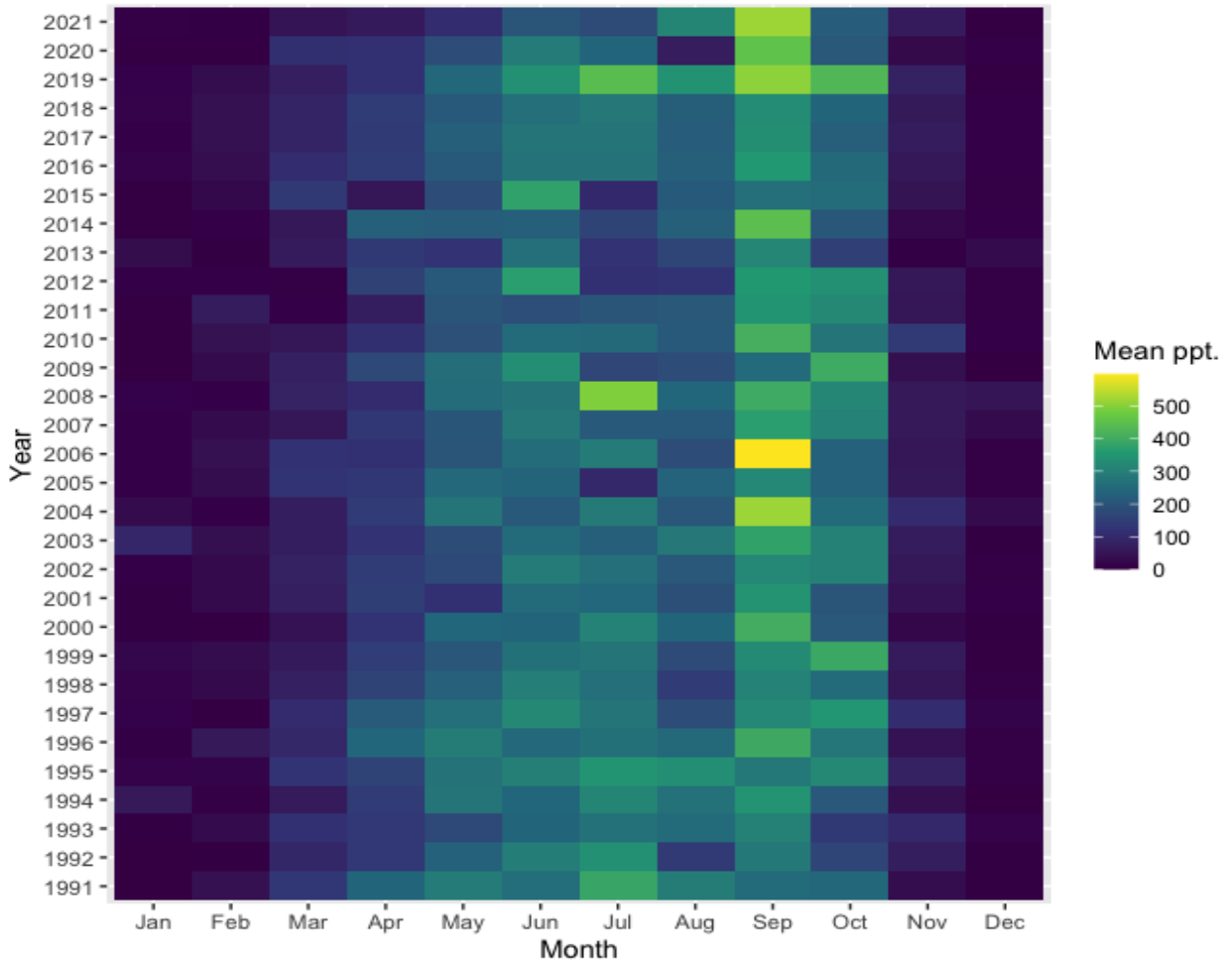


Fig 4.5 Precipitation Mean Plot.

Source: Author, 2023.

4.4 Changes in River Flow in the Lower Niger River Region

Over the past three decades, the flow regime of the Lower Niger Basin has experienced notable changes, marked by increased variability in flow rates. These shifts in flow patterns can be attributed to alterations in precipitation patterns, as highlighted in previous sections, as well as human activities in the area, including land use changes and deforestation. As illustrated in Fig 4.6, the runoff trend of the Lower Niger River over this 30-year period shows significant fluctuations that necessitate a closer examination.

To better understand the implications of these changes for flooding and extreme rainfall in the study area, we categorize river flow into three types: Ephemeral, Intermittent, and Perennial, as utilized in the research conducted by (Williamson et al., 2015). This classification allows for a detailed investigation of how each flow regime affects flooding dynamics and agricultural sustainability.

- **Ephemeral Flow Regime:** This type corresponds to streams that exhibit short-duration flow primarily in response to precipitation, typically occurring during rainfall periods. Such flows can contribute to sudden increases in river levels, amplifying flood risks.
- **Intermittent Flow Regime:** Streams classified as intermittent flow continuously during specific seasons, following predictable seasonal rainfall patterns. Understanding this flow type is crucial for managing agricultural planning and flood preparedness.
- **Perennial Flow Regime:** In contrast, the perennial flow regime represents streams that maintain a consistent flow throughout the year, sustained by groundwater discharge. This reliable water supply is vital for agricultural activities, supporting the livelihoods of local communities year-round.

Within the study area, all three distinct flow regimes are present, highlighting the diverse water resources that support farming and other economic activities. As seen in Fig 4.6, the trend of runoff in the study area provides an overview of changes in river flow over the past three decades, underscoring the need for adaptive water management strategies.

In summary, understanding these hydrological trends and flow regime classifications is essential for assessing the impacts of flooding and climate variability in the Lower Niger River Basin. This knowledge will inform strategies to enhance community resilience and promote sustainable land and water management practices in the face of ongoing environmental changes.

The flow regime of the Lower Niger Basin has experienced significant changes over the past three decades, characterized by increased variability and flow rates. These variations in the flow pattern are attributed to several factors, including modifications in precipitation patterns and human activities in the area (Chemelil, 1995). As shown in **Fig 4.3**, the runoff trend of the Lower Niger River exhibits significant fluctuations in both magnitude and timing, with notable increases in peak discharge during certain years. This increase in runoff is closely tied to intensified rainfall events, land-use changes such as deforestation, and agricultural expansion, which have altered the natural hydrological cycle, leading to more frequent and severe flooding events. These shifts in runoff patterns highlight the growing need for effective water resource management strategies to mitigate flood risks and ensure sustainable use of the region's water systems. The implications of this to flooding are significant, particularly as the increased variability and intensity of runoff contribute to more frequent and severe flood events in the Lower Niger Basin. When peak discharges rise due to intensified rainfall and human activities, the river's capacity to contain water is often overwhelmed, leading to widespread flooding that affects not only physical infrastructure but also livelihoods.

From an intersectional perspective, the impacts of flooding disproportionately affect marginalized and vulnerable communities, including smallholder farmers, women, and low-income households. These groups are often more dependent on natural resources such as land and water for their livelihoods, making them highly susceptible to disruptions caused by floods. For instance, smallholder farmers, who rely on seasonal rainfall and stable river flows for irrigation, face heightened risks of crop loss due to flood-induced soil erosion, waterlogging, and destruction of agricultural lands. Women in these communities, who are frequently responsible for managing household resources and agricultural labour, bear the brunt of these

challenges as they are left with fewer resources and increased caregiving responsibilities during disaster recovery periods (Rawlani and Sovacool, 2011).

In addition to economic and social vulnerabilities, the intersectionality of climate impacts extends to health and education. Flooding in the Lower Niger Basin often leads to the contamination of water sources, resulting in outbreaks of waterborne diseases such as cholera and diarrhoea, disproportionately affecting children and the elderly. Displacement caused by floods also disrupts educational systems, with children missing school and families struggling to rebuild their lives.

Addressing these intersecting challenges requires a holistic approach that considers not just the environmental aspects of flooding but also the socio-economic and gender dimensions. Sustainable development strategies that integrate flood management with community resilience-building efforts must be prioritized, focusing on equitable access to resources, gender-sensitive disaster planning, and inclusive decision-making processes (Sofi et al., 2020). By incorporating intersectionality into flood mitigation strategies, it is possible to ensure that the most vulnerable populations are better equipped to adapt to and recover from the impacts of climate change.

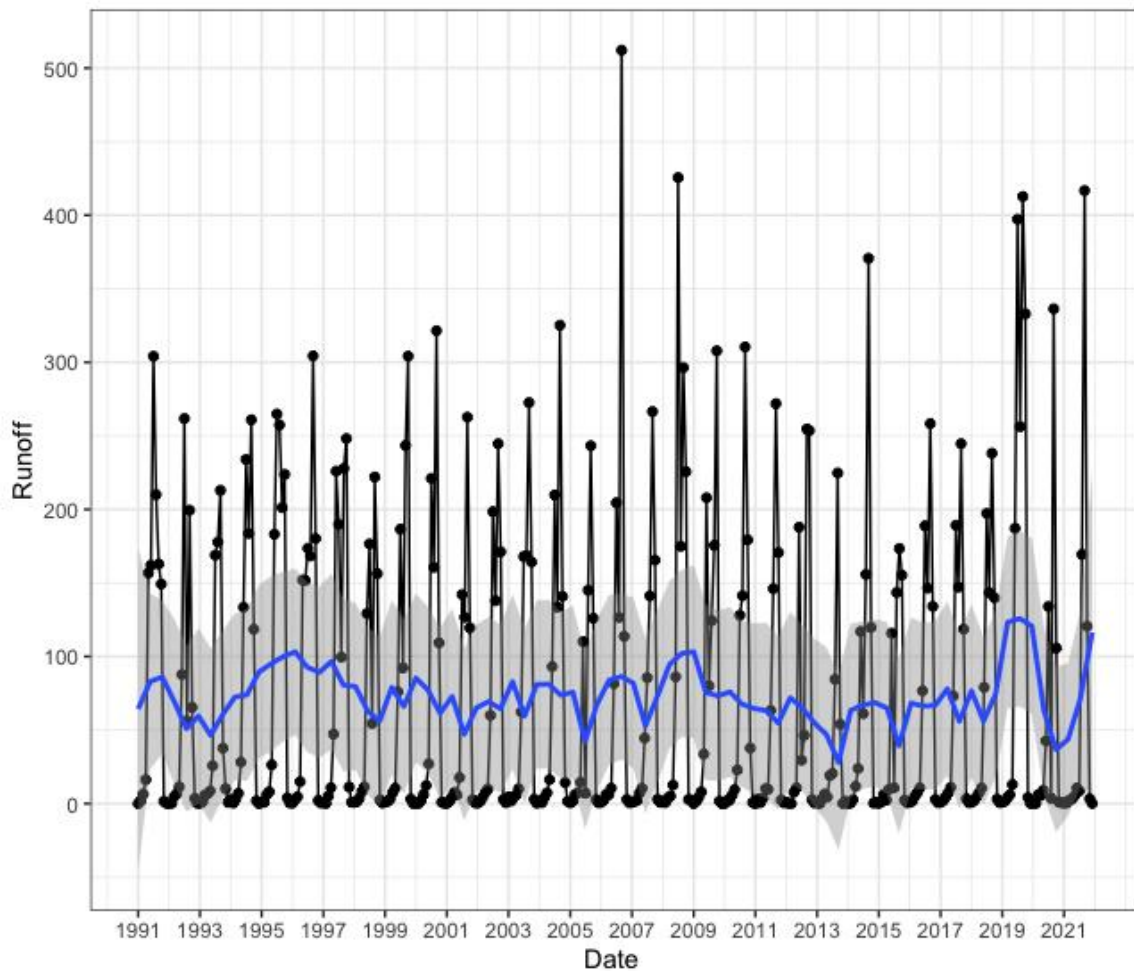


Fig 4.6 – Trend of Runoff in the Study Area.

Source: Author, 2023.

4.4.1 Understanding Hydrological Trends

To understand hydrological trends in the lower Niger River Basin, we begin by examining the variations in flow patterns. These patterns, involving the seasonality, volume, and velocity of river flows, are a fundamental component of the region's hydrology. Furthermore, we study significantly influenced by anthropogenic activities

4.4.2 Precipitation Pattern Modifications:

Building on the earlier discussions of hydrological trends and the variability in river flows (Section 4.4.2), it is essential to delve into how changes in precipitation patterns further complicate the flooding dynamics in the Lower Niger River Basin. As highlighted, the region's flow regimes have been increasingly influenced by shifts in rainfall intensity and distribution, directly correlating with the frequency and severity of floods observed.

The data from the questionnaire, presented earlier in this section, offers valuable insights into how local communities perceive and experience these changing precipitation patterns. Over 80% of respondents confirmed witnessing significant flooding events over the past decade, primarily due to excessive rainfall. The high frequency of extended rainfall periods, with 48.3% of participants reporting rainfall lasting more than seven days, further underscores the regularity of prolonged precipitation contributing to flooding. This aligns with the broader hydrological trends previously discussed, where increased rainfall magnitudes directly impact river flow rates and exacerbate flood risks in (Section 4.3).

Table 4.1 reinforces the cumulative percentages of respondents' awareness of climate change impacts, particularly concerning irrigation agriculture. A significant 59.1% of respondents indicated that their agricultural activities have been adversely affected by erratic precipitation and flooding, a trend that echoes the increasing unpredictability of river flow and flood magnitude discussed in earlier sections.

The profound implications of these modified precipitation patterns are particularly concerning for vulnerable farming communities, whose livelihoods depend on predictable rainfall and stable river systems. With the Lower Niger River Basin being highly dependent on agriculture, the frequent flooding events highlighted in this section disrupt planting cycles, reduce crop

yields, and lead to the loss of assets. These impacts, in turn, disproportionately affect the economically disadvantaged, amplifying food insecurity and deepening existing socio-economic vulnerabilities, which were initially raised when discussing the magnitude of climate impacts (Section 4.3).

Moreover, intersectionality plays a critical role in how these flooding events affect various groups within the region. Women, who often shoulder the responsibility of household and agricultural labour, experience heightened challenges during flood events. Similarly, marginalized communities with limited access to resources, such as land and financial services, struggle to recover from recurrent floods, reinforcing the cycle of poverty. This underscores the need for targeted flood risk management strategies that consider the socio-economic and gender disparities within the region.

Table 4.1: Climate Hazard Affecting Farming Household in the Last 10 years.

| | Sub Characteristics | Frequency | Percentage |
|--|----------------------------|------------------|-------------------|
| Climate hazards Witness Extreme rainfall that result in flooding | Yes | 197 | 99.4 |
| | No | 2 | 1.01 |
| Number of days witnessed flood in rainy season due to extreme rainfall in the last 10years | None | 6 | 3.0 |
| | 1-3days | 24 | 11.9 |
| | 4-6days | 74 | 36.8 |
| | >7days | 94 | 48.3 |
| | Total | 198 | 100 |
| Number of days experience flooding in the last 10years | None | 3 | 1.5 |
| | 1-3days | 28 | 14.1 |
| | 4-6days | 121 | 61.1 |
| | >7days | 46 | 23.2 |

| | | | |
|--|----------|-----|------|
| | Total | 198 | 100 |
| Number of times experience water scarcity in the last 10years | 1-3times | 49 | 24.7 |
| | 4-6times | 63 | 31.8 |
| | >7times | 86 | 43.4 |
| | Total | 198 | 100 |
| Awareness of changing temperature which affect farming system | Yes | 84 | 42.4 |
| | No | 114 | 57.6 |
| | Total | 198 | 100 |
| Number of times witness flooding event cause displacement of community and livelihoods in the last 10years | 1-3times | 73 | 36.9 |
| | 4-6times | 110 | 55.6 |
| | >7times | 15 | 7.6 |
| | Total | 198 | 100 |
| Climate change impact have negative effect on irrigation | Yes | 117 | 59.1 |
| | No | 81 | 40.9 |
| | Total | 198 | 100 |

Source: Author, 2023.

4.5 Statistics Analysis- Spearman Rank Correlation Coefficient

Linking back to the preceding discussions on the hydrological dynamics and changes in the Lower Niger River Basin, particularly Sections 4.3 and 4.4, it became essential to explore the quantitative relationships between key variables—precipitation, runoff, and temperature. In previous sections, we emphasized the increasing variability of rainfall patterns and runoff, as well as their implications for flooding and agricultural livelihoods. The statistical analysis,

specifically the Spearman Rank Correlation Coefficient, was employed to substantiate these observed trends with numerical evidence and assess the reliability of the data gathered.

The choice of the Spearman Rank Correlation Coefficient for this analysis was motivated by the need to understand the strength and direction of relationships between the key hydrometeorological factors. As previously discussed, changes in precipitation and runoff are directly tied to flood risks, while temperature variations may indirectly affect runoff by influencing evaporation rates and river discharge levels. Thus, a statistical examination was necessary to confirm the degree of correlation between these variables and determine whether these observed relationships aligned with the broader patterns highlighted throughout the chapter.

The correlation analysis revealed a positive coefficient of **0.87** between precipitation and runoff, supporting the earlier argument that increased rainfall typically leads to higher runoff in the Lower Niger River Basin (refer to Section 4.3 for the discussion on flood risks due to high precipitation levels). This correlation confirms that as precipitation intensifies, the river flow becomes more variable, heightening the likelihood of flooding events. Moreover, the negative correlation of **-0.70** between runoff and temperature aligns with findings from Section 4.4, where we noted that cooler conditions often prevail during high runoff periods. This inverse relationship suggests that when runoff increases—often due to heavy rains—temperature tends to drop, likely due to increased cloud cover and reduced solar heating.

These statistical findings offer critical insights into the interrelationships among the hydrological variables discussed in earlier sections, reinforcing the need for a comprehensive understanding of the interplay between climate, hydrology, and flood risks. Additionally, this

analysis underlines the importance of integrated flood management strategies that account for these correlations, particularly when developing predictive models for extreme weather events.

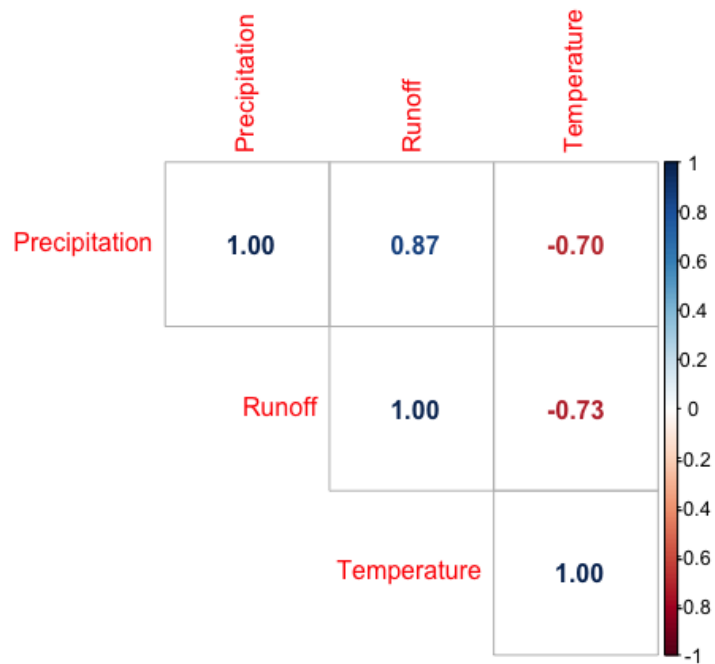


Fig 4.7: Correlation Matrix

Source: Author, 2023.

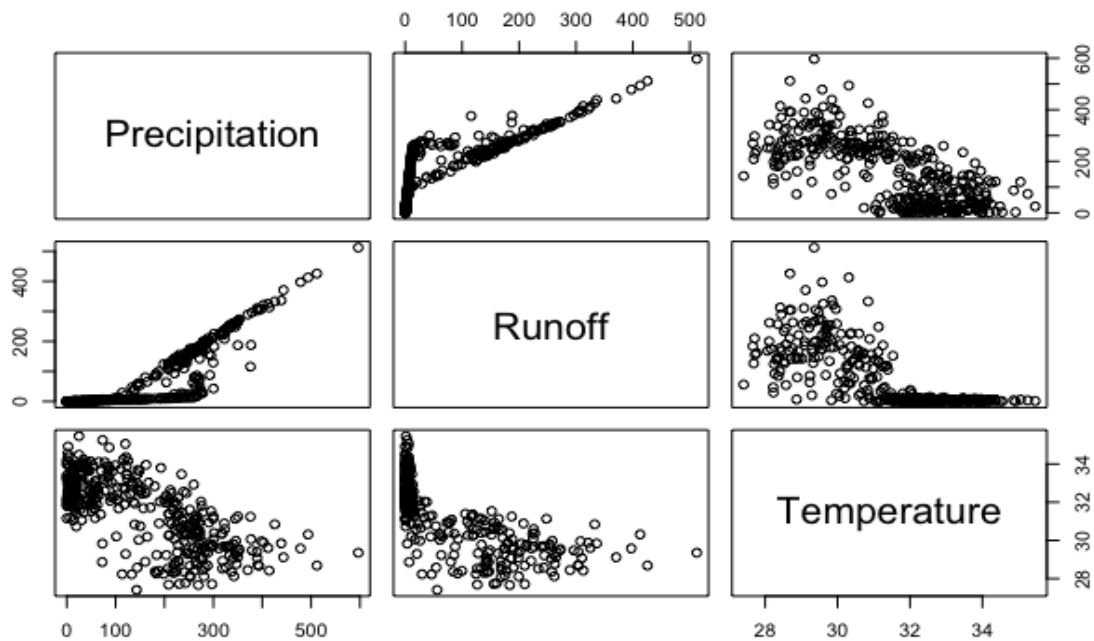


Fig 4.8: Correlation Scatter Plot for Precipitation, Runoff and Temperature

Source: Author, 2023.

4.6 Evolving Socio-Environmental Trends in the Lower Niger River Basin

The Lower Niger River region is a dynamic socio-cultural landscape shaped by the interplay of environmental and human factors. This section explores the evolving trends in population dynamics, land use and land cover changes, urbanization and its impact on runoff, changes in water quality, and conflicts among farmers, highlighting the interconnectedness of these elements.

4.6.1 Population Dynamics

The Lower Niger River Basin has witnessed significant shifts in population dynamics, which closely mirror the broader trends in population growth throughout the country. The Lower Niger River region stands as a notable centre of human habitation, boasting a population that exceeded 30 million individuals, as documented during the 2006 population census. This remarkable demographic concentration translates to an estimated population density of

approximately 265 persons per square kilometre, underscoring the region's pivotal role in Nigeria's demographic landscape. To put it into perspective, the Lower Niger River region contributes to over 23 percent of Nigeria's overall population(Commission, 2013, Macro and Commission, 2009).

However, when considering the projected population of the Lower Niger River Basin in 2023, considering a consistent growth rate of 7%, the figure approximates to a striking 61,894,680 individuals. This projection reveals the substantial impact of urbanization on the region, giving rise to an array of urbanization-induced neo-risks. These challenges encompass the proliferation of informal settlements and unauthorized constructions that disregard established building standards, overcrowded living conditions, challenges in waste management, escalating air and water pollution, inadequate access to fundamental utilities such as clean water and electricity, and the degradation of environmental quality.

4.6.2 Land Use Land Cover Changes

There has been a noticeable decline in water levels in the study area, attributable to ongoing human activities that influence both the frequency and magnitude of change. Our analysis of land use and land cover changes spanning a 30-year period reveals significant alterations in land use patterns, as depicted in Figs. 4.9 and 4.10. These findings underscore the substantial impact of human activities on modifying the hydrological regime of the Lower Niger River.

The changes observed are largely driven by increased physical development, intensified farming practices, and land clearance techniques(Pretty and Bharucha, 2014). These activities alter ground surface characteristics, such as vegetation cover and soil moisture content, thereby disrupting the delicate hydrological systems at play(Vereecken et al., 2022). Consequently, these modifications can significantly affect water flow dynamics and overall hydrological

processes in the region, leading to a cascade of effects that directly contribute to the loss and damage experienced by local farmers and their livelihoods.

These human-induced changes in land use and hydrological patterns are closely linked to the region's vulnerability to flooding. By altering natural drainage patterns and increasing surface runoff, these activities exacerbate flood risks and intensify the impacts of flood events on agricultural lands and communities along the Lower Niger River. The intersectionality of these issues is critical; marginalized communities, often reliant on subsistence farming, bear the brunt of these environmental changes. As flooding disrupts agricultural productivity, it deepens economic disparities and food insecurity among vulnerable populations (Toromade et al., 2024). Additionally, the declining water quality resulting from land use changes can further complicate the situation, impacting health and livelihoods (Raschid-Sally et al., 2005). Poor water quality can lead to conflicts among farmers and between communities, particularly as access to clean water becomes scarce. These conflicts are exacerbated by competition over dwindling resources, highlighting the interconnected nature of environmental degradation, social vulnerability, and economic challenges (Raschid-Sally et al., 2005).

Addressing these challenges requires a comprehensive approach that incorporates sustainable land management practices, integrated water resource management strategies, and community-based resilience-building initiatives. Such measures are crucial for mitigating the adverse effects of human-induced changes on local livelihoods and ecosystem health, fostering an environment where all community members can thrive despite the ongoing challenges posed by climate change and hydrological alterations.

4.6.3 Trend of Land Use Land Cover Changes (1991-2021)

Table 4.2 illustrates the estimated land size covered by different land uses in the Lower Niger River region from 1991 to 2021, as depicted in Fig 4.9. The analysis categorizes land use into

four primary types: waterbody, floodplains, vegetation, and built-up areas. In 1991, vegetation dominated the landscape with 47.7%, followed by floodplains at 42.7%, built-up areas at 5.9%, and waterbodies at 4.7%. However, significant changes occurred by 2001, with floodplains becoming the predominant land use at 47.1%, marking a substantial increase. Vegetation coverage decreased to 35.3%, while built-up areas expanded to 13.3% and waterbodies slightly decreased to 4.4%. By 2011, floodplains and vegetation remained dominant, covering 39.4% and 29.6% of the land area, respectively, while built-up areas and waterbodies occupied 27.1% and 3.9%. The trend continued into 2021, with built-up areas becoming the largest land use category at 38.7%, followed by vegetation at 33.0%. Floodplains comprised 25.4% of the land area, and waterbodies accounted for 3.0%. These shifts in land use and land cover patterns reflect human-induced modifications in the Lower Niger River region, influenced by urbanization, agricultural expansion, and infrastructure development. The increasing dominance of built-up areas underscores urban sprawl and infrastructure growth, which alter natural drainage patterns and contribute to increased flood risks in the region. These changes highlight the interplay between land use dynamics and flood vulnerability, emphasizing the need for sustainable land management practices and integrated flood risk management strategies to mitigate the impacts of these shifts on local communities and their livelihoods.

Table 4.2: Total Estimate of Area (Km²) of Each Land Use Land Cover Change of the Lower Niger River (1991-2021)

| LULC Category | 1991 | | 2001 | | 2011 | | 2021 | |
|---------------|-----------------|-----|-----------------|-----|-----------------|-----|-----------------|-----|
| | km ² | % | km ² | % | km ² | % | km ² | % |
| Water Body | 346.249 | 4.7 | 321.249 | 4.4 | 289.714 | 3.9 | 220.097 | 3.0 |

| | | | | | | | | |
|-------------|----------|------|----------|------|----------|------|----------|------|
| Flood Plain | 3152.734 | 42.7 | 3477.983 | 47.1 | 2910.999 | 39.4 | 1875.383 | 25.4 |
| Vegetation | 3453.697 | 46.7 | 2610.714 | 35.3 | 2185.943 | 29.6 | 2435.228 | 33.0 |
| Built up | 438.409 | 5.9 | 981.143 | 13.3 | 2004.434 | 27.1 | 2860.381 | 38.7 |

Source: Researcher' Computation

Source: Author, 2023.

The analysis of Land Use Land Cover changes, depicted in Fig 4.9 and 4.10, illustrate the alterations over three study periods, specifically between 1991-2001. It is evident that the area designated as "Built-up" expanded significantly by 31.26%, while "Floodplain" increased by 18.74% during this time frame. In contrast, there was a substantial loss of "Vegetation" covering 48.56% of the land, and "Water Body" experienced a reduction of 1.44%.

A comparison of these changes across the three study periods revealed some intriguing patterns. The category "Built-up" exhibited substantial growth, increasing by 31.26% during the initial study period (1991-2001), a noteworthy 50.0% in the second phase (2001-2011), and a still considerable 38.72% in the third phase (2011-2021). It is worth highlighting that the highest rate of expansion occurred during the second study period.

These observations indicate that the intrusion and conversion of land uses, especially the loss of vegetative land use at a rate of 27.70% in the second study period and 29.6% in the third study period, can be attributed to population growth and the rising demand for housing development. Similarly, "Floodplain" land use experienced a loss of 39.4% in the first study period and 46.85% in the third study period.

These findings align with the work of Anik et al. (2023), which emphasizes the impacts of climate change on water resources and associated health risks, as evidenced in Bangladesh.

The study further emphasizes that the increased occurrence of climate-induced extreme weather events, such as floods and droughts, can lead to water scarcity and contamination. In addition, the results demonstrate a declining trend in water bodies across the three study periods, primarily due to climate variability and the growing demand for water in agriculture and industrial activities. The combination of these factors not only reduces the availability of water but also has consequences for water quality in the region aligning with the research findings of Nkiruka et al. (2023). The alterations in land use and land cover are seen to influence the frequency and severity of flooding in the area, thereby implying potential adverse impacts on the environment and posing health risks to the local human population due to the presence of heavy metals in the sediment. Furthermore, these changes have broad-reaching health implications, extending to the prevalence of waterborne diseases and malnutrition among the affected communities.

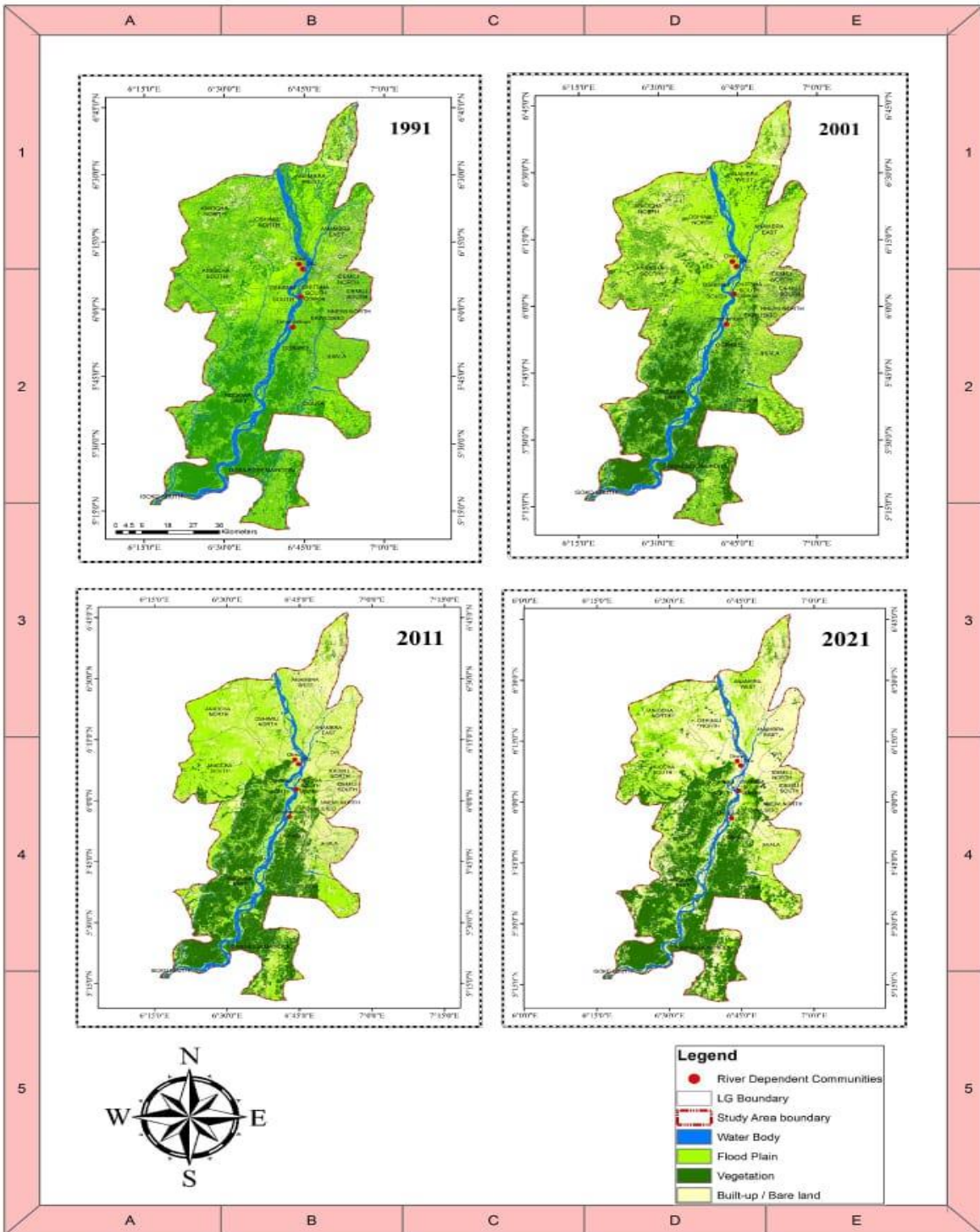


Fig 4.9 Land Use Land Cover Change

Source: Author, 2023

4.6.4 Urbanization and Runoff

Urbanization is rapidly transforming river-dependent communities across the world, driven by economic opportunities in commerce, agriculture, fishing, trade, and investment. This population growth is particularly pronounced in urban areas of Nigeria, making it one of the fastest urbanizing countries in Africa. The United Nations projects that Nigeria's population will reach 295 million by 2050, bringing various levels of vulnerability and a corresponding increase in flood risk, especially in river-dependent communities globally (Akinola, 2024).

Stakeholder interviews shed light on how population growth amplifies climate risk in the region which is sequel to the work of Dermawan et al. (2022), (Gotor et al., 2022), emphasise the interconnectedness of population and runoff, highlighting how changing urbanization can lead to food insecurity, economic losses, and increased health risks for coastal populations. The surge in population leads to increased housing construction, resulting in alterations to the river systems. This transformation affects fluvial geomorphology, hydrology, and ecology on river systems of various stream orders, creating inconsistencies in meeting human needs and exposing river-dependent communities to climate hazards.

As urbanization progresses, it modifies land use and land cover (LULC) by replacing green vegetation with impermeable surfaces. This transition exacerbates surface temperature anomalies and prolongs heavy precipitation events in river-dependent communities, further heightening climate risks. Urbanization also contributes to increased peak runoff in rivers while reducing the natural filtration capacity of landscapes during rainfall events.

The Lower Niger River, notable for its urbanization, showcases specific characteristics in trade, transportation, and industrial activities that significantly impact the water cycle and river systems. These activities continuously reshape watersheds and drainage tributaries within the

region. The changing land use and land cover patterns, illustrated in Fig 4.10, reveal a substantial **38.7%** increase in built-up land use by **2021**. This shift signifies a growing occupancy of flood-prone areas, putting more people and property at risk during flood events.

Additionally, the concentration of buildings signifies focal points of socio-economic activities, which magnify the effects of climate change, including heat stress, extreme precipitation, coastal flooding, drought, and water scarcity. This intensifies the vulnerability of people, assets, economies, and ecosystems, exposing them to elevated risks associated with climate variability and extreme weather events.

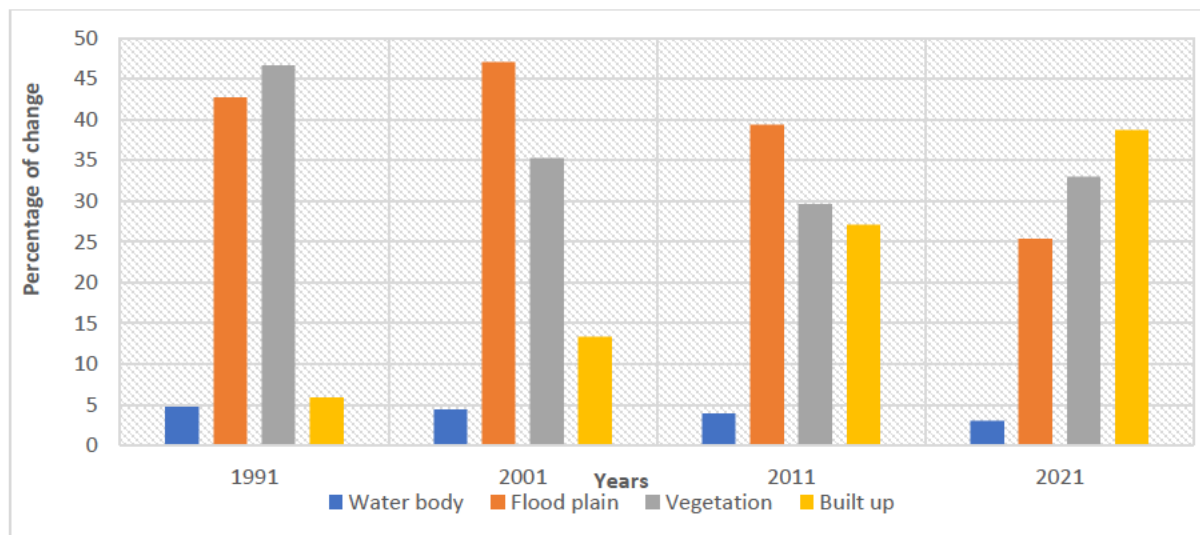


Fig. 4.10 Land Use Land Cover Change

Source: Author, 2023

4.6.5 Changes in Water Quality

The Niger River serves as a vital water source in the region, catering to various essential needs such as drinking, agriculture, and industrial processes (Ngene et al., 2021). However, the quality of this crucial water resource has been compromised by a range of human activities. Industrial discharges, municipal sewage, agricultural runoff, and oil spills have collectively contributed to the pollution of river water in the area.

Apart from the pollution issue, the act of consuming this contaminated water places individuals at risk of waterborne diseases. Contaminated water can harbour harmful bacteria and infectious agents, leading to various health ailments. The region has witnessed outbreaks of diseases, including cholera, typhoid fever, diarrhoea, and Guinea worm infestations. These illnesses can trigger severe health consequences, particularly in vulnerable populations like children and pregnant women, resulting in dehydration, malnutrition, and, in some cases, even fatalities.

The transformation in the hydrology of the primary rivers, especially those of high stream order, is unmistakable, primarily stemming from human-induced alterations. A noticeable change has been the increase in runoff volume, a consequence of river channel dredging and modifications in impermeable surface coverage, leading to the expansion of the river channels. In contrast, the lower stream order tributaries have undergone an opposing transformation, gradually narrowing, or even disappearing altogether. This phenomenon can be attributed to river channel sedimentation and the encroachment of urban development, factors that disrupt natural water flow and exacerbate flooding risks. This resonates with the findings in the work of Agbola et al. (2012), (Israel, 2017) who similarly highlighted the role of sedimentation and unchecked urban expansion in increasing flood susceptibility in vulnerable areas. Their studies emphasise the urgent need for sustainable land-use planning and regular maintenance of river channels to mitigate the compounded impacts of these environmental and anthropogenic changes. These studies have shown that interference with natural drainage channels can exacerbate bottlenecks in the river's flow, causing ripple effects that are transmitted upstream to the main river and its tributaries.

4.6.6 Farmers Conflict

The ongoing conflict between farmers and herdsmen within the Lower Niger River Basin represents a formidable challenge with broad implications for the region's food security,

economic progress, and the sustainable well-being of its agricultural communities (Misselhorn et al., 2012). The movement of herdsmen from the northern region of Nigeria to the southern areas in search of grazing lands for their livestock, driven by the arid conditions in the north, frequently leads to encroachments on and destruction of agricultural lands. This recurring conflict has generated significant tensions and disputes between farmers and herdsmen, carrying substantial consequences for the physical infrastructure of the region and the livelihoods of its farming populations (Adeoye, 2017).

As detailed in Table 4.4, households residing in areas affected by these conflicts have experienced a range of detrimental impacts on their livelihoods. These shocks encompass aspects such as rising price inflation, heightened insecurity, incursions, and damage to farmlands by herdsmen, loss of income, attacks by pests on crop seedlings, and even the prohibition of natural resource harvesting. The extent to which households are exposed to these shocks varies, with their responses serving as indicators of the severity of the influence on their overall well-being.

Table 4. 3: Livelihood Risk Exposure in the Last 10years (N=198)

| Livelihood risk | % Of Exposure | Frequency | | | |
|------------------------------------|---------------|-----------|----------|----------|---------|
| | | None | 1-2times | 3-4times | >5times |
| Hike in food price | 55.1% | 2.0 | 28.8 | 19.6 | 49.4 |
| Insecurity | 65.8% | 5.05 | 48.5 | 24.2 | 22.2 |
| Invasion of farm by herdsmen | 13.6% | 9.6 | 29.7 | 40.4 | 20.2 |
| Pest attack on seedlings | 6.9% | 57.5 | 21.1 | 11.7 | 9.3 |
| Loss of income | 20.7% | 3.0 | 39.4 | 30.3 | 27.3 |
| Ban on natural resource harvesting | 16.7% | 8.6 | 22.7 | 25.8 | 42.9 |
| High rate of theft/crime | 28.9% | 2.0 | 40.4 | 19.6 | 37.9 |

Source: Author, 2023

4.7 Climate Change Impact Affecting Households in the Last 10years.

In the initial phase of our study, respondents were surveyed about their direct encounters with heavy rainfall and resulting flooding over the past decade. An overwhelming majority, exceeding 80% of participants, affirmed experiencing heavy rainfall leading to flooding during this period. This underscores the frequent occurrence of extreme weather events in the Lower Niger River region, which are linked to the seasonal variability and intensity of rainfall. These heavy rainfall events are significant contributors to flooding in the area, exacerbating risks to communities and their livelihoods by inundating agricultural lands, damaging infrastructure, and disrupting daily life.

These findings highlight the profound implications of climate change on local communities, particularly on agricultural livelihoods in the region. Table 4.5 provides an overview of respondents' awareness and concerns regarding climate change impacts in the area. Notably, 59.1% of participants acknowledged that climate change had adversely affected irrigation agriculture over the past decade, underscoring its detrimental impact on farming practices and productivity. The alteration in precipitation patterns, characterized by heavy rainfall events, directly impacts irrigation systems and crop management, leading to increased vulnerability to flooding during the rainy season.

Furthermore, the survey revealed a notable lack of understanding regarding temperature fluctuations, with 57.6% of respondents reporting unawareness of how rising temperatures affect agriculture. This gap in knowledge underscores challenges in adapting agricultural practices to changing climate conditions, which are crucial for sustaining food security and economic stability in the region. Temperature increases contribute to the intensification of rainfall events, thereby heightening the risk of flooding. Warmer temperatures can lead to more frequent and intense rainfall episodes, amplifying the potential for flood-related damages and disruptions.

Moreover, a significant 56.6% of respondents recalled witnessing flooding events that resulted in community displacement and disruptions to livelihoods within the past decade. These displacements were most frequently experienced 4-6 times by most respondents, with 36.9% reporting 1-3 instances, and a minority of 7.6% observing such events more than 7 times. This recurrent exposure to flooding underscores the vulnerability of river-based livelihoods, with severe implications for agriculture, food security, and overall community well-being. Flood events not only displace communities but also damage agricultural fields and infrastructure, leading to crop loss, soil erosion, and economic hardships for farmers reliant on these resources. These statistics underscore the urgent need for comprehensive flood risk management strategies and climate resilience measures in the Lower Niger River region. Addressing these challenges requires integrated approaches that enhance community preparedness, improve infrastructure resilience, and promote sustainable agricultural practices. By mitigating the impacts of flooding and climate change, these efforts can safeguard the livelihoods of farmers and enhance the overall resilience of communities in the face of ongoing environmental challenges.

Table 4.4.: Climate Hazard Affecting Farming Household in the Last 10 years.

| Climate hazards | Sub Characteristics | Frequency | Percentage |
|--|----------------------------|------------------|-------------------|
| Witness Extreme rainfall that result in flooding | Yes | 197 | 99.4 |
| | No | 2 | 1.01 |
| Number of days witnessed flood in rainy season due to extreme rainfall in the last 10years | None | 6 | 3.0 |
| | 1-3days | 24 | 11.9 |
| | 4-6days | 74 | 36.8 |
| | >7days | 94 | 48.3 |
| | Total | 198 | 100 |
| Number of days experience flooding in the last 10years | None | 3 | 1.5 |
| | 1-3days | 28 | 14.1 |
| | 4-6days | 121 | 61.1 |
| | >7days | 46 | 23.2 |
| | Total | 198 | 100 |

| | | | |
|--|--------------|------------|------------|
| Number of times experience water scarcity in the last 10years | 1-3times | 49 | 24.7 |
| | 4-6times | 63 | 31.8 |
| | >7times | 86 | 43.4 |
| | Total | 198 | 100 |
| Awareness of changing temperature which affect farming system | Yes | 84 | 42.4 |
| | No | 114 | 57.6 |
| | Total | 198 | 100 |
| Number of times witness flooding event cause displacement of community and livelihoods in the last 10years | 1-3times | 73 | 36.9 |
| | 4-6times | 110 | 55.6 |
| | >7times | 15 | 7.6 |
| | Total | 198 | 100 |
| Climate change impact have negative effect on irrigation | Yes | 117 | 59.1 |
| | No | 81 | 40.9 |
| | Total | 198 | 100 |

Source: Author, 2023

4.7.1 Deforestation

Deforestation in the Lower Niger River Basin is a critical issue that is closely linked to the widespread reliance on unsustainable energy sources for cooking. Field study data provides a stark picture of the extent of this dependency, with 78.6% of households in the region using firewood as their primary cooking fuel. An additional 12.8% rely on charcoal, and 8.4% use kerosene for cooking. This high prevalence of firewood usage is not only a matter of concern for energy sustainability but has far-reaching implications for the environment, human health, and the global fight against climate change of which the result align with the work of Oyedepo (2012), that 60-70% of Nigerian households do not have access to clean cooking energy.

The heavy dependence on firewood for cooking has resulted in severe deforestation in the region. Trees and forests are being rapidly depleted to meet the insatiable demand for firewood, resulting in large-scale tree removal and forest degradation. This unsustainable practice not only disrupts the ecosystem but also leads to soil erosion, reduced biodiversity, and loss of critical habitats for wildlife.

Moreover, the impact of deforestation extends beyond the environmental realm with consequences of deforestation of trees and forests as a primary energy source which has significant implication on the social and health wellbeing of people and the environment additionally, it places enormous burden on women and children who are often responsible for collecting firewood and cooking with it. In some homes in the study area, household complained that the time expended in the collecting firewood, diverts valuable time and resources away from their children education, economic activities, and participation in social groups.

Furthermore, the reliance on firewood for cooking contributes to serious health implications. The inefficient burning of firewood generates indoor air pollution, leading to respiratory diseases and other health issues, especially among women and children who are most exposed. This puts a considerable strain on local healthcare systems and exacerbates existing health disparities. In addition to the local implications, deforestation linked to firewood usage has a global impact. It contributes to greenhouse gas emissions, particularly in the form of carbon dioxide, which further exacerbates climate change. Thus, the deforestation resulting from this heavy reliance on firewood is not only an environmental concern but also a contributor to the larger climate crisis.

Efforts to address deforestation in the Lower Niger River Basin must consider not only the environmental aspects but also the social and health dimensions. Transitioning to cleaner and more sustainable cooking technologies and promoting forest conservation are essential steps in

mitigating the adverse effects of deforestation, protecting the environment, and safeguarding the well-being of local communities which align with the work of Okoh and Okpanachi (2023), that the transition to a low-carbon economy will offer a better opportunities for people, community and reducing the expansion of fossil fuel infrastructure. This transition not only addresses environmental concerns but also offers a path towards sustainable energy solutions and a more secure energy future.

4.7.2 Agricultural Practices:

Agricultural practices undeniably form the backbone of livelihoods in the Lower Niger River region, as affirmed by the findings of our comprehensive field study. In this region, a significant majority of the population is actively engaged in farming, with a substantial 49.9% dedicated to agricultural activities. An additional 23.7% of the population is involved in fishing, leaving the remaining 26.4% participating in a range of diverse activities, primarily cantered around trade.

The agricultural landscape in the Lower Niger River region is multifaceted, encompassing a variety of practices, including rainfed agriculture, small-scale farming, wetland farming, fisheries, and poultry farming. Notably, wetland farming stands out as a crucial agricultural activity, with 30.3% of the respondents actively involved in this practice. The popularity of wetland farming is attributed to the region's abundance of water resources, which enable year-round agricultural activities. Land ownership in the area is distributed among individuals (58.6%), families (15.2%), and communities (32.3%). Furthermore, farmers are classified based on their landholding sizes, with 22.2% categorized as small farmers (<0.5 hectares), 41.1% as medium-sized farmers (0.5-1 hectare), and 36.4% as large farmers (>1 hectare).

Over the years, the region has witnessed a significant transformation in agricultural practices. Traditional farming systems have gradually given way to modern agricultural practices,

primarily driven by the rapid pace of urbanization and the heightened demand for agricultural products to feed the burgeoning population. This transition towards modernization carries substantial implications for land use, water resource utilization, and overall food security.

One concerning aspect of this shift is the proliferation of different crop varieties. While the aim is to enhance agricultural productivity, these practices may inadvertently pose health risks to the local population. The usage of various agricultural chemicals, pesticides, and genetically modified crops can contribute to the degradation of soil and water quality. Additionally, these practices raise concerns about the potential long-term health impacts on communities as they consume these crops.

This transition to modern agriculture has also escalated the need for mechanization and irrigation. The adoption of these practices places significant pressure on the region's water resources, potentially leading to water resource depletion and the alteration of local hydrological patterns. The expansion of irrigation systems, which is crucial for enhancing agricultural productivity, could contribute to the over-extraction of groundwater and the diversion of river water, further straining the already vulnerable water ecosystem of the Lower Niger region.

The modernization of agriculture does not only impact water usage but also transforms land-use patterns in the region. Traditional farming systems were characterized by diverse crop cultivation, promoting biodiversity and soil fertility. However, the shift towards modern, large-scale mono-crop farming for cash crops or staple foods may lead to a loss of diversity. This loss can have adverse ecological consequences and affect the region's overall food security.

It is important to note that smallholder farmers, who heavily rely on land and natural resources for their livelihoods, often face constraints in investing in natural conservation and preventing land degradation. Rising population, lack of technology, and poor institutional coordination hinder their access to incentives. Poverty, coupled with a growing population, can exacerbate

resource degradation, especially when farmers struggle to access fertilizers, which can lead to poor crop yields and worsen land degradation. Additionally, limited access to finance, an indicator of poverty, restricts their ability to invest in land management practices. The impacts of climate change further exacerbate their vulnerability.

Furthermore, the extensive use of fertilizers and agrochemicals in modern farming can result in the contamination of local water sources. Runoff from agricultural fields carries these chemicals into rivers, streams, and wetlands, leading to water pollution. This pollution poses risks not only to aquatic ecosystems but also affects the quality of water available for drinking and other domestic purposes.

In conclusion, the evolution of agricultural practices in the Lower Niger River region signifies a substantial shift towards modernization and intensified production. While this transformation has the potential to enhance crop yields and meet the demands of a growing population, it also raises critical concerns regarding land use, water management, and environmental sustainability. The unintended consequences of these changes, such as water pollution and potential health risks associated with agrochemicals, underscore the importance of adopting sustainable and eco-friendly agricultural practices to ensure long-term food security and the well-being of the local population.

4.8 Summary:

This chapter delves into a comprehensive exploration of the Lower Niger River Basin's evolving dynamics, particularly the interplay of climate change, hydrological shifts, and sociodemographic trends. The Lower Niger River region, with its distinctive wet and dry seasons, has not remained immune to the global wave of climate change, resulting in increased

frequency of extreme weather events. These climatic shifts have profound impacts on local communities, affecting livelihoods and daily life in multifaceted ways.

In examining the hydrological changes of the Lower Niger River, we uncover a complex picture characterized by variations in flow rates and increasing flow variability. These transformations can be attributed to factors such as shifting precipitation patterns and human activities in the area. The classification of river flow into "Ephemeral," "Intermittent," and "Perennial" types, as per the framework used by Sofi et al. (2020), provides valuable insights into the relationship between river flow and flooding in the region.

The chapter also explores evolving social trends in the Lower Niger River Basin, touching on diverse elements, including population dynamics and urbanization. The region boasts a rich tapestry of more than 40 ethnic groups speaking over 100 languages, creating a highly heterogeneous landscape. The increasing urbanization in the Lower Niger River Basin is giving rise to a series of urbanization-led neo-risks, including slum settlements, substandard housing, overcrowding, pollution, and inadequate access to basic services.

Examining the region's population dynamics, the chapter reveals the substantial demographic concentration in the Lower Niger River area, with a population of over 30 million people recorded in the 2006 census. Moreover, projections estimate a population of approximately 61.9 million in 2023, underlining the impact of intensified urbanization on the region.

The chapter also delves into the pressing issue of conflict between farmers and herdsmen, a significant challenge with implications for food security, economic development, and livelihoods in the agrarian communities of the Lower Niger River Basin. The movement of herdsmen in search of grazing lands, driven by arid conditions in the north, leads to conflicts and tensions with farmers, resulting in a range of livelihood shocks.

In summary, this chapter underscores the multifaceted nature of change in the Lower Niger River Basin, highlighting the intricate web of climate, hydrology, and sociodemographic shifts that shape the region's present and future.

CHAPTER FIVE

FLOOD VULNERABILITY MAP ASSESSMENT.

5.0 Introduction

Having laid the groundwork in the previous chapters, this chapter marks a pivotal step in our study as we delve into the assessment of flood vulnerability within the Lower Niger Basin. Utilizing advanced tools such as the Digital Elevation Model (DEM) and various indicators including precipitation, elevation, slope, land use, and land cover changes, we employ ArcGIS to develop comprehensive flood vulnerability maps.

The chapter begins by outlining our methodology, which integrates data from the Climatology Lab and utilizes high-resolution DEM raster formats at a scale of 30m-by-30m. This approach allows us to precisely map out areas susceptible to flooding based on terrain characteristics and climatic variables.

Our analysis focuses on delineating zones at risk of inundation, identifying vulnerable communities, and assessing the factors contributing to flood susceptibility. By synthesizing these spatial data layers, we aim to provide a detailed understanding of flood dynamics in the region, informing proactive measures for disaster preparedness and mitigation strategies.

This chapter serves as a crucial link between our conceptual framework and empirical findings, highlighting how geospatial technologies can enhance our comprehension of environmental risks and bolster resilience in flood-prone areas of the Lower Niger Basin.

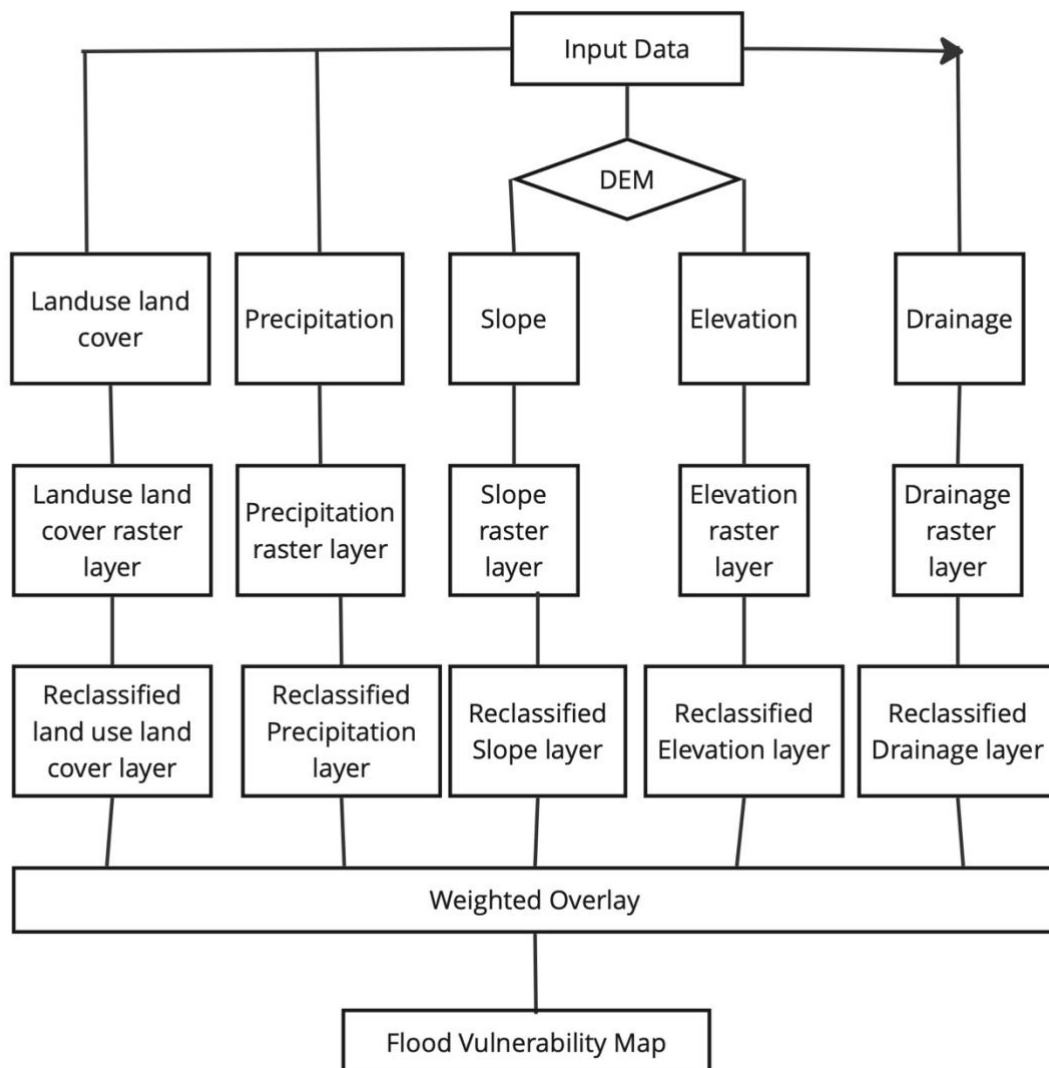


Fig 5.1 Flowchart of Parameters for Assessing Flood Vulnerability

Source: Author 2023

5.1 Flood vulnerability assessment.

Flood vulnerability assessment is a process of identifying and evaluating the potential impacts of flooding on a specific area or community. To actualize this using ArcGIS, we rasterised and categorised the DEM and other indicators as explain in the methodology of this section in Fig5.1. In addition, we illustrated the terrain surface elevation in 3-D of the digital Elevation Model to show to demonstrate the terrain of the Basin. We then discussed the indicators as used in the vulnerability assessment.

5.1.1 Slope

Slope is another important factor in flood vulnerability assessments, as it helps determine the areas that are more prone to flooding based on the steepness of the terrain. By categorizing slope data into discrete sub-groups, it becomes possible to identify areas with different levels of flood vulnerability. The slope data of the lower Niger Basin was extracted from the digital elevation model (DEM) and modified within a GIS environment. To facilitate further analysis, the slope data was converted from a shapefile format to a raster format using a conversion tool. The re-categorization of the slope data into five scales was performed, as shown in Fig 5.2. Each scale corresponds to a certain slope category and reflects a range of slopes:

- Very gentle slope: Locations in this category often have slopes between 0 and 1.5. These locations have a gentle gradient and are less prone to flooding and quick water runoff.
- Gently slope: This classification includes regions with slopes ranging from 1.5 to 3.3. The terrain is moderately inclined, allowing water to flow relatively smoothly without significant risk of flooding.
- Moderately steep: This category includes areas with a slope ranging from 3.3 to 5.8. These places have moderately steep topography, which might increase the likelihood of water runoff and cause localised flooding.
- Steep: This category comprises areas with a slope ranging from 5.8 to 10.1. The terrain in these areas is steep, which can result in faster water flow and increased flood risks.
- Escarpment: This category represents areas with the highest slope, ranging from 10.1 to 35.8. The terrain is characterized by significant steepness, leading to rapid water runoff and heightened flood vulnerability. By re-categorizing the slope data into these five scales, researchers can identify and prioritize areas within the lower Niger Basin based on their slope

characteristics. This information is essential for understanding the terrain's impact on flood vulnerability and implementing appropriate flood mitigation measures.

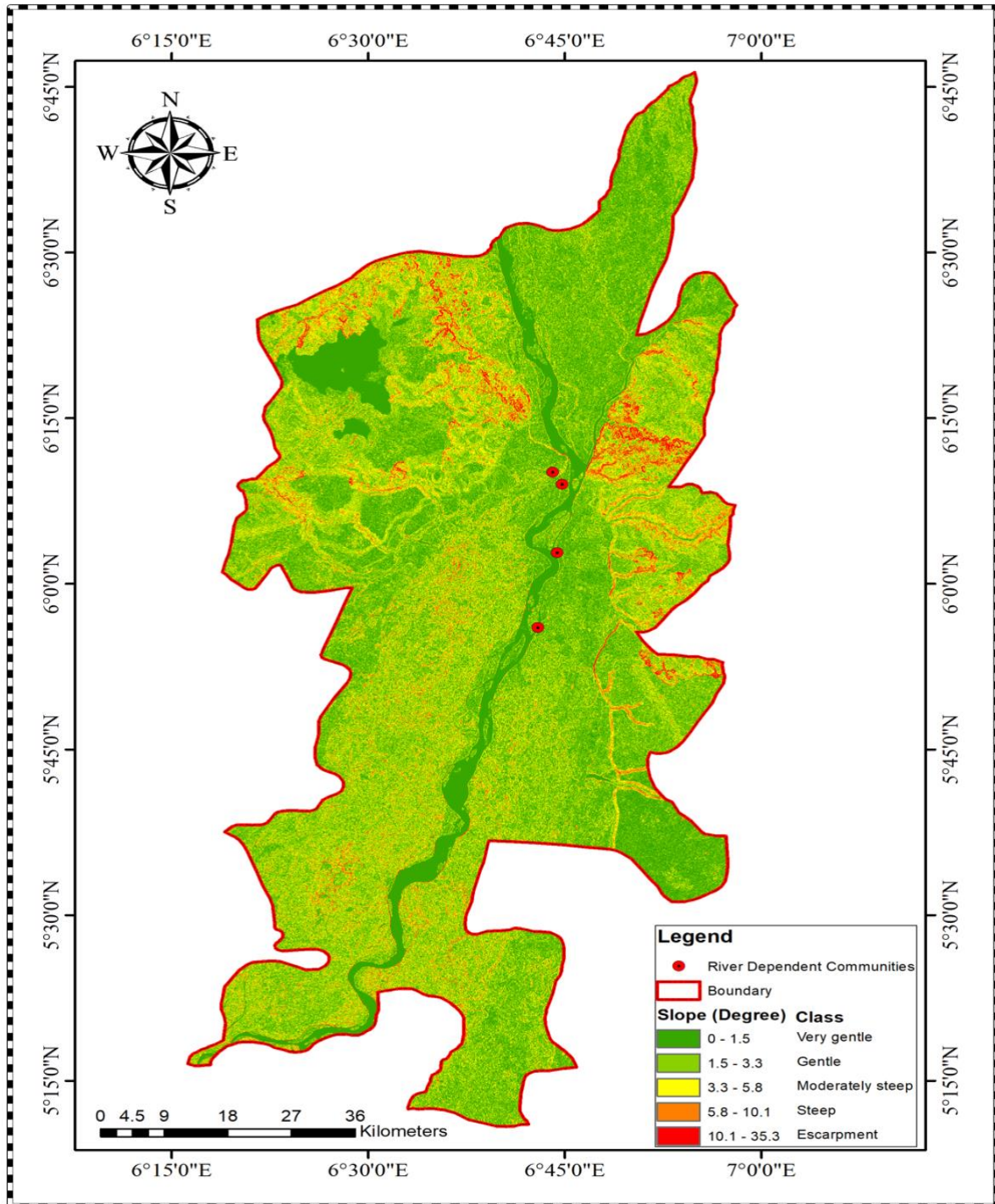


Fig 5.2 Reclassified Raster Map of Slope

Source: Author, 2023

5.1.2 Elevation Factor

The elevation factor plays a crucial role in flood vulnerability assessments as it helps identify areas that are particularly susceptible to flooding. By categorizing elevation data into distinct sub-groups, it becomes possible to analyse and prioritize areas based on their flood vulnerability.

The elevation data for this study was processed and re-categorized into five sub-groups using a normal classification system in ArcGIS. The five sub-groups are as follows: very low, low, moderate, high, and very high, as represented in Fig 5.3.

The re-categorization of elevation data enables me to identify different elevation ranges that exhibit varying levels of vulnerability to flooding. Since the landscape is usually flatter in locations with lower altitudes, there may be a greater risk of flooding in these areas. A higher flood vulnerability rating is consequently given to these areas.

Higher elevations, on the other hand, typically have steeper slopes, which might lessen flood hazards by facilitating water flow. The rating of these places' flood susceptibility as lower.

Assessments of flood susceptibility can prioritise regions according to their elevation features by examining the elevation factor and its related subgroups. For managing and comprehending flood hazards in the study area, this information may be useful.

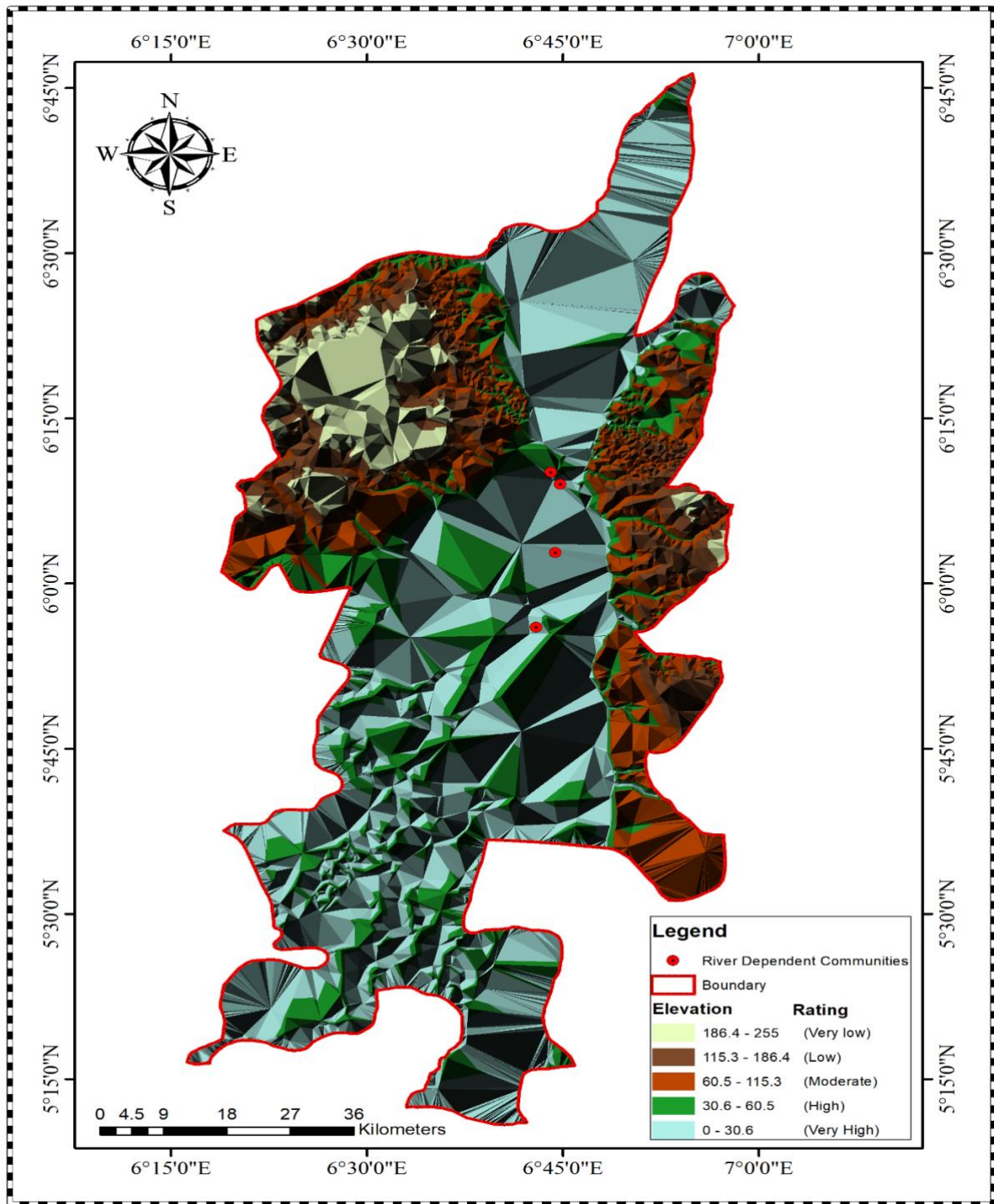


Fig 5.3 Reclassified Raster Map of Elevation

Source: Author, 2023

5.1.3 Precipitation Factor

The precipitation factor is an essential factor in assessing flood vulnerability as it helps identify areas that are more susceptible to high levels of flooding. In this instance, the rainfall data from the Terra Climate dataset, accessed from climatologylab.org, was analysed to derive the precipitation factor as shown in Fig 5.4.

To calculate the precipitation factor, the annual average rainfall data was processed in ArcGIS using a weighted overlay analysis. This analysis considers various factors such as the amount and intensity of rainfall at different locations within the study area. The obtained rainfall data was subsequently transformed into a raster layer, enabling additional analysis and visualisation. The amount of rainfall recorded at each location determined the values that were allocated to the re-categorized rainfall data to reflect the precipitation factor, which ranged from one to five (1-5). The data was divided into five ranks, with higher values indicating higher levels of precipitation and increased susceptibility to flooding.

Based on the colour representation provided in Figure 5.4, It is evident that places with greater precipitation values (between 16.7 and 21.2) are more likely to experience flooding. These regions get greater rainfall totals, which could possibly result in more flooding situations. On the other side, regions with lower values for precipitation (between 3 and 6.1) show a lower rate of flooding, indicating that these regions receive less precipitation and are less vulnerable to flood disasters.

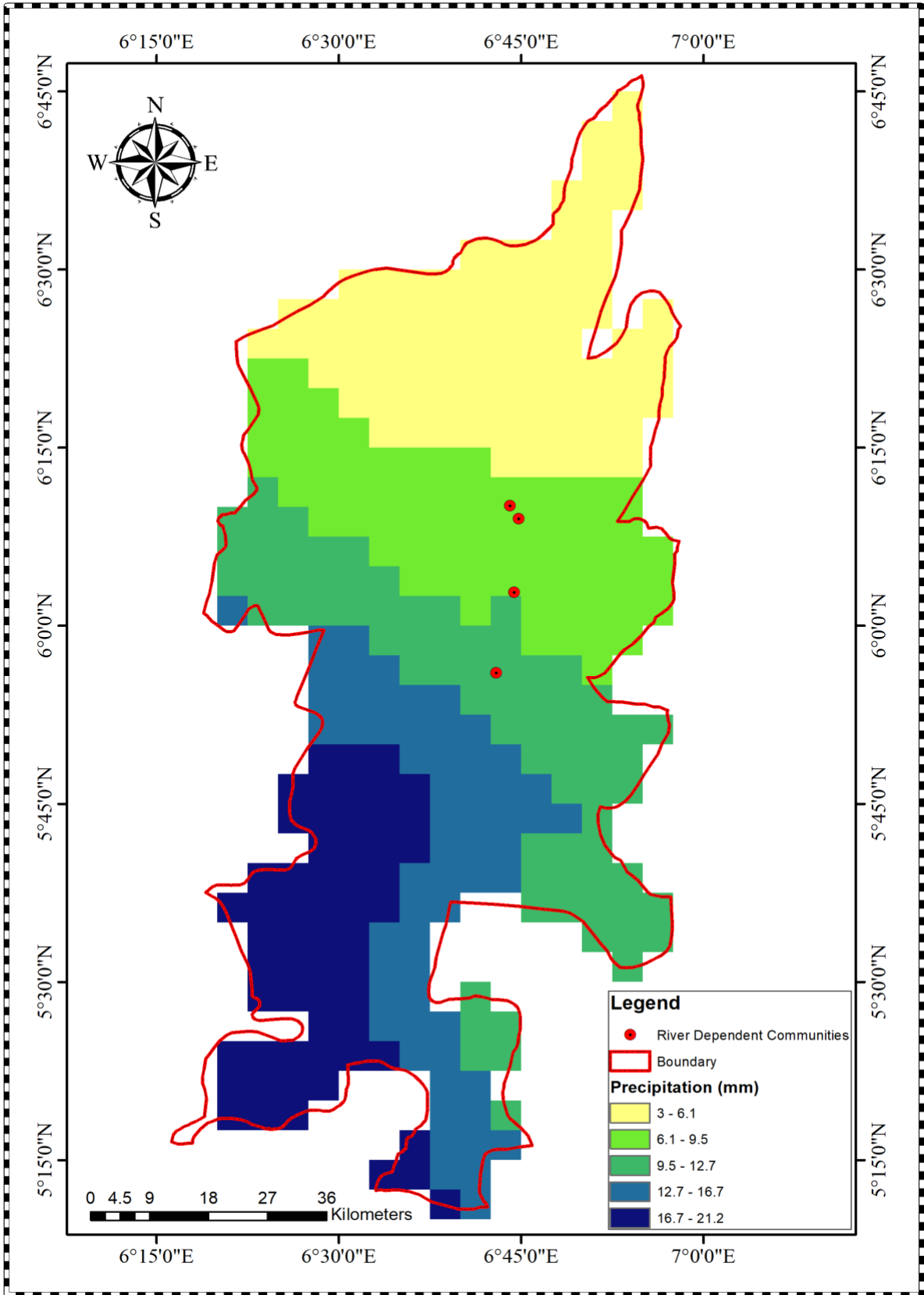


Fig 5.4 Reclassified Raster Map of Precipitation

Source: Author, 2023

5.1.4 Land use land cover factor.

The land use/land cover factor is an important component in assessing the risk of flooding in a particular area. It considers the various forms of land use and land cover and how they could affect the likelihood and severity of flooding. In reassigning the land use/land cover of the area, it was classified into five common grades and was converted into a raster layer in ArcGIS as shown in Table 5.1. Five grades of this land use/land cover factor were established for the study area. After that, it was divided into four groups based on how they affected inundation rates.

The four classes and their rankings are as follows:

Vegetation (Ranked as class one): Vegetation is assigned the lowest ranking as it has very low capability to create flooding in the study area. This category includes forests, grasslands, and other types of natural vegetation.

Floodplain (Ranked as class two): Floodplains are assigned a higher ranking than vegetation as they have a moderate potential to contribute to flooding. Low-lying, periodically prone-to-flooding lands near rivers or streams are called floodplains.

a waterbody (class three): Floodplains are assigned a lower ranking than waterbodies, such as lakes, ponds, and rivers. Due to their capacity to collect and hold water, they have a higher impact on flooding.

Built-up land use (Ranked as class four): Built-up land, including urban areas, infrastructure, and buildings, is assigned the highest ranking as it has the potential to increase the degree of flooding in the area. Impermeable surfaces and altered drainage patterns in urbanized areas can lead to increased runoff and reduced infiltration, exacerbating flood risks.

Fig 5.5 shows the percentages of each land use and land cover type in the research area.

According to the figure, the distribution of land use/land cover in the study area is as follows:

- Built-up land use: 38.7% of the total land area
- Vegetation: 33.0% of the total land area
- Floodplain: 25.5% of the total land area
- Waterbody: 3.0% of the total land area

By considering the different rankings and proportions of land use/land cover classes, the land use/land cover factor can provide valuable insights into the potential impact of different land types on flooding within the study area.

Table 5.1 Categorization of Land Use Land Cover

| LULC Category | Description |
|----------------------|---|
| Water Body | Covered with river, streams, pond, open water in flood plains |
| Vegetation | Land covered by forest, trees, shrubs, and plantation |
| Floodplains | Area covered by swamp, permanently waterlogged, degraded plant area used predominantly for farming and fishing |
| Built up | Area covered with buildings of different categories ranging from residential, commercial, industrial, recreation, stadium and transport facilities like road, railway, airport. |

Source: Author work, 2022.

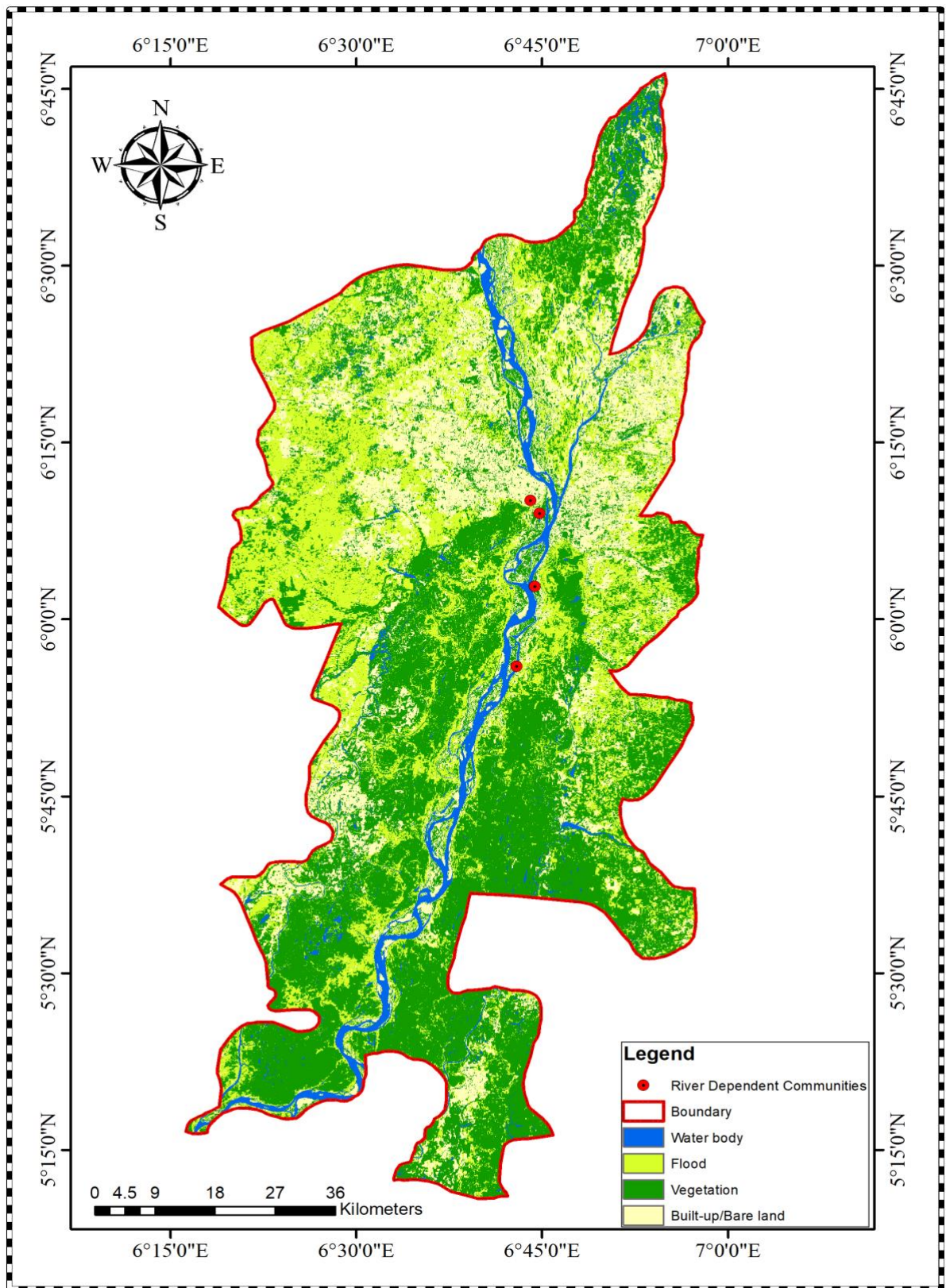


Fig 5.5 Reclassified Raster Map of Land Use Land Cover

Source: Author, 2023

5.1.5 Drainage Factor

The drainage factor is an important component in flood vulnerability assessments as it helps determine the capacity of the river system to carry water and its potential impact on flooding. By analysing the amount of water that can be accommodated by the river system in a basin, it becomes possible to identify areas that are more susceptible to flooding.

In this case, the drainage factor was assessed using data from the Terra Climate dataset obtained from climatologylab.org. The data was added as a raster file in ArcGIS, allowing for further analysis and classification. The natural break method was used to classify the data, resulting in the categorization shown in Fig 5.6.

The drainage factor was classified into five ranks based on the runoff density values:

1. Very low value: This rank corresponds to a runoff density ranging from 0.2 to 0.3 km. Areas with very low runoff density have limited capacity to carry water, indicating a higher susceptibility to flooding.
2. Low value: This rank represents a runoff density ranging from 0.3 to 0.5 km. Low runoff density areas nonetheless offer a moderate danger of flooding while having a significantly larger capacity to convey water than very low runoff density areas.
3. Moderate value: This rank corresponds to a runoff density ranging from 0.5 to 0.7 km. Areas with moderate runoff density have a moderate capacity to carry water, implying a moderate flood risk.
4. High value: This rank represents a runoff density ranging from 0.7 to 0.9 km. In comparison to the previous ranks, areas with high runoff density have a larger capacity to convey water. This indicates a lower flood danger.
5. Highest runoff density: The runoff density for this ranking is between 0.9 and 1.1 km. As a result of their greater capacity to transport water, areas with the highest runoff density may be at a lesser risk of flooding than those in the lower ranks. By analysing the drainage factor and

its associated ranks, it becomes easier to identify areas within the lower Niger basin that are more likely to experience flooding based on the capacity of the river system to handle water.

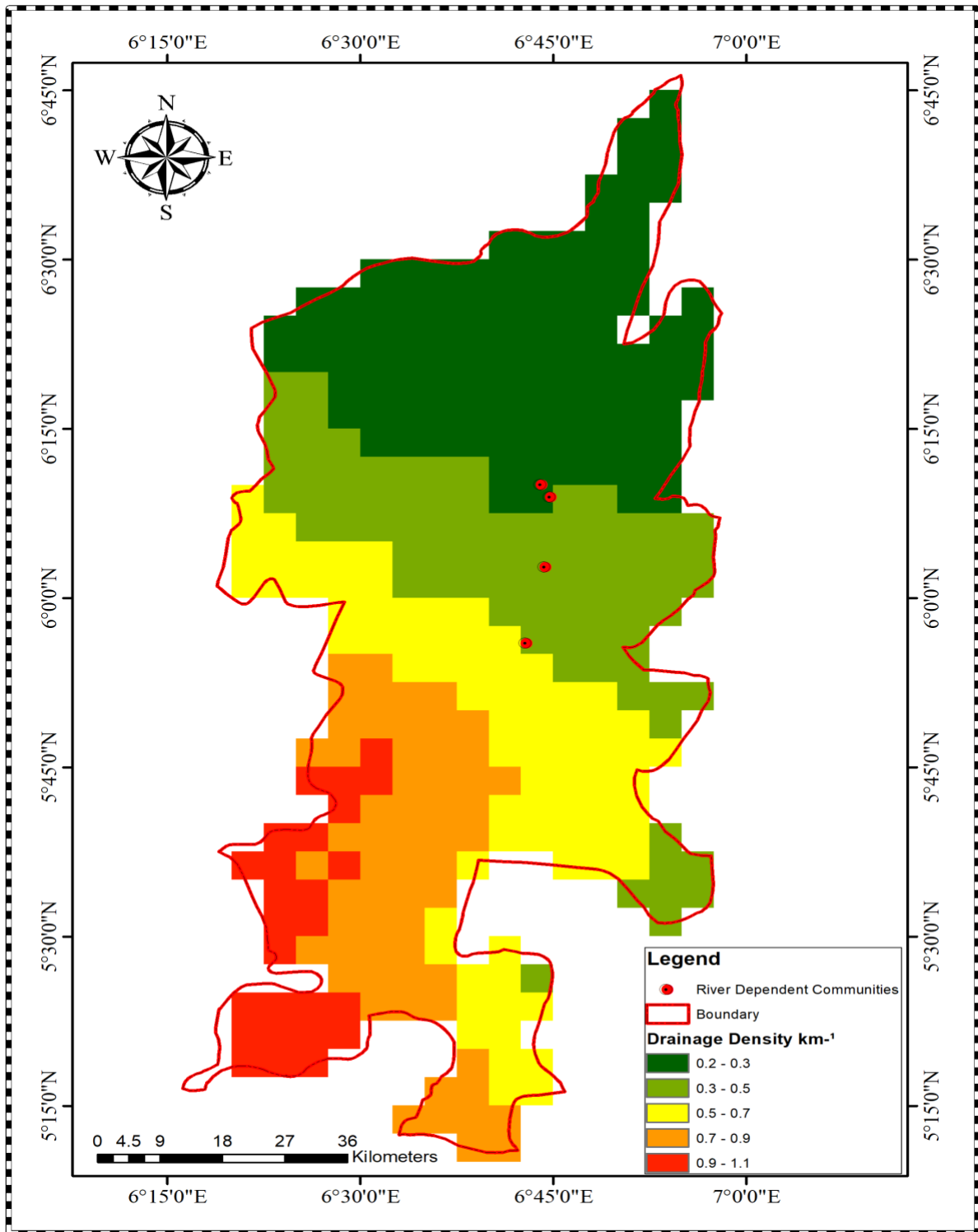


Fig 5.6 Reclassified Raster Map of Runoff

Source: Author, 2023.

5.2 Flood Vulnerability Map

The flood vulnerability map for the Lower Niger basin was developed by integrating various factors that contribute to vulnerability, including land use/land cover, precipitation, elevation, slope, and drainage characteristics. Each factor's contribution to overall vulnerability was ranked and assessed, as detailed in Table 5.4.

Using GIS techniques, these factors were combined to create the flood vulnerability map shown in Fig 5.7, which categorizes vulnerability into five levels: very low, low, moderate, high, and very high. This spatial representation highlights areas most susceptible to flooding based on the cumulative impact of these factors.

Analysis of the map reveals significant flood vulnerability across the Lower Niger basin, with 3564 square kilometres or 50.5% of the land area classified as moderately vulnerable to floods. This indicates a substantial level of susceptibility in these regions. Additionally, the upstream, middle, and downstream sections of the basin exhibit high to extremely high flood risks, covering a total land area of 61 square kilometres and 676 square kilometres, respectively. Particularly, the Ogbaru community stands out as heavily affected by these high-risk zones, exacerbated by its proximity to the Niger River, intense rainfall, and potential sea level rise.

The flood vulnerability map provides valuable insights into areas at greater risk of flooding within the Lower Niger basin. Decision-makers, planners, and communities can use this information to develop targeted flood mitigation plans aimed at reducing the impact on populations and infrastructure.

Geographers and urban planners can leverage the flood vulnerability map to inform strategic decisions and enhance flood management practices in the region. By understanding the spatial distribution of vulnerability, planners can prioritize areas with high and very high vulnerability for urgent interventions. For example, these efforts can focus on improving infrastructure

resilience, such as enhancing drainage systems, constructing flood barriers, and implementing early warning systems.

Furthermore, the map supports informed land use planning decisions that promote sustainable development practices, mitigate flood risks, and protect natural ecosystems. By integrating scientific data and spatial analysis, the flood vulnerability map facilitates effective collaboration with local communities and stakeholders. This collaborative approach strengthens resilience-building efforts, not only reducing the impacts of flooding but also enhancing overall adaptive capacity in response to climate change challenges.

Ultimately, the flood vulnerability map serves as a proactive tool for promoting sustainable development and safeguarding livelihoods in the vulnerable Lower Niger basin, ensuring a resilient future for its inhabitants.

Table 5.2 Ranking of Weighted vulnerability

| Parameter | Relative weighted | Reclassified Parameter | Ranking |
|------------------------|-------------------|------------------------|---------|
| Land cover Land Change | 42% | Water body | 1 |
| | | Floodplain | 2 |
| | | Vegetation | 3 |
| | | Built-up/bare land | 4 |
| Precipitation (mm) | 26% | 3-6.1 | 1 |
| | | 6.1-9.5 | 2 |
| | | 9.5-12.7 | 3 |
| | | 12.7-16.7 | 4 |
| | | 16.7-21.2 | 5 |
| Drainage Density (km2) | 16% | 0.2-0.3 | 1 |
| | | 0.3-0.5 | 2 |
| | | 0.5-0.7 | 3 |
| | | 0.7-0.9 | 4 |
| | | 0.9-1.1 | 5 |
| Slope (degree) | 10% | 0-1.5 | 1 |
| | | 1.5-3.3 | 2 |
| | | 3.3-5.8 | 3 |
| | | 5.8-10.1 | 4 |
| | | 10.1-35.3 | 5 |
| Elevation | 6% | 186.4-255 | 1 |
| | | 115.3-186.4 | 2 |
| | | 60.5-115.3 | 3 |
| | | 30.6-60.5 | 4 |
| | | 0-30.6 | 5 |

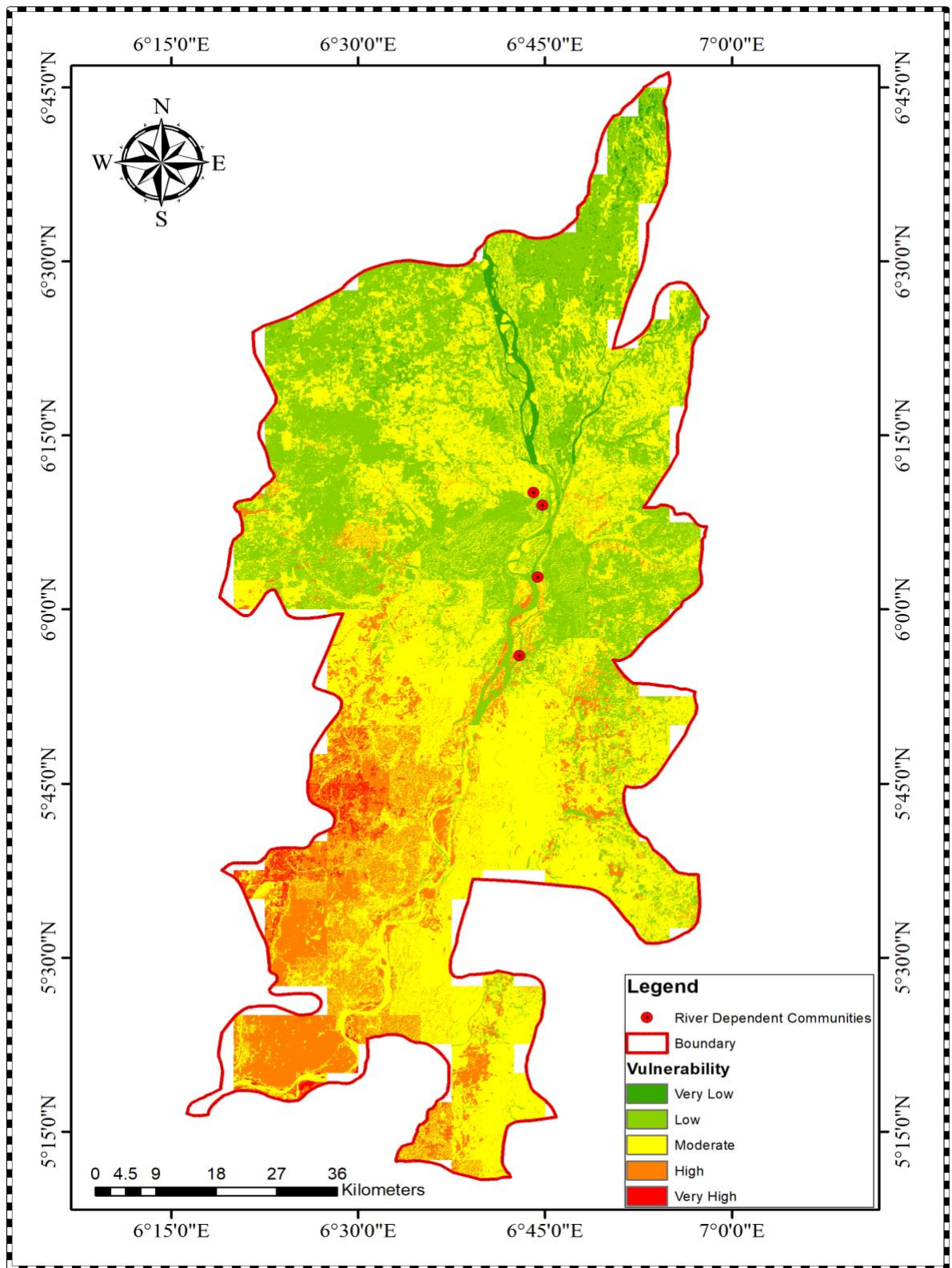


Fig. 5.7 – Flood Vulnerability Map

Source: Author, 2023

5.3 Summary

In summary, the flood vulnerability map of the Lower Niger Basin indicates that the area is moderately vulnerable to flooding. The map was generated by considering various factors, including land use/land cover change, rainfall, drainage density, slope, and elevation.

The identified factors play significant roles in determining the flood vulnerability of the study area. Land use/land cover change, such as the presence of built-up areas, vegetation cover, floodplains, and water bodies, influences the capacity of an area to either increase or decrease the risk of flooding. The Terra Climate dataset's rainfall patterns give us information on the precipitation factor and how it affects flood susceptibility. The elevation and slope factors both consider the height of the ground. The drainage factor evaluates the river system's ability to transport water and its impact on flooding.

The flood vulnerability map makes it clear that the Lower Niger Basin has a moderate level of flood susceptibility. However, the upstream, middle, and downstream areas of the basin are at a higher risk of flooding, with certain regions, particularly the Ogbaru community, experiencing high to extremely high vulnerability.

In the subsequent chapter, the focus will shift to discussing land policy and livelihood vulnerability, addressing the broader implications of flood vulnerability on land use practices, policies, and the socio-economic well-being of the affected communities in the study area. This conversation will offer more insights into the broader vulnerability context and support the creation of effective solutions for reducing the risk of flooding and fostering resilient livelihoods.

CHAPTER SIX

LAND USE POLICY AND VULNERABILITY

6.0 Introduction

In this chapter, we explore the intersection of land use policy and vulnerability in the context of flood-prone areas within the Lower Niger River region. As we shift focus from the physical and environmental aspects discussed in previous chapters, we turn our attention to the socio-legal framework governing land tenure in Nigeria.

Land tenure, encompassing both formal statutory laws and customary practices, plays a pivotal role in determining access to and management of land resources. This chapter investigates how disparities in land tenure systems contribute to differential vulnerabilities among farmers, particularly in response to flooding events.

The analysis underscores how insecure land rights exacerbate risks and constrain adaptive capacities during environmental crises. By examining historical precedents and contemporary practices, we aim to elucidate the complex dynamics shaping land use policies and their implications for community resilience.

Through this exploration, we seek to highlight the critical importance of equitable land governance in enhancing the ability of vulnerable populations to cope with and recover from the impacts of flooding. This chapter serves as a bridge between our empirical findings and policy recommendations, emphasizing the need for inclusive and sustainable land management strategies in mitigating flood-related vulnerabilities in the Lower Niger River region.

6.1 Land Tenure System in Nigeria

Land tenure is the system governing the ownership, use, and transfer of land, holds paramount significance in understanding vulnerability in the Lower Niger River region of Nigeria (Abdullah, 2021). Land, often described as the very bedrock of human existence, serves

as a crucial asset upon which individuals depend for sustenance, shelter, raw materials, and clothing(Assefa, 2012). It is not merely a resource but a cornerstone of human society and economic stability, embodying wealth, well-being, and cultural identity. This intrinsic value of land emphasizes its role in sustainable development and highlights the complex challenges associated with land governance in Nigeria. The governance of land is intricately linked to a web of legal and regulatory frameworks, reflecting diverse and often competing interests(Scarlett and McKinney, 2016). These policies and practices significantly influence ecosystems, agricultural conservation, and the livelihoods of communities along the Lower Niger River. Therefore, understanding land tenure is crucial for assessing vulnerability, particularly in the context of how changes in land use, environmental conditions, and socio-economic factors intersect.

In Nigeria, the prevailing land policy framework does not actively encourage sole ownership, posing formidable challenges for those interested in large-scale farming and investment (Okoye and FLEAD, 2016). This lack of clarity in land ownership has profound implications for local populations. Some households may become landless, while others are compelled to diversify their income sources, thereby altering the fabric of their lives and communities. This intersection of land tenure, socio-economic pressures, and environmental challenges sets the stage for a deeper exploration of vulnerability.

To appreciate the complexities of land tenure in Nigeria, it is essential to examine its historical trajectory, tracing the evolution of land management from the precolonial era to the present. This historical context reveals how land management practices have shaped agricultural development and accessibility in Nigeria. As we have seen in previous sections—particularly in the discussions on population dynamics, urbanization, and land use changes—the interplay

between land tenure and these factors underscores the vulnerability faced by farmers and communities.

The analysis of land use and land cover changes, along with the impacts of urbanization on runoff, illustrates how modifications to the landscape can exacerbate flood risks, particularly in areas where land tenure remains insecure. This further emphasizes the intersectionality of environmental change, socio-economic conditions, and land governance. For instance, the increasing dominance of built-up areas, driven by urbanization, has altered natural drainage patterns, compounding flood risks for communities dependent on agriculture.

Moreover, the issues of water quality and farmers' conflicts, discussed in earlier sections, are also intricately linked to land tenure. Poor land governance can lead to disputes over land use, especially in flood-prone areas where the availability of fertile land becomes increasingly contested. Addressing these challenges requires a holistic approach that considers the socio-economic dimensions of land tenure, the environmental impacts of land use changes, and the vulnerabilities faced by diverse communities. By weaving together, the narratives of land tenure, population dynamics, urbanization, and environmental challenges, we can develop a comprehensive understanding of the vulnerabilities that shape the lives of individuals in the Lower Niger River region. Recognizing these interconnections not only illuminates the complexities of land governance but also highlights the urgent need for integrated policies that address both social equity and environmental sustainability.

6.2 Precolonial Land Management:

The land tenure system in Nigeria was historically characterized by its diversity and a profound connection to local customs and traditions. In the precolonial era, communities had well-defined systems of land ownership. Land was often collectively held by chiefs, and rights to

the land were primarily based on use and occupation. This communal approach fostered a strong sense of interconnectedness among community members and made it relatively simple for individuals to access land for various purposes. It is noteworthy that Alao and Shuaibu (2013) emphasized the creation of a robust and harmonious relationship between individuals and society regarding the utilization, control, and administration of land within this system.

This traditional land tenure system not only promoted community cohesion but also enabled sustainable agricultural practices. Generations of families could cultivate the same land, and there was no fragmentation of land as individuals and families could access as much land as they required. Land administration was firmly rooted in the customary laws, traditions, and values of distinct regions across Nigeria. For instance, land in the southern part of Nigeria was held by chiefs, Obas, and Obong, while in the northern part, it was administered by the Emirs. Findings from interview supports that there was absence of formal planning and management of settlements during this era. However, discernible patterns of physical development were evident in prominent traditional cities in Nigeria (Omole and Akinbamijo, 2012). For example, the structural layout of many Yoruba settlements in the southwestern part of Nigeria featured the King's palace positioned near the primary market area, enclosed by formidable walls.

While there was no formal urban planning system, there was a functional division within these cities, with specific sections designated for administrative, trading, and defensive purposes. Urban planning in the precolonial era was primarily influenced by natural geographical factors and deliberate human effort. The authority for such matters rested with the rulers and leaders of societies, such as Obas, Emirs, Eze's, and Obis (Baldwin, 2016). Nigerian settlements were structured around the central point of the palace, where these traditional rulers resided.

During this time, acquiring land for agricultural purposes was relatively straightforward, as there were no legal constraints on land use. Additionally, conservation practices were uncomplicated, as farmers could request land from the traditional ruler and rotate their cultivation to different plots in subsequent farming seasons. To further substantiate this claim, we conducted interviews with stakeholders who candidly shared their observations regarding land administration in the precolonial era in Nigeria. They emphasized discernible changes in land management characterized by bottlenecks, expensive and uneasy access to land, leading to fraudulent activities and land fragmentation across families.

Participants emphasised the complex effects of these changes, especially farmers' limited access to land. The Lower Niger River region is renowned for farming and fishing, and the consequences of restricted land access were evident. Participants highlighted how these changes created disparities between the wealthy, who could easily access land, and the poor, who struggled to secure land for farming. Furthermore, participants expressed concerns about the increased risks associated with the lack of access to land, potentially leading to poverty, hunger, and illnesses, particularly among vulnerable populations.

In agricultural production, the effects of limited land access were acutely felt. Participants shared their experiences of how it had led to a monocropping structure among farmers, whereas access to land would have allowed for the planting of different crop varieties and the practice of mixed farming. Those who were tenants or landless voiced their grievances about the high costs of renting land for farming, which could increase the vulnerability of those with limited financial capacity. This vulnerability could be exacerbated by climate-related disasters, potentially resulting in agricultural losses that have negative impact on livelihood and food security.

6.2.1 Customary Land law

Land under the customary rule was in the control of individual, family and they were entitled to use land for themselves and family(Ghebru et al., 2014). The most important aspect of this rule was that land is an ancestral reliance which is shared among the living and dead and therefore, no community member was deprived of the use of land and the right to land was in perpetuity or lifetime especially when used for farming purposes(Fabiyi, 1979, Oshio, 1990). Prior to Colonialism, Nigeria had two protectorates, and the control and use of land was different from North to South(Ayandele, 1967, Blench et al., 2006, Oshio, 1990). In the Northern part of Nigeria, land tenure system vested all land on the Emir who gave it to the people Adeyemi (2019), (Fabusoro et al., 2008), and in the Southern Nigeria, land was vested on the chief or Obong holding the land in trust for the whole community, village and family(Fabusoro et al., 2008, Oshio, 1990). Therefore, as trustee holding the land in trust, absolute ownership was not vested on the chief but the community and the chief was a mere care-taker performing administrative functions under the customary law(Ghebru et al., 2014). Under the customary law, land later became alienable which makes cooperate ownership gained prevalence over individual ownership. However, the dynamics of customary land law evolved over time. Land became alienable, leading to a rise in corporate ownership at the expense of individual rights. This shift was not without complications; chiefs and individuals in positions of authority often exploited their administrative roles for personal gain, undermining the collective interests of the community. In many instances, chiefs appropriated income from corporate land holdings for their benefit, creating a system rife with inequity. This corruption led to significant insecurity regarding land titles, as the same plots of land were sometimes sold to multiple parties, resulting in conflicts and disputes. In extreme cases,

individuals resorted to displays of strength or violence to secure their land rights, further exacerbating tensions within communities.

The interplay between customary land law and socio-economic conditions highlights critical intersectional issues, particularly for marginalized groups. Those without land access faced increased vulnerability, as their livelihoods relied on tenuous arrangements like tenancy or labouring on others' lands. The lack of secure land tenure directly impacted agricultural production, often forcing land-poor farmers into monocropping systems due to limited access to diverse plots of land. This restriction hampered their ability to adopt sustainable farming practices, which would otherwise promote food security and resilience against climate-related shocks.

Additionally, the historical fragmentation of land ownership created disparities between wealthy landholders and poorer, landless individuals. These disparities have lasting implications, contributing to social stratification and economic inequality in the Lower Niger River region. Interviews with stakeholders reveal that this inequity extends beyond economic ramifications, as restricted access to land has been linked to rising poverty rates, food insecurity, and health issues among vulnerable populations.

As we transition into discussing formal land management systems and the impacts of colonialism, it is essential to recognize how the legacy of customary land law continues to shape land use practices today. The historical context provided here lays the groundwork for understanding the complexities of land tenure and the vulnerabilities experienced by communities along the Lower Niger River, particularly considering ongoing urbanization and environmental changes.

6.3 Colonial Influence

The colonial influence on land management in Nigeria initiated a transformative shift that irrevocably altered the landscape of land tenure systems. The introduction of individual land ownership and registration systems was a radical departure from the precolonial communal practices that had previously governed land use. This shift was not merely administrative but was deeply entwined with the broader objectives of colonial control and resource extraction, which had significant repercussions for local communities.

6.3.1 Changes in Land Tenure Practices

The British colonial administration aimed to facilitate control over land resources, seeing land to bolster economic gains for the colonial power. By establishing a formalized land tenure framework, the colonial rulers sought to streamline taxation processes and enhance their authority over land use. As part of this agenda, traditional systems of land tenure, which fostered communal ownership and utilization, faced substantial disruption.

The feudal tenure system imposed by the Fulani Jihad in Northern Nigeria in 1882 further exemplified this shift. This system established hierarchical relationships between landowners and tenants, often undermining the collective rights of communities (Hickey, 1984). In 1903, the colonial government solidified its control over land rights through Lord Lugard's administration, marking a transition towards a more centralized approach to land management.

6.3.2 Statutory Regulation and the Erosion of Customary Rights

The introduction of the Land Ordinance of 1910 and its subsequent amendment in 1916 represented critical turning points in the legal landscape of land ownership. Under these regulations, land rights were effectively ceded to the colonial government, which asserted that land should be utilized for public benefit. This approach allowed for the continued exploitation of land resources while sidelining the customary rights of indigenous populations.

Particularly significant was the amendment in 1916, which vested control of all native lands in the hands of the government. This legislation effectively disenfranchised local communities, as non-natives—defined as individuals whose fathers were not indigene to Northern Nigeria—were prohibited from holding any land interest except through leases granted by the government (Maduekwe, 2014, Ghebru et al., 2014). This legal reconfiguration not only stripped traditional leaders of their authority but also reduced the power dynamics within communities, making them increasingly dependent on colonial governance for land access.

6.3.3 Implications for Vulnerability and Social Inequality

The colonial restructuring of land tenure systems laid the groundwork for entrenched social inequalities and vulnerabilities that persist in contemporary Nigeria (Maduekwe, 2014). The centralization of land control meant that local farmers and community members often found themselves at the mercy of colonial policies, facing challenges in securing land rights and access to resources. These changes fostered disparities between those who could navigate the new legal frameworks and those who could not, amplifying existing inequalities.

Furthermore, the erosion of communal land practices has had lasting effects on agricultural productivity and food security (Nwokoro and Chima, 2017). The fragmentation of land ownership into individual parcels, coupled with the imposition of external regulations, has restricted the ability of farmers to engage in sustainable land management practices. As highlighted in previous sections, limited land access exacerbates the vulnerability of local populations, particularly marginalized groups who rely on agriculture for their livelihoods.

6.3.4 Bridging to Contemporary Land Management Issues

The colonial legacy of land management practices continues to resonate in Nigeria's current land tenure systems. Understanding this historical context is essential for addressing ongoing issues related to land access, food security, and social equity in the Lower Niger River region. As we move to examine contemporary land management strategies and their implications for

local communities, it is crucial to consider how the remnants of colonial land policies inform current vulnerabilities and shape the socio-economic landscape.

This examination of colonial influence on land tenure in Nigeria not only highlights the historical shifts that have occurred but also sets the stage for discussing the complexities of current land management practices and their intersection with social dynamics in the region.

The advent of colonial powers in Nigeria marked a significant turning point in the region's land management practices. This era ushered in a new set of rules, values, and socioeconomic aspirations that significantly departed from the traditional precolonial norms. The British colonial administration introduced a series of transformative measures, including the establishment of individual land ownership and registration systems, which had profound implications for the traditional communal land tenure practices that had been deeply ingrained in Nigerian society.

6.3.5 Land Management Under Colonial Rule

The influence of colonial governance on land management in Nigeria is evident through a series of legislative actions that fundamentally altered the landscape of land tenure. Starting with the Town Improvement Ordinance in 1863, aimed at regulating urban development in Lagos, the colonial administration-initiated measures that would shape land use for decades to come. This was followed by the establishment of cantonments under Lord Lugard's Cap 37 proclamation in 1911, and the Township Ordinance of 1917, which sought to codify municipal responsibilities based on community needs(ADEBAYO, 2021).

However, the status quo persisted largely unchanged until 1928, when a bubonic plague outbreak in Lagos necessitated urgent reforms. This public health crisis led to the formation of the Lagos Executive Development Board, which became Nigeria's first planning authority, specifically tasked with addressing urban planning issues in the wake of the

epidemic(Murunga, 2006). The establishment of this board marked a turning point in the formalization of land management processes.

In 1946, the Nigerian Town and Country Planning Law was enacted, drawing inspiration from the British Town and Country Planning Act of 1933. This was followed by additional relevant legislation, including the Lands Development Law of 1948, which focused on road management, and the Building Lines Regulation of 1948, which guided city development. These laws were instrumental in reshaping traditional land tenure systems that had endured for centuries, introducing concepts such as individual land ownership and registration systems.

6.3.6 Impact on Traditional Practices and Community Relationships

The implementation of these new land management frameworks elicited mixed reactions from indigenous populations, with many vehemently opposing the radical changes to their established communal land tenure practices. Participants in qualitative interviews indicated that one of the primary motivations behind these reforms was the colonial government's desire to create a more formalized and regulated land tenure system that would streamline taxation and enhance land control. This aligns with the findings of Nwankwo and Ocheni (2020), who assert that such changes were aimed at consolidating colonial authority and economic interests. The shift from communal land stewardship to individual ownership disrupted long-standing relationships within communities. Traditional chiefs and community leaders, who once held land in trust for their people, found their authority diminished and their roles redefined. This transition posed significant challenges to the collective governance of land, leading to a fragmentation of land ownership that has had lasting consequences.

6.3.7 Consequences for Property Rights and Community Dynamics

The legacy of colonial land management practices has significantly influenced property rights, exacerbated issues of land fragmentation and creating legal complexities that persist in contemporary Nigeria. Disputes over land ownership and access have become common, with communities grappling with the repercussions of a system that favoured individual ownership over communal rights (Mwangi, 2007). The imposition of new land laws also laid the groundwork for future conflicts, as competing interests emerged over land that was previously managed collectively.

Moreover, the entrenchment of individual land ownership has altered power dynamics within communities, leading to inequities that disproportionately affect marginalized groups. As noted in previous sections, the disruption of traditional governance structures has contributed to ongoing vulnerabilities, particularly among those who rely on agriculture for their livelihoods. The colonial emphasis on resource exploitation and economic gain continues to resonate today, shaping land administration practices and fiscal policies within Nigeria's contemporary governance structures.

6.3.8 Bridging to Contemporary Land Management Challenges

Understanding the impact of colonial rule on land management is crucial for addressing the ongoing challenges related to land tenure in Nigeria. The historical context provides insight into the complexities of current land administration systems and highlights the need for reforms that acknowledge and rectify the inequities established during the colonial period. As we explore contemporary land management practices in subsequent sections, it is essential to consider how these historical legacies inform present-day governance, land access, and community resilience. The intersectionality of land management, social equity, and economic stability remains a critical area of inquiry as Nigeria navigates its path toward sustainable development.

6.4 Post-Independence Reforms:

Following Nigeria's independence in 1960, the country faced the challenge of reconciling its complex land tenure system, which combined customary land practices with statutory land laws inherited from the colonial era. Despite attempts at reform, these systems persisted in parallel, creating challenges for land access, development, and governance.

One of the most significant legislative efforts to address this complexity was the Land Use Act of 1978, which remains a cornerstone of Nigeria's land administration today. The Act was introduced as a response to the challenges posed by the plural land tenure system and sought to centralize land ownership under state control. By doing so, it aimed to simplify land acquisition for development and personal use. According to the Act, all land in each state of Nigeria was vested in the state governors, who were to hold and administer it in trust for the public (Ugonabo et al., 2023).

In non-urban areas, land management was vested in the chairman of the local government, who had control over the land under specific provisions. While the Act attempted to centralize land ownership, it resulted in a dual land tenure system, with state control over urban areas and continued customary ownership in rural areas. The period following independence was thus marked by ongoing tension between these systems, as Nigeria sought to modernize land governance while respecting long-standing traditions.

6.4.1 Urban and Regional Planning Law

The Urban and Regional Planning Law of 1992 is another key piece of legislation that governs land use and planning in Nigeria. This law provided a framework for coordinating urban and regional planning activities across different levels of government. It established state physical

planning boards and local government planning authorities, with the responsibility of overseeing physical planning at their respective levels(Arimah and Adeagbo, 2000, Omole and Akinbamijo, 2012).

However, the rapid urbanization experienced in Nigeria has raised concerns about the effectiveness of the Urban and Regional Planning Law. Nigeria's urban population grew from 16.3 million in 1975 (21% of the total population) to 36.2% by 1993(Effiong et al., 2024b). This explosive growth, particularly in cities like Lagos, Ibadan, and Kano, has outpaced urban planning efforts, leading to the proliferation of informal settlements, overcrowded living conditions, and the emergence of unauthorized buildings. These issues, often described as "neo-risks" by which Srivastava and Srivastava (2020), include deteriorating infrastructure, inadequate waste management, air and water pollution, and insufficient access to basic services like electricity and clean water. Furthermore, insufficient access to basic services, such as reliable electricity and clean water, disproportionately affects marginalized groups, limiting their ability to adapt to environmental and socio-economic stressors.

In response to these challenges, the Urban and Regional Planning Law attempted to provide a structured approach to managing physical development. However, its implementation has been uneven, particularly in terms of the allocation of authority and responsibilities between state and local governments. Critics argue that the law often marginalizes the role of local governments, despite their pivotal role in managing urban development at the grassroots level (Potts, 2012). This imbalance has led to the development of biased regulations, inefficient administrative structures, and excessive political interference, further complicating efforts to manage Nigeria's urbanization effectively.

The Land Use Act of 1978 and the Urban and Regional Planning Law illustrate the ongoing struggle to create a unified land management system in post-independence Nigeria. These laws reflect attempts to modernize land governance, but they also highlight the challenges posed by rapid urban growth, political interference, and the persistence of customary land tenure practices.

Table 6.1 – Summary of Governance Periods and Land Administration Vulnerabilities

| Period | Key Legislation | Land Administration Practices | Vulnerability |
|-------------------------------------|---|---|---|
| Pre-colonial rule (1500-1900) | Customary law | Communal ownership under chiefs and community leaders | Equitable land access but lack of formal land rights |
| Colonial Rule (1900-1960) | Ordinances and Land Use Ordinances | Introduction of individual land ownership, registration systems. | Fragmentation of land ownership, legal complexities, and dispossession of communal land |
| Post-Colonial rule (1960-till date) | Land Use Act (1978), Urban and Regional Planning Law (1992) | Centralized land ownership under state control, formal planning authorities created | Dual land tenure system, urbanization pressures, and political interference |

Source: Author 2023.

6.5 The Legacy of Colonialism and Land Reconfiguration and governance

The enduring legacy of colonialism has left an indelible imprint on the reconfiguration and governance of land in numerous nations worldwide, with a particularly profound impact in Africa. Colonial powers wielded significant influence over land management, and the historical reverberations of this influence persist in the way land is controlled, allocated, and administered in many post-colonial states. Post-colonial development evokes a range of emotions. On one

hand, it brings a sense of happiness as it provides us with valuable insights into the art of governance. However, this joy is tinged with sadness when we delve into the legacy left behind, one that was constructed on the unstable foundation of cultural imperialism. Colonialism introduced our region to a complex dynamic – the intricate relationship between land reconfiguration and governance. This relationship continues to exert a profound influence on our contemporary landscape, sparking debates and dispelling misconceptions about indigenous communities and their crucial role in environmental stewardship(Noxolo, 2016).

As we navigate the intricate interplay between post-colonial development, land reconfiguration, and governance, it becomes evident that understanding this complex relationship is essential for shaping a more sustainable and equitable future for our communities and the environment. This understanding has never been more critical, especially considering the escalating misconceptions, resource exploitation, agitation, and stereotypes that have begun to deeply affect individuals, ethnic groups, and communities.

A notable example of this can be observed in the southeastern part of Nigeria, where some individuals and ethnic groups have been advocating for a breakaway from the country due to what they perceive as marginalization. These groups have devised strategies such as observing a sit-at-home protest every Monday to express their discontent with the perceived injustices they face. Unfortunately, this approach has led to unwarranted killings, conflicts of interest, and social disruptions.

The parallels between these contemporary challenges and the legacy of colonialism are striking. Much like the colonial governments that arrived in the region with the primary goal of resource exploitation, these situations undermine the cultural development that once unified the people. The legacy of the colonial era, characterized by a history of resource extraction and

cultural suppression, continues to cast a long shadow on the dynamics of the present. These contemporary movements are, in many ways, a response to the enduring socio-economic disparities and the unequal distribution of resources. Much like the colonial powers of the past, these situations fuel a sense of injustice and inequality, fostering divisions and creating conflicts of interest.

The legacy of colonialism is notably marked by the British government's introduction of individual land titles across many of its colonies, part of a comprehensive strategy to formalize and privatize land ownership systems(Mathur and Mulwafu, 2018). This shift in land tenure, brought about by the transition to individual land titles, significantly impacted the socio-economic landscape of these regions. However, as the demand for change gains momentum, persistent disparities continue to prevail, and the existing governance framework remains skewed in favour of the affluent during the process of land title regularization. The exclusion of financially disadvantaged households from the land title regularization processes has left many indigenous claimants feeling that their broader community aspirations have not been adequately addressed. In essence, despite advancements in securing land rights, unresolved issues pertaining to indigenous rights, well-being, and self-determination continue to cast a long shadow over the affected regions.

6.6 Influence of Colonial System

The laws governing land access and tenure in many regions around the world, particularly in former colonies, were heavily influenced by the colonial system. Colonial powers imposed legal frameworks and land administration systems that served their own interests and often disregarded or undermined the customary land tenure systems that existed prior to colonization.

Here's how colonialism influenced land laws:

6.6.1 Land Grabbing and Dispossession: Colonial powers frequently engaged in land grabbing and dispossession of indigenous peoples' lands to expand their territories, extract natural resources, and establish settler colonies. This often involved disregarding indigenous land rights and imposing new land tenure systems that favoured colonial settlers and commercial interests. In our pursuit of a comprehensive understanding of the challenges within the current land management system, particularly in relation to the Land Use Act of 1978, we conducted interviews with stakeholders who provided valuable insights into the intricacies and complexities of the existing land tenure framework.

According to the participants, the present state of land management in Nigeria is beset with numerous challenges, with one of the foremost issues being the disregard to indigenous land right and makes it difficult for individual to obtain a valid certificate of occupancy. These challenges have deterred many individuals from pursuing the necessary land title documents, primarily due to the exorbitant cost of administrative fees associated with the process. The high financial burden associated with securing land title documents has effectively discouraged many from legalizing their land ownership. In practice, these approaches have led to various outcomes for different communities, and their responses are influenced by a range of factors, including historical experiences, economic opportunities, and power dynamics within the region. We recognize similar dynamics as in other parts of the world, as alluded to in the work of Foran (2023), (Noxolo, 2016), that not all Indigenous or local communities reject the extension of property through neoliberal approaches, which include market-based instruments. They averred that some communities have found ways to adapt to these approaches and use them to transform their complex relationships with resources into marketable commodities.

In the Nigerian context, it is crucial to understand that the process of land title is inherently social and complex, rather than a straightforward, linear procedure. Indigenous groups do not

always have full control over the outcomes of this process. We observed that Indigenous groups or local communities have embraced the commoditization of their interests, particularly in the management of natural resources. For example, in the context of fisheries, some communities welcome the idea of turning their interests into marketable quotas within quota-management systems. By doing so, they can harness the power derived from these newly created assets to assert their influence and, at times, displace the fishing interests of other Indigenous or local groups.

6.6.2 Introduction of Individual Land Ownership:

Another enduring legacy of colonialism lies in the establishment of a discernible pattern of land ownership and rights that has persisted, further accentuating disparities between the affluent and the impoverished. This stark disparity has exacerbated the vulnerability experienced by poor households, particularly those lacking the financial means to secure land for various purposes. For those who are entirely landless, the challenge is even more daunting, as they often lack any tangible resources to acquire land, let alone embark on developmental initiatives. The introduction of individual land ownership by many colonial regimes marked a significant departure from traditional communal land tenure systems prevalent in numerous indigenous societies. This shift had profound implications, as it undermined the established traditional land governance structures and eroded the control that indigenous communities had over their lands.

In traditional communal land tenure systems, land was typically held and managed collectively by the community, with usage rights allocated based on customary practices and social norms. However, colonial powers imposed Western concepts of property ownership, which emphasized individual rights to land. This imposed model conflicted with indigenous land

tenure systems, leading to the marginalization and disempowerment of indigenous communities.

The transition to individual land ownership resulted in the fragmentation of communal lands and the privatization of resources that were previously shared among community members. This fragmentation weakened the collective control that indigenous communities had over their lands, as individuals gained the ability to buy, sell, or lease land independently of communal decision-making processes.

The consequences of this shift were far-reaching, impacting indigenous peoples' ability to sustain their livelihoods, preserve cultural heritage, and maintain social cohesion. Moreover, it perpetuated inequalities in land distribution, with individuals who had access to economic resources benefiting disproportionately from the new land ownership regime.

This finding is consistent with the research of Ugonabo et al. (2023), which underscores how colonial policies designated lands as "Native Lands" and vested control and disposition authority in the hands of colonial administrators. These administrators, acting as intermediaries between indigenous communities and the colonial state, held and administered land for the purported "common benefit" of the natives. However, in practice, this often led to the exploitation and dispossession of indigenous peoples' lands for the benefit of colonial powers and external interests.

6.6.3 Consequences of Colonial Land Systems

The legacy of colonial land reconfiguration continues to reverberate across Nigeria and other former colonies, manifesting in several ongoing challenges:

1. **Inequities in Land Distribution:** Colonial land policies led to skewed land distribution, concentrating ownership in the hands of wealthy individuals and

organizations(Frankema, 2010). Even after independence, these disparities persisted, with economically advantaged groups benefiting more from land reforms than indigenous communities and poorer households.

2. **Marginalization of Indigenous Communities:** The shift from communal to individual land ownership has further entrenched the marginalization of indigenous communities. Without access to financial resources or the political influence necessary to secure land, many indigenous groups remain disenfranchised(Crabtree-Hayes et al., 2015). This has also contributed to social fragmentation, as individual land ownership undermines the traditional social bonds that were tied to communal land stewardship.
3. **Social Discontent and Unrest:** The contemporary socio-political landscape in Nigeria, particularly in regions like the southeast, reflects the enduring impact of colonial land reconfiguration. Ethnic groups and communities, feeling marginalized and deprived of land rights, continue to push for autonomy or, in extreme cases, secession. For instance, the sit-at-home protests every Monday in southeastern Nigeria are a direct response to perceived marginalization and injustices in land governance(Dean and Levi, 2003). These movements, while often tied to broader political grievances, are also rooted in the legacy of land dispossession and inequality established during the colonial period.
4. **Challenges to Land Title Regularization:** The process of obtaining land titles and legal ownership remains cumbersome and costly in Nigeria(Ekemode et al., 2017). This disproportionately affects poorer households and indigenous claimants, as they struggle to afford the administrative fees associated with securing land titles. Despite efforts to regularize land ownership and promote equitable access to land, the current system remains skewed in favour of affluent individuals, perpetuating the inequalities established during the colonial era.

6.7 Implication of Land Policy on Livelihood of Farmers in the Region

This section delves into the implications of land policies for farmers' livelihoods, addressing key themes like landlessness, tenure insecurity, and the marginalization of vulnerable groups. These dimensions are critical in understanding the broader structural factors that perpetuate poverty and agricultural underperformance in the region. By examining these issues through an intersectional lens, we can better appreciate how land policies disproportionately affect different social groups—particularly women, indigenous communities, and landless farmers.

6.7.1 Landlessness

Landlessness, exacerbated by the Land Use Act, remains a pressing issue that stifles agricultural innovation and large-scale farming. This reality is shaped by the intersection of class (land ownership) and geography (access to fertile land). Communities near water bodies or ecologically valuable land face greater fragmentation, making it difficult for them to engage in productive farming. This echoes findings from Adegbite and Machethe (2020), on the impact of fragmented land tenure systems on agriculture. The complexity of these issues is heightened by the dual burden of landlessness and geographical vulnerability to floods, which disproportionately impact marginalized farming communities.

6.7.2 Tenure Insecurity

Tenure insecurity, deeply rooted in colonial legacies, further limits the livelihoods of farmers, making them reluctant to invest in long-term improvements. The intersection of colonial history and contemporary legal frameworks creates an environment where disputes over land boundaries proliferate. As a result, farmers face not only economic insecurity but also social

exclusion, particularly women and non-indigenous farmers who are further marginalized due to gendered and ethnic barriers to land access. This reflects the critical need for legal reforms that consider the intersection of gender, race, and class in shaping land ownership and agricultural productivity(Razavi, 2003).

6.7.3 Inability to Access Community Land

Limited access to community land in the lower Niger region profoundly impacts traditional livelihoods, particularly for women and non-indigenous groups. The patriarchal system and corruption in land allocation exacerbate marginalization, deepening ethnic and gender disparities(Peters, 2004). Women face restricted access to arable land, hindering their economic independence and exacerbating food insecurity. Similarly, non-indigenous groups are often excluded from decision-making, leading to heightened poverty and economic inequality(Das et al., 2013). This systemic exclusion fosters social fragmentation and erodes trust in community institutions, undermining the resilience of vulnerable populations against environmental changes. Addressing these issues requires equitable land reform and inclusive governance to support sustainable livelihoods for all.

6.7.4 Marginalization of Vulnerable Groups

The Land Use Act disproportionately affects non-indigenous and female-headed households, who face numerous obstacles to land ownership. The interplay of patriarchal norms and state-level legal barriers significantly restricts access to land for marginalized groups, including women and non-indigenous communities. This systemic exclusion exacerbates their vulnerability to economic insecurity and environmental shocks, such as floods. Patriarchal practices not only limit women's rights to land ownership but also undermine their economic autonomy, leaving them reliant on precarious forms of income. Concurrently, legal frameworks

that favour dominant ethnic groups further marginalize non-indigenous communities, reducing their ability to secure livelihoods. As a result, these intertwined factors heighten the risk of poverty and limit adaptive capacity in the face of environmental challenges. This insight underscores the interconnected nature of gender, ethnicity, and class in shaping agricultural vulnerability in the lower Niger region.

6.7.5 Constraints on Agricultural Development

The constraints imposed by the Land Use Act, particularly regarding farm size, present a significant barrier to agricultural development in the Lower Niger region. The survey from the study reveals that over 80% of farmers are engaged in small-scale farming, intersecting pressures of land fragmentation, tenure insecurity, and environmental vulnerability compound these challenges. Fragmented land holdings limit the adoption of large-scale farming techniques, while insecure tenure discourages long-term investment in land improvements (Deininger and Jin, 2006). Environmental vulnerabilities, such as floods, further strain farming efforts, making it difficult for farmers to scale up production or adopt sustainable practices, thereby stifling overall agricultural growth and resilience. This analysis highlights the need for comprehensive land reforms that address the intersectional nature of these challenges, as well as the social and environmental impacts of land policies.

6.8 Implications for Resilience to Floods

The analysis of flood vulnerability provides a crucial link between land use policies and resilience to climate shocks. Here, intersectionality becomes critical in understanding how different social groups experience floods based on their land access, tenure security, and socio-economic status.

6.8.1 Land Use Planning

Land use planning is critical for flood mitigation, preventing overdevelopment in flood-prone areas. However, the unequal enforcement of land use laws disproportionately affects poor and marginalized communities, leaving them more exposed to flooding risks. This aligns with the work of Cradock-Henry et al. (2021), who emphasise how socio-economic inequalities and governance failures exacerbate vulnerability to environmental hazards. Additionally, scholars like Wisner and Uitto (2009), in their "Pressure and Release" model have highlighted how political and economic structures contribute to disaster risk, emphasizing that marginalized groups often bear the brunt of weak regulatory frameworks. This intersection of land use governance and social vulnerability deepens the existing inequalities in climate-related risk exposure. Furthermore, socio-economic inequalities intersect with weak land governance, making vulnerable groups more susceptible to environmental hazards. Integrating social vulnerability into land use policies would ensure that climate adaptation strategies prioritize the most at-risk communities, promoting more equitable and effective flood resilience. This approach would help address both the structural inequalities and environmental challenges faced by these marginalized populations.

6.8.2 Access to Land

The accessibility of land, as regulated by the Land Use Act, directly influences how different groups cope with floods. Those with insecure land tenure face heightened risks, as they are less likely to invest in flood-resistant infrastructure. This resonates with the work of Sugden and De Silva (2014), who emphasise how tenure insecurity, combined with socio-economic status, exacerbates vulnerability to climate-related shocks. In contexts where land rights are

precarious, the incentive to invest in long-term resilience measures diminishes, further entrenching these communities in cycles of poverty and environmental vulnerability, particularly in flood-prone regions. This illustrates the intersection of tenure security, socio-economic status, and geographic location, where communities in flood-prone areas without secure land rights endure a dual burden of environmental and economic vulnerability. Their inability to invest in resilience measures exacerbates their susceptibility to both immediate flood impacts and long-term economic instability, highlighting the compounding effects of legal and structural inequalities.

6.8.3 Community Engagement

Community involvement in land planning processes is critical for ensuring that flood management strategies are inclusive. However, women and non-indigenous groups are often excluded from decision-making, compounding their vulnerability to floods (Parsons and Fisher, 2022). This observation collaborates with what Sugden and De Silva (2014) noted, highlighting how social inequalities, especially along the lines of gender and ethnicity, amplify vulnerability by limiting marginalized groups' participation in essential land and resource management decisions. This marginalization prevents them from influencing decisions that affect their access to land and resources, exacerbating their exposure to environmental risks. Addressing these intersectional exclusions is essential for building resilience across all community sectors, as equitable participation ensures that the needs of the most vulnerable are incorporated into flood mitigation strategies, leading to more comprehensive and effective climate adaptation measures.

6.9 Understanding Livelihood Vulnerability

In this section, we move from the broader land policies to a focused examination of how floods impact livelihoods in specific communities. To delve into the dynamics of livelihood vulnerability in the study area, a detailed analysis of flooding as a significant shock was undertaken. The focus was to capture how local communities perceive the severity of flooding and its impacts on their livelihoods. The survey was conducted as part of a comprehensive field study aimed at assessing community perceptions of flooding and its impact on livelihoods across various villages in the study area. A structured questionnaire was designed and distributed to 198 respondents from four key villages: Odekpe, Umunankwo, Oko, and Okwe. Respondents were asked to rate the significance of flooding on a scale from "highly insignificant" to "highly significant," reflecting their experiences and perceptions of the environmental threat posed by flooding.

The survey targeted a diverse demographic, including different age groups, gender, and socio-economic classes, ensuring that the data captured a wide range of perspectives on flood vulnerability. The results, summarized in **Table 6.2**, provide key insights into how flooding is perceived across different regions. Notably, **33.3%** of respondents, predominantly from the Oko and Okwe villages, described flooding as a highly significant issue, reflecting the frequent and severe impact of flooding in areas closer to water bodies. Another **27.8%** of respondents considered flooding to be a significant issue, further underscoring the widespread recognition of flood risks beyond the most affected villages.

The geographic vulnerability of the villages was visually represented in **Figure 6.1** which highlights how the positioning of communities like Oko and Okwe—close to rivers or low-lying areas—correlates with their heightened exposure to flooding. The data obtained from this

survey provides a strong basis for recommending targeted flood mitigation strategies that address the specific risks and vulnerabilities identified in each village. Additionally, the survey results reveal an important intersectionality between geographic location, socio-economic factors, and access to resources in shaping community perceptions of flooding. While Plate 6.1 depicts buildings submerged in floodwaters, highlighting the severe impact of flooding in certain areas, a notable portion of respondents—between 9.1% and 12.8% from villages such as Odekpe, Umunankwo, Oko, and Okwe—perceived flooding as relatively insignificant. This disparity points to the existence of more robust flood control measures or infrastructure in some regions, which likely mitigate the immediate threat of flooding for those residents.

However, this intersection of geographic vulnerability and flood mitigation measures is deeply influenced by social inequalities. Communities that experience flooding as less significant may have better access to land use planning, flood defences, or socio-economic resources, which can reduce their vulnerability. On the other hand, marginalized groups, such as women and non-indigenous residents, often face exclusion from decision-making processes about flood management and land use planning. This exclusion compounds their vulnerability, as they are less likely to benefit from such protective measures. These inequalities reflect how socio-economic status, gender, and geographic location intersect, leading to different experiences and responses to flooding risks across the community.



Plate 6.1: Houses Submerged by Flood in the Study Area

Source: Author, 2023

Table 6.2: Shock from Flooding

| Shock (Flooding) | Odekpe | Umunankwo | Oko | Okwe | Total | % |
|----------------------|-----------|-----------|-----------|-----------|------------|------------|
| Highly insignificant | 4 | 5 | 9 | 7 | 25 | 12.6 |
| Insignificant | 4 | 4 | 5 | 6 | 19 | 9.6 |
| Not significant | 9 | 6 | 7 | 11 | 33 | 16.7 |
| Significant | 17 | 15 | 11 | 12 | 55 | 27.8 |
| Highly significant | 19 | 14 | 22 | 11 | 66 | 33.3 |
| Total | 53 | 44 | 54 | 47 | 198 | 100 |

Source: Author, 2023.

6.9.1 Spatial Analysis of Flood Vulnerability: Insights from Community Mapping and Remote Sensing

A deeper exploration of flood vulnerability was carried out using community mapping and remote sensing tools. Community members were actively involved in mapping flood-prone areas, identifying the ways floods affect livelihoods, infrastructure, and natural resources. This participatory approach provided a spatially grounded understanding of vulnerability, allowing the creation of flood vulnerability assessment maps. **Plate 6.2** presents residential settlements in flood-prone zones, underscoring the risks faced by communities living in these high-risk areas.



Plate 6.2. Farmers' Residential Settlements in Flood-Prone Areas

Source: Author, 2023

Remote sensing data further highlighted the vulnerability across the Lower Niger region, with Fig. 6.2 presenting a flood risk analysis map based on Google Earth data. Areas marked in deep green indicate lower flood vulnerability due to strategic positioning and elevation, while light green areas, though slightly elevated, still face flooding challenges due to insufficient drainage systems.

This analysis revealed that approximately 3564 square kilometres (or 50.5% of the land area) in the study region is moderately impacted by floods. Moreover, the Ogbaru community is particularly affected by high flood risks, as the region spans both the upstream and downstream sections of the Lower Niger Basin. In total, 61 square kilometres and 676 square kilometres of the land are categorized as high-risk flood zones, making these areas particularly vulnerable to environmental shocks.

Several factors contribute to this vulnerability. The proximity of these areas to low-lying lands along the Niger River, combined with seasonal heavy rainfall and potential sea-level rise, increases the susceptibility of these communities to flooding. In addition to natural factors, human-induced activities further exacerbate the risk. Deforestation, urbanization, and the conversion of permeable surfaces to impermeable materials such as roads and buildings increase runoff and reduce the soil's ability to absorb water, intensifying flood risks. Additionally, inadequate drainage systems and poor land management practices contribute to erosion and sedimentation, further amplifying the impact of floods.

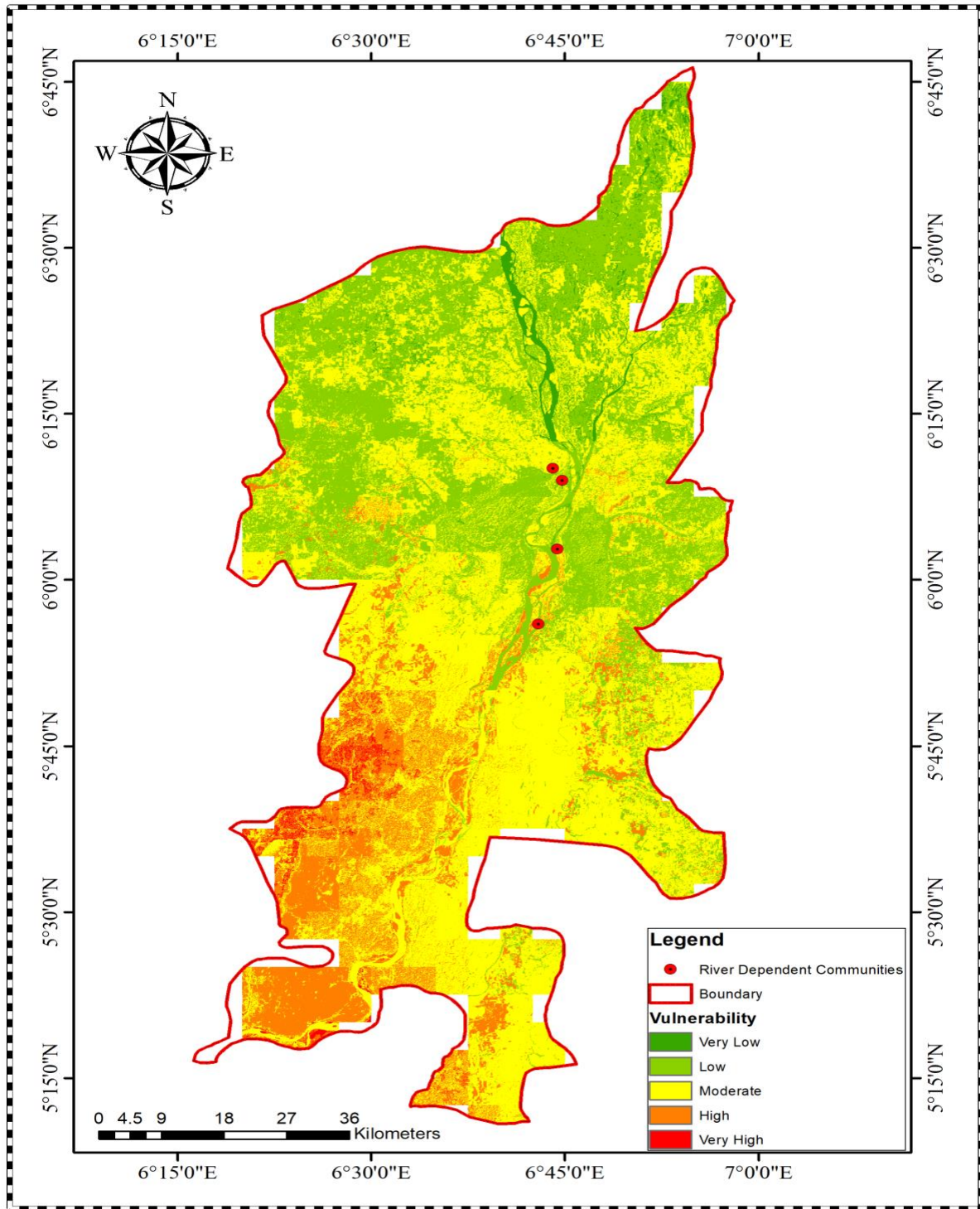


Fig 6.2- Flood Vulnerability Analysis Map

Source: Author, 2023

6.9.2 Discussion on Livelihoods and Resilience

This comprehensive analysis of livelihood vulnerability shows that flooding is both a critical issue and a varied experience across the study area. While some villages benefit from better infrastructure and social safety nets, other regions, especially Ogbaru, remain highly vulnerable. The differential impacts of flooding emphasise the importance of tailored interventions, such as improving flood management infrastructure and investing in community-based resilience strategies.

Furthermore, the intersectionality of vulnerability in the study area must be recognized, as the effects of flooding are not uniformly experienced across different demographics or communities. In the villages of Oko, Okwe, Odekpe, and Umunankwo, factors such as gender, socio-economic status, and access to land and resources shape how individuals and households cope with and respond to floods.

For example, in Oko and Okwe, where 33.3% of respondents viewed flooding as "highly significant," women and poorer households are disproportionately affected. Due to limited land ownership rights and restricted access to resources, women often lack the means to invest in flood-resistant infrastructure or recovery efforts. This issue is further exacerbated by socio-economic constraints that restrict their participation in decision-making processes about land use and flood management.

Conversely, in Odekpe and Umunankwo, where between 9.1% and 12.8% of respondents considered flooding to be a minor issue, stronger flood mitigation measures, such as embankments or drainage systems, likely reduce the perceived threat. However, even in these better-protected villages, marginalized groups, including women and the economically disadvantaged, may still face higher risks. They may live in more vulnerable areas within the village or have less capacity to recover from flood impacts, reinforcing the intersection of socio-economic status and flood vulnerability.

This variation in perception and experience demonstrates that flood vulnerability is not only a geographic issue but is also influenced by intersecting factors like gender, economic status, and land tenure. An intersectional approach to flood management, which considers these diverse vulnerabilities, is crucial to ensuring that the most at-risk populations are not left behind in resilience-building efforts across the study area

CHAPTER SEVEN

VULNERABILITY AND IMPACT ON FLOODING

7.0 Introduction

In the previous chapter, we explored the significant role of land use policies and their implications for vulnerability in the Lower Niger River region. Specifically, we examined how various land tenure systems—statutory, customary, and informal—shape access to land and resources, highlighting their influence on who holds land rights, how they are acquired, and under what conditions they can be utilized. These tenure systems are instrumental in determining the socio-economic positioning of individuals and communities, and as a result, they deeply affect responses to environmental threats like flooding. The chapter also underscored how inequalities embedded in land tenure systems, particularly insecure land rights, exacerbate vulnerability during environmental hazards by limiting adaptive capacities and resilience. This analysis emphasized the historical and contemporary factors that influence land use practices, further shaping the ability of farming communities to recover from floods. Building on this foundation, this chapter will delve deeper into the multifaceted aspects of livelihood vulnerability and the specific impacts of flooding on communities. We will analyse both climatic and non-climatic factors influencing vulnerability, including environmental conditions, socio-economic factors, and political dynamics that exacerbate risks. Additionally, we will assess how dynamic changes in land use and land cover further complicate efforts to build resilience, adding another layer of socio-economic complexity for the affected communities.

This chapter also aims to bridge the insights from the previous analysis by focusing on the experiences of communities affected by flooding, identifying key vulnerabilities, and highlighting their intersections with socio-economic and environmental challenges.

7.1 Livelihood and Social Groups in the Lower Niger Basin

Livelihood and socio-economic play a crucial role in shaping the dynamics of communities and their ability to cope with and adapt to various challenges, including those related to climate change and natural hazards. These groups have unique traits, social networks, and social resources that affect their vulnerability, adaptability, and livelihood options. Understanding the dynamics of livelihood and social groups is essential for designing inclusive and context-specific interventions to enhance resilience and sustainable development. We identify the social groups based on the field data from questionnaire on various challenges that affect their livelihood including social, economic, and environmental factors as shown in Table 7.2.

Within the vibrant farming communities in this region, a stark contrast emerges between the experiences of rich and poor farmers. Among these communities, primarily composed of Urhobo, Isoko, and Yoruba people, the dynamics of climate change, land degradation, and the intricate interplay of land policy and conflicts with herdsmen shape the very essence of farming practices, forging a path that diverges significantly for these two distinct groups of farmers.

7.1.1 Intersectionality of Socio-Economic Status and Vulnerability Among Farming Communities in the Lower Niger Basin

In **Section 7.1** on *Livelihood and Social Groups in the Lower Niger Basin*, we discussed how various livelihood groups in the region are shaped by socio-economic dynamics and their differential vulnerability to environmental challenges, including flooding and land degradation. These socio-economic disparities influence how groups cope with climate risks and adapt to shocks, particularly in terms of their access to resources and resilience mechanisms.

Building on this understanding, **Section 7.1.1** delves into the intersectionality of socio-economic status with farming groups—rich, medium, and poor—and how these disparities amplify vulnerability during flood events.

The rich farmers, classified as those holding more than 2 hectares of arable land, have greater access to financial resources, enabling them to implement flood-resistant infrastructure, recover more quickly from environmental shocks, and maintain consistent agricultural production. In contrast, poorer farmers, who hold less than 0.5 hectares, face compounded vulnerabilities. Their limited financial capacity restricts their ability to invest in adaptive measures, making them more exposed to both short-term losses and long-term livelihood degradation during flooding events (Haque, 2016). Medium-scale farmers, falling between these two extremes, experience a mix of these challenges, but with moderate capacity to mitigate risks.

This socio-economic intersectionality shows that wealth is not just about land size but also about access to social networks, capital, and political influence, which allow richer farmers to recover and rebuild more effectively than their poorer counterparts (Williams, 2021). Thus, addressing the vulnerability of farming communities in the Lower Niger Basin requires a nuanced approach that considers these socio-economic intersections to ensure that flood management and adaptation strategies are equitable and inclusive.

7.1.2 Women and Children: Flooding can disrupt access to education, exposing children to long-term impacts on their future opportunities. Similarly, the stress of coping with flood-related challenges, including loss of property and livelihood, can have significant psychosocial impacts on women. Children exposed to the trauma of flooding events can develop anxiety, depression, and other mental health issues. Furthermore, societal norms and gender inequalities

may restrict women's participation in decision-making regarding preparedness, response, and recovery efforts. Children often have limited control over their circumstances during flooding, relying on adult decision-makers for safety and well-being.

7.1.3 Fishing:

The fishing communities in the Lower Niger Basin, primarily composed of Ijaw and Itsekiri groups, are heavily dependent on the river for their livelihoods. However, they face growing challenges that threaten their income and food security. Pollution from industrial activities and overfishing are long-standing issues, while climate change-related alterations in water levels further complicate their ability to sustain fishing activities(Doelle and Puthucherril, 2023).

During flood events, fishing activities are severely disrupted, with fishers experiencing direct economic losses as their primary source of income becomes temporarily inaccessible(Bhadra, 2020). These disruptions not only affect individual livelihoods but also impact the larger community, which relies on fisheries for food security. In addition, the floodwaters often damage critical fishing equipment such as boats and nets, creating additional economic strain for these communities. Given that many fishers lack alternative sources of income, the financial burden of repairing or replacing damaged equipment is immense, leaving them highly vulnerable to subsequent environmental shocks.

For those with limited resources, recovering from these losses is particularly challenging, emphasizing the need for targeted interventions to improve the resilience of fishing communities against the effects of both environmental changes and flooding.

7.1.4 Non-Indigenous Group: Non-indigenous ethnic groups are not indigene but migrated to the region to engage in farming and fishing due to available natural resources. However, they are faced with challenges of exclusion and marginalisation which result in poverty, food insecurity and cultural practice. Marginalized communities often lack access to proper education and resources for sustainable land use practices(Ahmadzai et al., 2021). This can lead to inappropriate land use decisions such as deforestation, improper agricultural practices, and unregulated development, which can significantly alter local hydrological patterns. For instance, deforestation can lead to increased surface runoff and soil erosion, impacting local hydrology.

7.1.5 Minority Ethnic Group:

Minority ethnic groups in the Lower Niger Basin, including smaller sub-communities within the broader cultural framework, are particularly vulnerable to the impacts of flooding due to their geographical and socio-economic circumstances. Many of these groups are settled in flood-prone areas such as low-lying regions, coastal zones, or floodplains, where the physical risk of flood-related hazards is significantly higher(Komolafe et al., 2015). The settlement patterns of these communities, often shaped by historical and socio-political factors, further expose them to environmental risks, as they are more likely to inhabit marginal or less-protected land.

In addition to geographic vulnerabilities, minority ethnic groups frequently face disparities in access to essential resources that are critical for building resilience against floods(Okoroji, 2018). Limited access to financial resources, education, healthcare, and infrastructure can hinder their ability to effectively prepare for, cope with, and recover from the impacts of flooding. These communities often lack the necessary tools to implement flood-resistant

infrastructure, such as reinforced housing or adequate drainage systems, making them particularly susceptible during flood events.

Moreover, these groups experience unequal access to opportunities, services, and decision-making processes (Durand et al., 2014). Exclusion from local governance structures, including land-use planning and disaster response initiatives, further contributes to their heightened exposure to flood risks. The intersectionality of ethnicity, poverty, and marginalization compounds the challenges faced by minority ethnic groups, limiting their capacity to adapt to and recover from floods in the region. Addressing these inequalities is essential for developing inclusive flood mitigation strategies that consider the specific needs of vulnerable populations and integrate them into broader resilience-building efforts.

7.1.6 People with Disability:

People with disabilities (PWDs) in the Lower Niger Basin face significant vulnerabilities that impact their livelihoods, particularly during environmental crises like flooding. Beyond the daily challenges of limited access to education, employment, and social inclusion, their vulnerability is further magnified during floods (Baker, 2012). These individuals often encounter significant barriers in accessing safe shelters, relief centres, or other emergency services, leaving them at a higher risk of injury or displacement during flood events.

Due to physical and mobility challenges, PWDs may find it difficult to evacuate quickly during floods, increasing their exposure to the hazards associated with rising water levels. The design of infrastructure, including roads, buildings, and emergency facilities, is often not inclusive, further restricting their movement and access to critical services (McAllister and McAllister, 2013). This lack of accessibility can leave many individuals stranded during disasters, with limited options for safety and support.

In the context of livelihood, the impacts of flooding on PWDs extend beyond immediate physical safety. With fewer employment opportunities and higher rates of poverty, people with disabilities often rely on fragile income sources that can be disrupted by environmental disasters. Flooding not only damages their homes and resources but also disrupts the local economy, leaving PWDs with limited means to recover financially. Additionally, social exclusion and discrimination can prevent them from fully participating in community-driven recovery efforts, further hampering their ability to restore their livelihoods and improve their standard of living.

7.2 Socio-Economic Characteristics of Respondents

The socio-economic characteristics of respondents in the Lower Niger River region play a critical role in understanding flood vulnerability, as highlighted in the previous sections on livelihood and social group dynamics. Building on the challenges faced by farmers, fishers, minority ethnic groups, and people with disabilities, the data presented in Table 7.2 provides further insights into how these communities are impacted.

Most respondents, 56.1%, are male, indicating that gender-specific vulnerabilities may be at play, particularly in relation to access to land and resources. As noted earlier, women often face barriers in decision-making and resource access, which can heighten their vulnerability during flood events. The gender disparity in resource access also suggests that women may be less equipped to implement adaptive strategies, such as investing in flood-resistant infrastructure, further compounding their risk.

The study reveals that farm sizes among respondents vary, with small-scale farmers making up 22.2%, medium-scale farmers comprising 41.4%, and large-scale farmers representing 36.4% of the total. This aligns with previous discussions on the disparity between rich and poor farmers. Larger farms often have the financial resources to invest in mitigation strategies, while

small-scale farmers, who represent the most vulnerable group, face significant constraints in their adaptive capacity due to limited land and financial resources.

Farming, at 49.0%, remains the predominant occupation in the region, reinforcing the heavy reliance of these communities on agriculture, which is highly susceptible to flood risks. This demographic is particularly sensitive to flooding due to their dependency on arable land and consistent production cycles. As seen with the fishers and other occupational groups, flooding disrupts essential livelihoods, amplifying economic insecurity and reducing the ability to recover from future shocks.

In terms of age, most respondents fall within the 36-40 years range (33.3%), suggesting that the working-age population is significantly impacted by flooding. This group is typically responsible for maintaining household incomes and providing for dependents, which means that flood-induced disruptions to their livelihoods can have ripple effects on the entire community's economic stability.

These socio-economic characteristics provide critical context for understanding the intersectionality of vulnerability in the region. Factors such as gender, farm size, occupation, and age all play roles in shaping how individuals and households respond to and recover from flood events. Thus, nuanced, multi-dimensional strategies are required to address the specific needs of each demographic, ensuring equitable and inclusive resilience-building efforts.

Table 7.2: Socio-Economic Characteristics

| Characteristics of Respondents | Sub Characteristics | Frequency | Percentage |
|---------------------------------------|----------------------------|------------------|-------------------|
| Gender of Respondent | Male | 118 | 56.1 |
| | Female | 87 | 43.9 |
| | Total | 198 | 100 |
| Farm Size | Small farm (<0.5hac) | 44 | 22.2 |
| | Medium farm (0.5-1hac) | 82 | 41.4 |
| | Large farm(>1hac) | 72 | 36.4 |
| | Total | 198 | 100 |

| | | | |
|--------------------|-----------------------------|------------|------------|
| Occupation | Fishing | 47 | 23.7 |
| | Farming | 97 | 49.0 |
| | Craftmanship/self-employed. | 11 | 5.6 |
| | Civil servant | 7 | 3.5 |
| | Mixed livelihood | 10 | 5.1 |
| | Trading | 24 | 8.6 |
| | Total | 198 | 100 |
| Age of Respondents | 20-25years | 7 | 3.5 |
| | 26-30years | 27 | 13.6 |
| | 31-35years | 48 | 24.2 |
| | 36-40years | 66 | 33.3 |
| | 41-45years | 38 | 19.2 |
| | 46 and above | 12 | 6.1 |
| | Total | 198 | 100 |

Source: Author, 2023.

7.3 Land Ownership

Smallholder farming, comprising 39.4% of the total farming practices, is the most represented category, indicating challenges in flood preparedness due to limited resources. Smallholder farmers typically operate on restricted land areas and may lack the resources for advanced flood-resistant infrastructure (Mavhura, 2019). The constrained scale of their operations often means they heavily rely on the productivity of their land for sustenance. Consequently, during flooding events, there are substantial losses for smallholder farmers, impacting their crops and potentially leading to financial hardships. This aligns with the findings in the work of Effiong et al. (2024c), which affirm that the inherent limitations in financial capacity and resource access make smallholder farmers more susceptible to the adverse effects of flooding. The vulnerability of farming groups in the Lower Niger River Region to flooding is closely tied to their land ownership patterns. Small farmers, predominantly owning individual plots. The vulnerability of this group is heightened as individual land ownership often implies limited resources and capacity to implement flood-resistant infrastructure or adaptive measures. They are confronted by an array of formidable challenges, making them significantly more

vulnerable to the impacts of climate change, land degradation, and land access issues. These farmers often lack the financial means to implement sustainable practices or to invest in technologies that could bolster their resilience. Their smaller landholdings with <0.5ha limit their capacity to diversify crops or rotate their fields effectively, amplifying the threat of land degradation. Land policy intricacies and conflicts with herdsmen frequently leave them in precarious positions, with uncertain land tenure and persistent land disputes. The threat of displacement looms large for these "poor farmers," further exacerbating their food insecurity and perpetuating a cycle of poverty.

Similarly, Medium farmers represent an intermediate category between small-scale subsistence farmers and large-scale commercial farmers, characterized by their landholding size and level of commercialization. In the study area, individuals classified as medium farmers typically possess land sizes ranging from 0.5 to 1 hectare, with 41.4% of respondents falling into this subgroup. These farmers typically operate larger plots of land compared to small-scale farmers and may employ hired labour or utilize family members to assist with agricultural activities. Their farming practices often involve a combination of subsistence and commercial farming, where they produce crops and livestock for both household consumption and sale in local markets. Medium farmers cultivate a diverse range of crops, encompassing staple food crops such as maize, rice, or wheat, as well as cash crops like coffee, cocoa, or cotton. This diversification allows them to mitigate risks associated with market fluctuations and climate variability, contributing to their adaptive capacity to external shocks such as flooding. Their relatively larger landholding size and diversified production systems provide medium farmers with greater resilience to flooding compared to small-scale subsistence farmers. Additionally, their integration into local markets and engagement in commercial farming activities may

afford them access to resources and support mechanisms that enhance their ability to cope with and recover from flood-related losses.

Large farmers, constituting 42.9% with various ownership types, exhibit a comparatively lower vulnerability. They are often referred to as the "rich farmers," have managed to navigate the challenges of climate change and land degradation with relative resilience. They possess the means to adapt to shifting environmental conditions and invest in sustainable agricultural practices. For instance, rich farmers in the region reported that they invest in drought-resistant crop varieties, to improved irrigation systems, and diversified their crops to mitigate the risks associated with climate variability. Additionally, they adopt conservation agriculture techniques such as minimum tillage and agroforestry to maintain soil fertility and enhance resilience to extreme weather events. These individuals, often equipped with financial resources, advanced technology, and larger landholdings with more than 2hectares which implies that 36.4% of respondents in the study were in this category. They employ adaptive strategies such as soil conservation, efficient irrigation methods, and crop diversification to mitigate the effects of a changing climate. Moreover, the "rich farmers" tend to have secure access to arable land, enabling them to maintain consistent agricultural production. Their ability to comply with existing land policies ensures stability in their land tenure, reducing vulnerability to land-related disputes and forced relocations. Their diversified land ownership, including individual, family, and government-owned plots, offers resilience and flexibility in adapting to flood impacts.

Those who are renting land, which disproportionately includes 18.6% of farmers as shown in **Table 7.5** faces unique challenges. as they face uncertainties regarding land access and tenure, amplifying their susceptibility to flooding impacts. For instance, during flooding, landowners prioritize protecting their own properties, leaving rented fields vulnerable to inundation.

Moreover, the uncertainty of land tenure for tenant farmers means they may lack the authority or resources to implement flood mitigation measures, such as building embankments or relocating crops to higher ground.

Additionally, the temporary nature of land tenure arrangements means tenant farmers may not have access to government assistance or compensation programs available to landowners affected by flooding. As a result, they are left with limited options to recover from flood-related losses, further exacerbating their vulnerability to flooding impacts. These findings align with Sugden and De Silva (2014), who observed that tenant farmers in South Asia face similar challenges, including limited access to government relief programs and exclusion from long-term adaptation planning. This dynamic leaves tenant farmers particularly exposed to the impacts of environmental hazards, as they often lack the resources and institutional support necessary for recovery and resilience. These parallels emphasise the importance of addressing structural inequalities in land tenure systems to ensure equitable access to disaster relief and adaptation support for all agricultural stakeholders.

Table 7.3 – Land Ownership

| Land Ownership | Small farmers | Medium Farmers | Large Farmers | Total | % |
|-----------------------|----------------------|-----------------------|----------------------|--------------|------------|
| Individual | 18 | 21 | 39 | 78 | 39.4 |
| Family | 15 | 6 | 9 | 30 | 15.2 |
| Community | 9 | 3 | 2 | 14 | 7.1 |
| Government | 11 | 5 | 8 | 24 | 12.1 |
| Rented | 9 | 7 | 21 | 37 | 18.6 |
| Landless | 5 | 4 | 6 | 15 | 7.6 |
| Total | 67 | 46 | 85 | 198 | 100 |

Source: Author, 2023.

7.4 Income Level

Income level significantly influences the economic and social dynamics of the Lower Niger region and directly impacts individuals' experiences with flood-related hazards. Among farming communities, income levels are closely linked to key economic activities, including job opportunities, business investments, and trade. Table 7.6 provides insights into the income distribution of farmers in the Lower Niger River region, illustrating the socio-economic landscape of the surveyed population. The data categorise farmers into income brackets, shedding light on their financial standings. Notably, 40.9% of respondents fall within the income category of ₦18,000 and above, further divided into small, medium, and large farmers, reflecting diverse economic positions within this group. Farmers earning between ₦18,001 and ₦50,000 account for 22.2% of the population, showcasing a substantial proportion of the community engaged in mid-range economic activities. Meanwhile, 17.2% and 15.2% of respondents fall into the ₦50,001–₦100,000 and ₦100,001–₦150,000 brackets, respectively, highlighting variations in financial capacity. Finally, the category "Above ₦150,000" represents 4.5% of farmers, depicting a smaller, affluent subset within the farming community. The financial data reveal significant differences in income among farming groups, with small farmers earning an average of ₦33,505.61, compared to ₦54,521.74 for medium farmers and ₦64,756 for large-scale farmers. These differences in financial standing influence farmers' ability to invest in flood mitigation measures, such as flood-resistant infrastructure, insurance, or recovery strategies. Farmers with higher incomes typically have greater financial flexibility to adopt adaptive measures, such as building embankments, raising structures, or purchasing flood insurance, enhancing their resilience to flooding. In contrast, lower-income farmers often struggle to implement similar protective measures due to limited resources. They may face challenges such as reduced access to credit or financial assistance programs, leaving them more

vulnerable to the impacts of flood-induced disruptions, including crop damage and livestock losses.

Moreover, income from non-farming activities, such as land ownership and off-farm employment, plays a critical role in shaping financial stability across all income brackets. Land ownership, for instance, provides security, serves as collateral for loans, and supports investments in agriculture. Similarly, off-farm income sources—such as seasonal jobs, small businesses, or remittances—augment financial capacity, enabling farmers to diversify livelihoods, invest in technology, or weather economic downturns.

Additional factors also contribute to the financial burdens of farming communities, particularly in flood-prone areas. Farmers with prior flood experiences often incur costs for implementing mitigation measures like raised beds, drainage systems, and flood-resistant crop varieties. Likewise, access to information on weather patterns and agricultural practices may require investments in equipment, subscription services, or training programs, all of which improve resilience but come with associated costs.

Insurance premiums and disaster recovery plans are another financial commitment for farmers aiming to protect their livelihoods. Research by Hossain et al. (2022), highlights the multifaceted nature of these vulnerability factors and their impact on farmers' abilities to afford insurance and other risk-reduction strategies. Rich farmers, with higher incomes, possess greater resources to adopt such measures, potentially exacerbating the gap in resilience between them and lower-income groups.

These findings underscore the critical role of financial resources in shaping adaptive capacities and resilience to flooding, revealing how income disparities influence the vulnerability of farming communities in the Lower Niger region.

Table 7.4 – Monthly Income Level of Farming Groups

| Income (monthly) | Small farmers | Medium Farmers | Large Farmers | Total | % |
|------------------|---------------|----------------|---------------|-------|------|
| 18,000 and below | 57 | 15 | 9 | 81 | 40.9 |
| 18,001-50,000 | 34 | 7 | 3 | 44 | 22.2 |
| 50,001-100,000 | 6 | 10 | 18 | 34 | 17.2 |
| 100,001-150,000 | 8 | 12 | 10 | 30 | 15.2 |
| Above 150,000 | 2 | 2 | 5 | 9 | 4.5 |
| Total | 107 | 46 | 45 | 198 | 100 |

Source: Author, 2023.

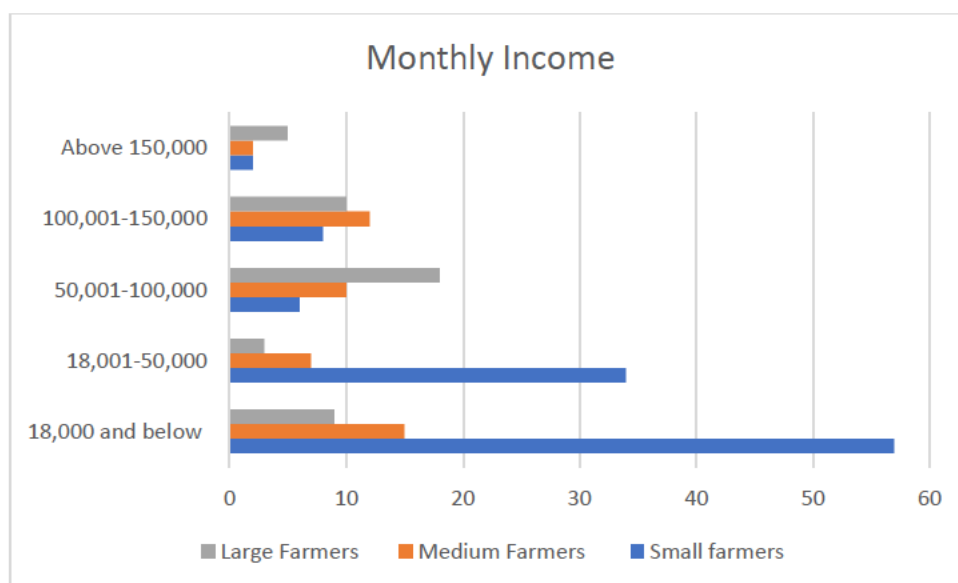


Fig.7.3 Summary of Monthly Income of Respondents

Source: Author, 2023.

7.5 Ethnic Group

Ethnic groups are well represented across all farmer categories, which suggests a level of diversity and inclusivity within the agricultural sector. The comparison of ethnic groups to farming categories in the Lower Niger River region reveals a nuanced intersectionality between cultural identity and agricultural engagement. See Table 5.7 which gives insight into the ethnic composition of farmers in different size categories and provides a basis for further analysis of agricultural trends and patterns within the region.

The Ibo ethnic group emerges prominent, constituting 46.5% of the total population and demonstrating a substantial presence across small, medium, and large farming categories. This is because they are the indigenous people with Igbo as their native language. The enterprising nature, particularly in trading activities, among the Igbo people is attributed to a capitalist orientation (Olutayo, 1999). Additionally, they have widespread engagement in agricultural activities among them, which suggests diverse exposure to flood risks. However, specific vulnerabilities would depend on individual farming practices and land management.

The Yoruba ethnic group, representing 15.2%, exhibiting a moderate presence across different farming groups in the study area. Most Yoruba are non-indigenous people who are settling in the region due to the presence of natural resources. Their diverse engagement in agriculture implies a range of adaptive capacities, but individual vulnerabilities could be influenced by factors such as education, land size, and income.

The Ijaw ethnic group, with a smaller numerical representation at 9.6%, could also be categorised as minority ethnic group. nevertheless, they are found across all farming categories and often rely on water-based livelihoods such as fishing, agriculture, and trade. While these activities are culturally significant, they can be vulnerable when water levels rise unexpectedly. Floods can disrupt fishing activities, damage crops, and hamper transportation routes critical for trade. As a minority ethnic group, the Ijaw may face challenges in accessing resources for adaptive measures. In terms of fishing, the Ijaw ethnic group have a long-standing tradition of fishing and rely heavily on fishing as a primary source of livelihood. They have a higher proportion of fishers compared to other ethnic groups in the region. Other ethnic groups such as the Igbo and Yoruba, also engage in fishing activities, although to a lesser extent compared

to indigenous riverine communities. Fishing in these areas may be practiced as a supplementary source of income or for subsistence purposes.

The significant presence of the Hausa/Fulani ethnic group (19.2%) across small, medium, and large farming groups reflects diverse agricultural practices within this community. The Hausa/Fulani are known for their nomadic or semi-nomadic lifestyle, driven by the need to find suitable grazing land for their cattle. Climate change, including altered rainfall patterns and changing environmental conditions, can impact the availability of green pastures in their usual locations (Obioha, 2008). The movement from north to south in search of green fields for cattle exposes them to different environmental conditions, including settling in areas prone to flooding. These migrations often lead them to settle in areas that are prone to flooding, especially in the Niger Delta region and other low-lying areas with abundant vegetation.

In these regions, the Fulani herders may lack reliable information about flood risks and the seasonal patterns of inundation. Without access to accurate forecasts or knowledge about local hydrological conditions, they are at increased vulnerability to sudden inundation. As a result, their cattle, as well as their own livelihoods, are put at risk when unexpected floods occur.

Efik/Ibibio and Tiv/Idoma ethnic groups, while representing smaller proportions at 4.0% and 5.6%, respectively, showcase nuanced vulnerability within their communities. These ethnic group being mostly non-indigenes and constitute small ethnic groups may have limited access to resources, information, and infrastructure for adapting to climate-related risks. This limited adaptive capacity can increase their vulnerability to the adverse impacts of flooding.

Table 7.5 Ethnic Group

| Ethnic Group | Small Farmers | Medium Farmers | Large Farmers | Total | % |
|---------------------|----------------------|-----------------------|----------------------|--------------|----------|
| Ibo | 43 | 26 | 23 | 92 | 46.5 |
| Yoruba | 16 | 8 | 6 | 30 | 15.2 |

| | | | | | |
|--------------|----|----|----|-----|------|
| Ijaw | 10 | 5 | 4 | 19 | 9.6 |
| Hausa/Fulani | 8 | 13 | 17 | 38 | 19.2 |
| Efik/Ibibio | 6 | 1 | 1 | 8 | 4.0 |
| Tiv/Idoma | 8 | 1 | 2 | 11 | 5.6 |
| Total | 71 | 68 | 59 | 198 | 100 |

Source: Author, 2023.

7.6 Educational Level

In the Lower Niger region, a substantial portion of farming groups have acquired formal education. Table 7.8 presents the distribution of educational levels among farmers in the Lower Niger River region, offering insights into the academic backgrounds of the surveyed population. The data is categorized into different educational attainment levels, highlighting the diversity in educational qualifications within the farming community.

The "No Formal Education" category comprises individuals who have not received any formal schooling, representing 21.2% of the total surveyed population. Farmers in this category may face higher vulnerability due to limited access to formal knowledge and information about flood risks. Their ability to understand and implement advanced flood mitigation strategies may be constrained.

The category labelled "SSCE and below" includes individuals with educational qualifications up to the Senior Secondary Certificate Examination (SSCE) level or its equivalent, representing the largest portion at 35.9%. Despite possessing basic education, this group may still face vulnerability due to potential limitations in accessing comprehensive flood-related information. Nevertheless, basic education has the potential to empower them with an understanding of simple preventive measures. This aligns with the findings of Konieczny et al. (2020), which

underscore the role of education in enabling individuals to take informed action against flood risks.

Moving to higher educational levels, the "OND" (Ordinary National Diploma) category includes individuals with a diploma qualification, accounting for 14.1%. This group represents farmers who have pursued post-secondary education at the diploma level. Farmers with diploma-level education may have a better understanding of flood risks and potential adaptive measures. The findings of the work of Atreya et al. (2017), (Sugden and De Silva, 2014) support the notion that individual with higher education are more likely to prepare against flooding compared to those with no educational qualification.

The category labelled "HND/bachelor's degree" encompasses individuals holding higher national diploma or bachelor's degree qualifications, representing 14.7% of the total population. This group signifies farmers with tertiary education, suggesting a segment potentially equipped with an advanced capacity for adopting modern agricultural practices. Individuals with tertiary education are presumed to possess heightened adaptive capacities, enabling them to grasp intricate flood-related information and implement sophisticated strategies. These findings align with the research conducted by Kamruzzaman et al. (2023), indicating that individuals with higher education exhibit greater innovative capacity to initiate flood-resistance activities. Moreover, they are likely to experience lower vulnerability to flooding compared to those with no educational qualifications.

Lastly, the "Postgraduate" category involves individuals with advanced degrees beyond a bachelor's, constituting 14.1%. This group signifies farmers with the highest level of educational attainment, potentially bringing advanced knowledge and skills to their agricultural practices. Farmers with advanced degrees may possess in-depth knowledge and skills, allowing them to implement advanced flood resilience measures. Their vulnerability to flooding may be comparatively lower due to a heightened ability to adapt. The observation reveals that small

farmers have a notably higher rate of being uneducated, with 35.9% compared to medium farmers and large farmers with 34.3% and 29.7%, respectively. This discrepancy in educational attainment suggests a potential reason for the lower investment and innovation levels among small farmers compared to their counterparts.

Table 7.6 Educational Level of Farming Groups

| Educational level | Small Farmers | Medium Farmers | Large Farmers | Total | % |
|-----------------------|---------------|----------------|---------------|-------|------|
| No Formal Education | 23 | 12 | 7 | 42 | 21.2 |
| SSCE and below | 33 | 20 | 18 | 71 | 35.9 |
| OND | 6 | 14 | 8 | 28 | 14.1 |
| HND/bachelor's degree | 7 | 9 | 13 | 29 | 14.7 |
| Postgraduate | 2 | 13 | 13 | 28 | 14.1 |
| Total | 71 | 68 | 59 | 198 | 100 |

Source: Author, 2023.

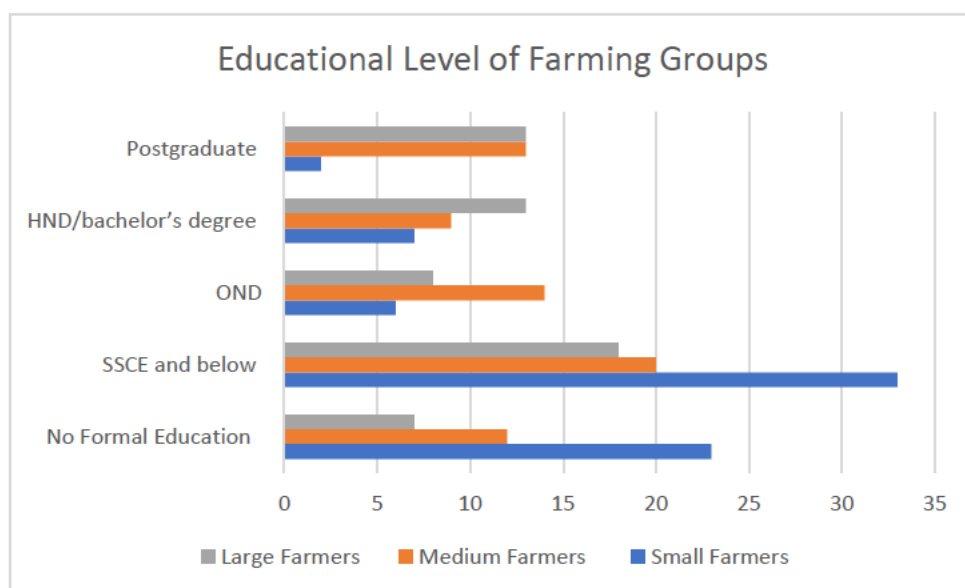


Fig.7.4 Summary of Educational Level of Respondent

Source: Author, 2023.

7.7 Type of Farming

The vulnerability of different types of farming to flooding as illustrated in Table 7.7 assessed based on the distribution of small, medium, and large farmers within each category. Irrigated farming, constitute 10.6% which indicates a relatively low vulnerability, with large farmers dominating this category, which implies that they potentially have the resources to implement flood-resistant infrastructure by improving drainage, regulating soil moisture, promoting crop health and resilience, diversifying livelihoods, and providing infrastructure for floodwater management.

Rainfed agriculture constitutes 18.2% of the total farming practices, with a balanced representation across small, medium, and large farmers, indicating a dependence on natural rainfall. This method relies on seasonal rainfall for crop cultivation, which is generally sustainable under normal conditions (Bedane et al., 2022). However, heavy, and prolonged rainfall can lead to flooding, causing damage to crop and infrastructure. The vulnerability of small farmers within the rainfed agriculture category is particularly notable, as they may face limitations in financial resources to invest in flood-resistant infrastructure or adopt alternative farming practices. This financial constraint heightens their vulnerability to the impacts of flooding, posing challenges to their livelihoods and agricultural productivity.

Fisheries farmers, constitute 14.1% of the total farming practices in the study area, are primarily engaged in the cultivation and harvesting of fish for commercial or subsistence purposes. This category is particularly vulnerable to flooding due to its reliance on water bodies. There are several reasons for this vulnerability. First, flood events can lead to the overflow or contamination of fishponds and water sources, resulting in the loss of fish stocks. Additionally,

the infrastructure associated with fisheries, such as fishponds and equipment, may sustain damage during floods, thereby impacting the livelihoods of those involved in fisheries. Furthermore, small farmers within the fisheries category may encounter additional challenges, given their potential lack of financial resources to invest in protective measures for their fishponds. The consequences of flooding extend to disrupting the breeding and growth cycles of fish, ultimately affecting the overall productivity of fisheries.

Wetland farming, accounting for 13.6% of all farming practices, emerges as a significant category underscoring the reliance on agricultural activities conducted in wetland areas. Wetlands, renowned for their biodiversity and ecological functions, are often likened to "earth kidneys" due to their vital role in water filtration and flood mitigation kidney (Yang et al., 2023). These areas serve as crucial flood recession farming sites, particularly during drier months as shown in Plate7.3.

However, the vulnerability of wetland farming to flooding remains a notable concern. Heavy and prolonged rainfall events can trigger the inundation of wetlands, resulting in damage to crops and infrastructure. This susceptibility is particularly pronounced for small farmers engaged in wetland farming, who often contend with limited financial resources for implementing flood-resistant measures. Moreover, the intricate dynamics of wetland ecosystems pose unique challenges in effectively managing flood risks, further complicating adaptation efforts for farmers in these areas.

Poultry farming and livestock rearing, comprising 13.1% of the total farming practices and involve the raising of birds and animals for different agricultural purposes. While this category may not directly cultivate crops, it is vulnerable to flooding in several ways. Firstly, flood events can lead to the loss of poultry and livestock, which can impact on the livelihoods of farmers especially those dependent on these animals. Secondly, the infrastructure for housing poultry and livestock is susceptible to damage from floods, leading to economic losses for

farmers. Thirdly, small farmers within this category may face challenges in safeguarding their poultry and livestock due to limited resources for protective measures. Additionally, disruptions to feed supply and the spread of waterborne diseases are potential consequences of flooding in poultry and livestock farming.

Table 7.7 – Type of Farming Engaged by Respondents

| Type of farming | Farming group | Population (respondents) | Crops cultivated |
|--|----------------------|---------------------------------|---|
| Rainfed Agriculture (Crop cultivation) | Crop cultivation | 36 | Maize, cassava, yam, sorghum, Millet, wheat |
| Irrigation | Irrigated farming | 21 | Rice, Paddy, sugarcane, vegetables |
| Small holder Farming | Smallholder Farming | 60 | Maize, beans, vegetables |
| Fishing | Fisheries | 28 | tilapia, catfish, shrimp |
| Wetland | Wetland farming | 27 | Rice, lotus, watermelon, maize, vegetables |
| Poultry/Livestock | Livestock farming | 26 | Chickens, goats, cows |

Source: Author, 2023.



Plate 7.3 Wetland Farming in the Study Area

Source: Author, 2023.

7.8 Types of Crops Cultivated

The Table 7.10 presents data on the distribution of different types of crops grown in four different locations in the study area covering Odekpe, Umunankwo, Okwe, and Oko respectively. It shows the number of each crop type grown in each location and the total number for each crop.

Furthermore, the Table 7.10 reveals data on a variety of crops cultivated across the four locations, including maize, millet, sorghum, wheat, rice, and combinations of these crops. The result shows that 44% of respondents involved in the cultivation of a single crop. Moreover, farmers who engage in wetland agriculture cultivate a diverse range of crops such as maize,

vegetables, watermelon, sorghum, millet, rice paddy, and wheat. Around 36.8% of the respondents were involved in mixed cropping, showcasing the variety in their agricultural practices.

This indicates diversity in agricultural practices and possibly diverse dietary preferences, or market demands in the region. Maize, rice, and wheat appear to be the most grown crops across all locations, as they have relatively higher counts compared to other crops. This suggests that these crops may be well-suited to the local climate and soil conditions, or they may have higher market demand or profitability. While the table does not directly provide data on wealth categories, it indirectly reflects wealth categories through the types of crops grown. This means that certain crops may require more resources, such as irrigation systems, fertilizers, or machinery, which could be indicative of larger-scale farming operations typically associated with rich farmers. Additionally, farmers cultivating a variety of crops may have diversified income streams, indicating a potentially higher income level. The income generated from their agricultural endeavours plays a crucial role in sustaining their families. However, despite the significant involvement of over 70% of the respondents in either fishing or farming activities, which contribute to the local economy and enhance food production, they face challenges related to recurrent flooding.

This is critical as it can exacerbate the vulnerability of groups, especially if they heavily rely on crops susceptible to flooding. Rice, known for its adaptability to flooded conditions, tends to withstand submersion better than crops like maize and millet, which are less suited to waterlogged environments and may experience reduced growth and increased disease susceptibility when flooded as shown in Plate 7.4. Sorghum and wheat fall in between, displaying moderate tolerance to flooding but still vulnerable to yield and quality reductions under extreme conditions. Consequently, groups dependent on flood-sensitive crops may face heightened risks of income loss and food insecurity during flood events, particularly small-

scale farmers with limited resources for crop diversification. Rich farmers with diverse crop portfolios are better positioned to weather such losses, exacerbating existing socio-economic disparities. Additionally, while rice stands out as less susceptible to flooding compared to other crops, prolonged submersion or extreme events can still cause damage.

Table 7.8 – Types of Crops Cultivated

| Type of Crop | Odekpe | Umunankwo | Okwe | Oko | Total | % |
|----------------------|-----------|-----------|-----------|-----------|------------|------------|
| Maize | 12 | 10 | 9 | 15 | 46 | 23.2 |
| Millet | 5 | 7 | 6 | 9 | 27 | 13.7 |
| Sorghum, yam | 2 | 2 | 3 | 4 | 11 | 5.6 |
| Wheat | 7 | 8 | 6 | 9 | 30 | 15.2 |
| Millet, Sorghum | 1 | 0 | 2 | 1 | 4 | 2.0 |
| Sorghum, Wheat | 2 | 1 | 1 | 0 | 4 | 2.0 |
| Rice, paddy | 8 | 5 | 8 | 10 | 31 | 15.7 |
| Maize, Rice, | 4 | 3 | 5 | 4 | 16 | 8.1 |
| Rice, Paddy, Millet | 1 | 2 | 2 | 0 | 5 | 2.5 |
| Millet, wheat | 1 | 2 | 1 | 0 | 4 | 2.0 |
| Wheat, maize | 1 | 2 | 2 | 0 | 5 | 2.5 |
| Maize, Millet | 2 | 1 | 2 | 1 | 6 | 3.0 |
| Rice, Paddy, Wheat | 2 | 0 | 1 | 0 | 3 | 1.5 |
| Sorghum, Rice, Wheat | 2 | 1 | 3 | 0 | 6 | 3.0 |
| Total | 50 | 44 | 51 | 53 | 198 | 100 |

Source: Author, 2023.

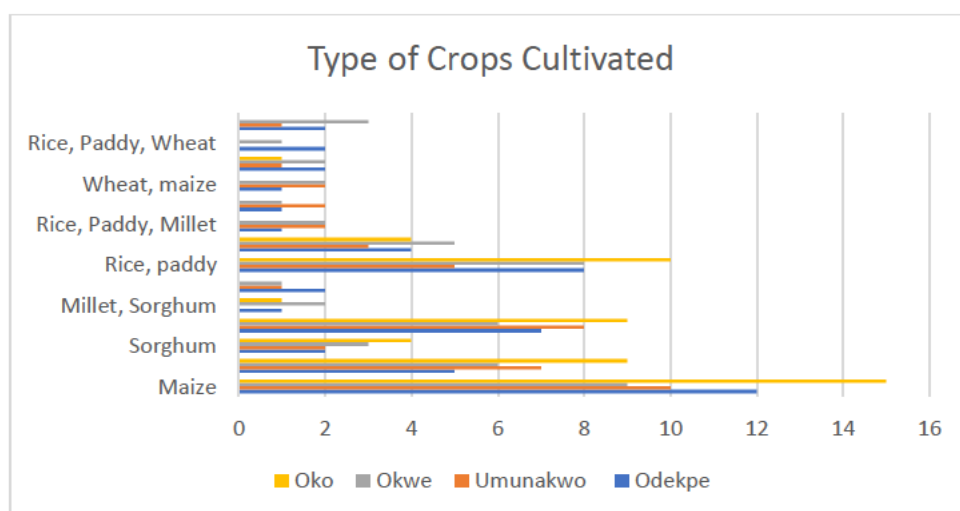


Fig.7.5 Summary of Crops Cultivated.

Source: Author, 2023.



Plate 7.4: Flood Affecting Maize Farming in the Study Area

Source: Author, 2023

7.9 Perceived Livelihood Impacts of Flooding.

As we delve deeper into the perceived livelihood impacts of flooding, it's essential to recognize that farmers also face various other climatic stresses. While our primary focus remains on flooding, we acknowledge the significance of these additional challenges for a comprehensive understanding of the agricultural landscape. Therefore, in this section, we will first explore some of the other climatic stresses that farmers have noted. Subsequently, we will shift our attention specifically to the impacts of flooding, providing detailed insights into its effects on agricultural practices and livelihoods. During the interviews, participants openly discussed the rising frequency and severity of floods impacting every facet of life in the Lower Niger River region. They highlighted the extensive damage floods inflict on homes, farms, and critical infrastructure. Their accounts conveyed a sense of urgency and deep concern, underscoring the mounting impact of flood events. These floods, typically triggered by heavy rainfall, have resulted in substantial damages and losses, leaving a profound and lasting impact on the communities affected.

Participants attested to the disastrous effects of these frequent floods by sharing poignant accounts of homes being submerged, property being damaged, and families being forced to relocate. Their narratives underscored the severe and multifaceted consequences of flooding, highlighting the need for immediate and effective interventions to mitigate these impacts and support the resilience of vulnerable communities.

To comprehensively assess this impact, we employed a systematic approach involving the calculation of mean scores for various aspects of livelihoods. Individuals provided ratings or scores based on their knowledge, experience, or perception, which were then averaged to derive the mean score for each aspect as shown in Table 7.9.

This method was applied consistently across all aspects listed in Table 7.9, shedding light on the diverse effects of flooding on different facets of livelihoods. Notably, crop production, encompassing crops such as wheat, rice, and maize, suffers significantly from flooding-induced damage. Large swathes of farmland are submerged, resulting in the loss of valuable resources, and exacerbating poverty levels in the Lower Niger Basin.

Farmers expressed how the changing rainfall patterns, characterized by limited rainfall and delayed onset, have profoundly affected their agricultural activities see Table 7.11. This has led to reduced crop yields, especially in the case of millet and sorghum. One farmer explained, *"We used to harvest millet and sorghum in large quantities, but due to the lack of support and the unpredictable nature of rains, millet and sorghum production has significantly reduced in quantity."*

Amidst these challenges, an intriguing theme emerged, centred on traditional coping techniques and local knowledge. Participants emphasized the invaluable role of indigenous knowledge, handed down through generations, in offering insights into flood forecasting based on natural indicators like wildlife behaviour and river flow patterns. They also described how

communities come together during flooding to aid those affected and provide shelter and support.

Another urgent concern raised by participants was the continuous movement of cattle by Fulani herdsmen from northern Nigeria, as noted by Lenshie and Jacob (2020), which exacerbates farmers' vulnerability during flood. This phenomenon causes significant damage to farmland and destroys crops, compounding the challenges faced by communities. As floods already compromise land availability and agricultural productivity, the additional strain from cattle encroachment intensifies the loss of crops and further undermines the resilience of farming communities. This confirms the findings of Elsamahi et al. (2021), which highlights that the varying perception of risk, particularly among those affected by farmer-herdsmen conflict, not only disrupts agricultural activities but also heightens the overall vulnerability of these communities to the adverse impacts of flooding.

7.9.1 Crop Vulnerability: Looking at the aspects related to farming in the table, such as crop yield and quality of yield, we observe high mean scores (4.3 and 4.1 respectively), indicating that flooding has a significant perceived impact on crop production. The high scores suggest that farmers perceive flooding as having a detrimental effect on crop yields and the quality of harvested crops. These impacts align with Toromade et al. (2024) who highlight that changes in water availability and soil conditions caused by flooding have a direct and significant effect on farmers' ability to cultivate crops successfully. These disruptions often result in reduced income and heightened food insecurity, compounding the vulnerabilities faced by farming households in flood-prone areas.

7.9.2 Livestock Health: For livestock rearing, aspects such as livestock health have a mean score of 3.8, indicating a moderate perceived impact of flooding on livestock health. While this

score may be lower compared to crop-related aspects, it still highlights the importance of addressing livestock health concerns during flooding events. Flooding can affect the health and productivity of livestock, leading to economic losses for livestock farmers and impacting their livelihoods, as mentioned in the explanation.

7.9.3 Water Management: Aspects related to water management, such as water quality, have relatively high mean scores (3.9), suggesting that farmers perceive flooding as having a significant impact on water quality, which is crucial for agricultural livelihoods. Effective water management is essential for sustaining agricultural production, particularly in areas prone to flooding. These observations are consistent with the findings of Effiong et al. (2022), who highlighted that poor waste management can degrade environmental quality. They emphasized the urgent need for adaptive water management strategies, considering fluctuations in water availability and quality due to both flooding and drought events. Plate 7.5 illustrates instances of poor waste management practices, which can adversely affect water quality in the study area. Addressing these issues is imperative to safeguarding agricultural productivity and ensuring resilience against environmental challenges in the Lower Niger River region.



Plate 7.5 Poor Waste Management in the Study Area

Source: Author, 2023

7.9.4 Economic Impacts: Aspects related to small businesses, such as market access and disruptions in the supply chain, have high mean scores (4.2 and 4.1 respectively), indicating significant perceived economic impacts of flooding. These economic impacts directly affect farmers' incomes especially small-scale farmers and their ability to support themselves and their families, highlighting the broader economic implications of flooding on agricultural livelihoods. One notable participant highlighted the challenges faced by small-scale farmers during flooding events. The participant emphasized that when floods occur, they disrupt

transportation routes, cause damage to critical infrastructure, and consequently hinder the smooth movement of goods and people. This disruption poses a significant obstacle for small-scale farmers, impeding their ability to access markets efficiently and distribute their products.

Table 7.9 Livelihood Activities Affected by Flooding

| Livelihood activity | Aspect | Mean score |
|----------------------------|------------------------------|-------------------|
| Farming | Crop yield | 4.3 |
| Farming | Quality of yield | 4.1 |
| Farming | Water quality | 3.9 |
| Fishing | Overflow pattern of water | 4.4 |
| Fishing | Fishing stock | 4.2 |
| Fishing | Access to fishing equipment | 4.0 |
| Livestock rearing | Livestock health | 3.8 |
| Livestock rearing | Availability of grazing land | 3.6 |
| Livestock rearing | Access to fodder | 3.9 |
| Small business | Market access | 4.2 |
| Small business | Price fluctuation | 3.9 |
| Small business | Disruption in supply chain | 4.1 |

Source: Author, 2023

7.10 The Impact of flooding on livelihoods, and what it means for different social groups.

Building on the socio-economic characteristics of respondents outlined in the previous section, the varying vulnerabilities across social groups influence how they experience and respond to flooding. The focus now shifts to understanding the direct impacts of flooding on livelihoods, particularly in agriculture and fisheries, which are central to the economic survival of these communities. By utilizing a set of five-point indicators, respondents were able to provide detailed assessments of the damage to their livelihoods. The findings, summarized in Tables 7.10 and 7.11, provide a comprehensive view of the extent of loss and damage across different dimensions of livelihood activities in the Lower Niger River basin, offering key insights into how social groups are differently affected.

7.10.1 Agriculture:

The data from the study reveals that floods impact several agricultural components, including crop production, crop yield, and land availability. These impacts contribute to the losses and damage experienced by farmers in the area.

7.10.2 Crop Yield:

The data indicates a significant impact on crop yield among households, with a notable proportion experiencing moderate losses and destruction. For instance, 34.34% of crop yields were moderately affected by floods, while 21.21% suffered significant destruction during flood events. This scenario poses grave consequences, potentially leading to high price fluctuations due to the scarcity of farming products, thereby exacerbating the plight of poor farmers and exacerbating poverty and landlessness.

Poor farmers, who often rely heavily on agriculture as their primary source of income, are particularly vulnerable in such circumstances. As illustrated in Table 7.12, a larger percentage of poor farmers may find themselves in categories reflecting moderate to extreme loss of crop yield. This underscores the heightened likelihood for poor farmers to experience substantial reductions in crop yield compared to their wealthier counterparts. The repercussions are even more severe for individuals leasing land for farming or those entirely landless, as they lack access to structured compensation mechanisms, further compounding socio-economic challenges within their livelihoods. Furthermore, the duration of flooding is critical, as prolonged inundation can amplify losses, heightening farmers' vulnerability and impacting other aspects of their livelihoods. This underscores the substantial impact of flooding on farmers in the region, leading to reduced agricultural productivity and potential shortages of farming goods. Consequently, these conditions can contribute to increased price volatility, negatively impacting farmers' incomes and overall livelihoods.

7.10.3 Crop Produce:

Table 7.12 illustrates that 20.20% of crop produce is moderately affected by floods, while 24.24% of crop produce is destroyed during flooding events. These figures highlight the potential for significant price fluctuations due to shortages of agricultural products, which could exacerbate poverty and contribute to landlessness among vulnerable farmers. The implication is that poor farmers may face challenges in post-harvest handling and storage of crops, making them more susceptible to losses in crop produce during flooding events. A larger percentage of poor farmers might report slight to extreme losses in crop produce, indicating a significant impact on their ability to harvest, process, and sell agricultural products. In contrast, rich farmers may have access to better storage facilities and market networks, enabling them to minimize losses in crop produce during flooding events. Furthermore, as shown in the table, a smaller percentage of rich farmers might report slight to extreme losses in crop produce, suggesting that they are better equipped to manage post-harvest challenges and mitigate the impacts of flooding on crop production.

7.10.4 Water Quality

In terms of water quality, while 18.18% of respondents indicated no impact, a significant portion, 27.78%, reported moderate effects, and 22.73% reported extreme impacts. These findings underscore the challenges faced by poor farmers who rely on local water sources for irrigation and livestock watering, as floodwaters can contaminate these sources, compromising water quality. Moreover, a larger percentage of poor farmers might report neutral to severely affected water quality, highlighting their limited access to clean water for agricultural purposes. In contrast, wealthy farmers may have access to private water sources or water treatment facilities, thereby reducing their dependence on local water bodies affected by flooding. As a result, a smaller percentage of rich farmers might report neutral to severely affected water

quality, suggesting that they are better equipped to maintain access to clean water for agricultural use despite flooding events.

7.10.5 Land Availability:

Farmers in the study area are disproportionately affected by land availability, with 23.23% and 24.24% of respondents reporting moderate and extreme impacts, respectively. This suggests that poor farmers, who may have limited land holdings, are more likely to cultivate in flood-prone areas with lower land quality. Consequently, a larger percentage of poor farmers might report neutral to extreme loss of land availability, indicating significant challenges in accessing and utilizing arable land for agriculture. Conversely, wealthy farmers may have larger land holdings and the financial means to afford land in less flood-prone areas with better soil quality. As a result, a smaller percentage of rich farmers might report neutral to extreme loss of land availability, implying that they are less affected by land degradation and loss due to flooding.

7.10.6 Quality of River Water:

In terms of the quality of river water, the data reveals a spectrum of impacts among farmers in the study area. While 15.5% of farmers reported no impact, 15.66% indicated slight effects, and 20.20% remained neutral. However, a substantial 27.78% reported moderate impacts, and 21.21% reported extreme effects. These findings underscore the severe implications for poor farmers who rely on river water for irrigation or livestock watering, as they may be disproportionately vulnerable to water pollution and contamination during flooding events.

Indeed, a larger percentage of poor farmers might report neutral to severely affected quality of river water, indicating significant challenges in accessing clean water for agricultural use. In contrast, wealthy farmers may have access to alternative water sources or water treatment facilities, enabling them to mitigate the impacts of flooding on water quality. As a result, a

smaller percentage of rich farmers might report neutral to severely affected quality of river water, suggesting that they are better equipped to maintain access to clean water for agricultural purposes despite flooding events.

7.10.7 Social Support Networks:

Poor farmers often grapple with limited social support networks, intensifying the repercussions of flooding on their livelihoods. Notably, nearly half of the poor farmers surveyed (48.99%) reported experiencing moderate to extreme losses in social support networks, signifying the hurdles they encounter in accessing assistance and resources during and after flood events. Conversely, a smaller but still significant proportion of affluent farmers (44.99%) reported similar losses in social support networks. This discrepancy suggests that wealthier farmers may benefit from stronger social connections and increased access to aid and resources during periods of crisis. The divergence in social support networks underscores the disparate abilities of poor and rich farmers to navigate and recover from the impacts of flooding, potentially shaping their resilience and overall well-being in the face of adversity.

Table 7.10: Extent of Damage from Flooding Agriculture

| N= 198 | | | | | |
|------------------------|-------------------------|----------------------------|-------------|-------------------------|-------------------------------|
| Livelihood aspect | Not affected at all (%) | Slightly affected loss (%) | Neutral (%) | Moderately affected (%) | Destroyed or extreme loss (%) |
| Crop yield | 15(7.58%) | 45(22.73%) | 28(14.14%) | 68(34.34%) | 42(21.21%) |
| Crop produce | 38(19.19%) | 50(25.25%) | 22(11.11%) | 40(20.20%) | 48(24.25%) |
| Quality of water | 36(18.18%) | 20(10.10%) | 42(21.21%) | 55(27.78%) | 45(22.73%) |
| Land availability | 39(19.70%) | 15(7.58%) | 50(25.25%) | 46(23.23%) | 48(24.24%) |
| Quality of river water | 30(15.15%) | 31(15.66%) | 40(20.20%) | 55(27.78%) | 42(21.21%) |

Source: Author, 2023.

7.11 Fisheries

In this section, we turn our focus to the fisheries aspect of livelihood assessment. We will delve into various dimensions of fisheries livelihood, including fish stock, access to fishing gear, and

availability of fishing equipment, as detailed in Table 7.13. By examining these factors, we aim to gain insights into the status of fisheries and its significance for the livelihoods of communities in the study area.



Plate 7.6 Fishing Canoe and Equipment on the Riverbank

Source: Author, 2023

7.11.1 Fish Stock:

The assessment provides insight into the profound loss and devastation experienced within fisheries livelihoods. It's evident that a significant portion of fish stocks endured substantial impacts from flooding, with 30.30% suffering moderate effects and 21.21% being destroyed.

Furthermore, the data presented in Table 7.13 highlights a striking trend: a notable proportion of poor farmers, accounting for 30.30%, reported experiencing moderate to extreme losses in fish stock due to flooding. This finding underscores the heightened vulnerability of poor farmers to declines in fish stock, a factor that carries profound implications for their livelihoods and food security. Conversely, the impact appears less severe for wealthier farmers, with only 21.22% reporting moderate to extreme losses in fish stock. This discrepancy suggests that rich farmers may be better equipped to weather the challenges posed by flooding, resulting in a comparatively lower impact on their fish stocks.

7.11.2 Access to Fishing Equipment:

A substantial proportion of poor farmers, comprising 48.99% of respondents, reported experiencing moderate to extreme losses in access to fishing equipment. Similarly, 27.78% of poor farmers faced moderate impacts on access to fishing gear and technology, while 21.21% reported complete destruction of such equipment. These findings underscore the significant challenges faced by poor farmers in maintaining access to essential fishing gear and technology, thereby impeding their ability to effectively engage in fishing activities. In contrast, a smaller percentage of rich farmers, totalling 44.99%, reported moderate to extreme losses in access to fishing equipment. This suggests that wealthier farmers are relatively less affected by disruptions in access to fishing gear and technology, implying a higher level of resilience to such challenges compared to their poorer counterparts.

7.11.3 Water Flow Pattern:

A notable proportion of poor farmers, accounting for 49.50% of respondents, reported experiencing moderate to extreme impacts on water flow patterns. These alterations in water flow have the potential to disrupt fish habitats and migration routes, thereby adversely affecting

fishing activities. This disparity underscores the heightened vulnerability of poor farmers to changes in water flow patterns, which can significantly impede their ability to engage in fishing effectively.

Conversely, a smaller percentage of rich farmers, also totalling 49.50%, reported experiencing moderate to extreme impacts on water flow patterns. This finding suggests that wealthier farmers exhibit a relatively lower vulnerability compared to their poorer counterparts, implying a higher level of resilience in navigating challenges associated with changes in water flow patterns.

7.11.4 Access to Fishing Grounds:

The data presented in Table 7.13 reveals a striking trend that a significant majority of poor farmers, comprising 47.47% experienced moderate to extreme losses in access to fishing grounds. This limitation severely constrains their ability to fish in areas known for high productivity, ultimately impacting their fishing yields and livelihoods. The findings suggest that poor farmers encounter considerable challenges in accessing suitable fishing grounds, highlighting the potential repercussions on their overall fishing activities and economic well-being. Conversely, a smaller proportion of rich farmers, also amounting to 47.47%, reported moderate to extreme losses in access to fishing grounds. This discrepancy indicates a relatively lower impact on wealthier farmers compared to their poorer counterparts. It suggests that rich farmers may possess greater resources or alternative means to mitigate the effects of restricted access to fishing grounds, thereby maintaining a relatively stable fishing environment and livelihood.

Table 7.11: Extent of Damage from Flooding: Impacts on Fishing and Accessibility

| |
|----------------|
| N = 198 |
|----------------|

| Livelihood aspect | Not affected at all (%) | Slightly affected loss (%) | Neutral (%) | Moderately affected (%) | Destroyed or extreme loss (%) |
|---------------------------------------|-------------------------|----------------------------|-------------|-------------------------|-------------------------------|
| Fish stock | 24(12.12%) | 36(18.18%) | 36(18.18%) | 60(30.30%) | 42(21.22%) |
| Access to fishing gear and technology | 35(17.68%) | 40(20.20%) | 26(13.13%) | 55(27.78%) | 42(21.21%) |
| Access to fishing equipment | 28(14.14%) | 38(19.19%) | 35(17.68%) | 52(26.26%) | 45(22.73%) |
| Water flow pattern | 20(10.10%) | 42(21.21%) | 38(19.19%) | 58(29.29%) | 40(20.21%) |
| Access to fishing ground | 30(15.15) | 40(20.20%) | 33(16.67%) | 50(25.25%) | 45(22.73%) |
| Access to market | 42(21.21%) | 20(10.10%) | 35(17.68%) | 46(23.23%) | 55(27.78%) |
| Price of product | 32(16.16%) | 26(13.13%) | 40(20.21%) | 52(26.26%) | 48(24.24%) |
| Product availability | 38(19.19%) | 42(21.21%) | 28(14.14%) | 45(22.73%) | 45(22.73%) |
| Income | 30(15.15%) | 31(15.66%) | 43(21.72%) | 50(25.25%) | 44(22.22%) |
| skills | 35(17.68%) | 40(20.20%) | 36(13.13%) | 52(26.26%) | 45(22.73%) |

Source: Author, 2023.

The assessment reveals that over 50% of fisheries and accessibility in the Lower Niger River basin were moderately to extremely affected by flooding, indicating a profound impact on the fishing industry. This impact encompasses reduced fish populations, constrained access to essential resources, and diminished fishing activities. These findings underscore the significant economic losses caused by flooding, compelling affected communities to seek alternative livelihoods and, in some cases, abandon traditional occupations. This transition to other economic activities may exacerbate challenges such as scarcity of goods, price hikes, and heightened vulnerability among affected households.

Furthermore, the assessment underscores the disruptive consequences of flooding on infrastructure, particularly concerning market accessibility and price stability. The results indicate that flooding has impeded market access, presenting logistical hurdles for farmers in transporting their agricultural goods. Consequently, farmers may be forced to sell their produce

at lower prices, leading to diminished profitability and potential financial hardships. Moreover, farmers may resort to borrowing funds for upcoming planting seasons, further straining their economic resilience.

7.12 Non-Climatic Factors Contributing to Vulnerability

This section delves into the intricate relationship between non-climatic factors and their amplification of vulnerability among farmers and fishers, rendering them more susceptible to the devastating impacts of flooding. While climatic factors undoubtedly play a significant role in shaping the frequency and intensity of flooding events, it is equally imperative to comprehend the non-climatic elements that compound these vulnerabilities. The experiences of those engaged in farming and fishing activities in flood-prone areas are inextricably linked with a multitude of socio-economic, political, and structural factors that exacerbate their susceptibility to the adverse consequences of flooding.

7.12.1 Pattern of Farming Practice

The patterns of land clearing for farming activities in the Lower Niger region, as shown in Table 7.12, highlight significant trends in land use and their environmental implications, particularly concerning flooding. Continuous clearing, which persists throughout the year without seasonal limitations, is the most prominent practice, reported by 36.8% of respondents. This high frequency of land clearing reflects a strong reliance on natural resources for agricultural purposes. However, such practices often result in soil degradation and increased vulnerability to flooding.

In contrast, 6.6% of respondents reported clearing land twice in the last decade, a frequency that allows for periods of natural regeneration and land recovery. This approach can mitigate soil erosion and other environmental impacts, reducing susceptibility to flooding. Land

clearing conducted three times within the decade, as reported by 20.7% of respondents, suggests a semi-annual or biannual pattern. This balanced frequency aligns with farming needs and natural cycles, though farmers adopting this practice may still face challenges such as flooding and soil degradation, limiting their resilience.

Clearing land four times in the last decade, noted by 19.7% of respondents, indicates regular intervals of clearing, approximately every 2–3 years. This practice supports seasonal land management, ensuring productivity while maintaining a level of environmental stability. Farmers in this group often have access to additional land, allowing them to rotate usage and reduce environmental pressure, which may lower their vulnerability compared to continuous clearing. Irregular clearing, reported by 16.2% of respondents, represents an ad hoc approach to land management without a fixed schedule. Field observations reveal that irregular clearing often occurs on community-owned land with restricted access, typically for specific activities such as harvesting palm fruits during designated periods.

These findings emphasize the close link between land clearing practices and the socio-economic and cultural factors that influence land use in the region (Olagunju, 2015, Onyena and Sam, 2020). Continuous year-round clearing reflects a significant dependence on agricultural land, often exacerbating environmental degradation and increasing flood risks. Conversely, less frequent or irregular clearing practices indicate more sustainable use of land resources, which can improve resilience to climate-related hazards.



Plate 7.7 Community Land with Palm Fruit

Source: Author, 2023.

Table 7.12 Farming Practice and Land Clearing in the Last 10years

| Land clearing in last 10years | Frequency | Percentage |
|--------------------------------------|------------------|-------------------|
| Continuous Clearing (all year round) | 73 | 36.8 |
| Twice | 13 | 6.6 |
| Thrice | 41 | 20.7 |
| Four | 39 | 19.7 |
| Irregular clearing | 32 | 16.2 |
| Total | 198 | 100 |

Source: Author, 2023.

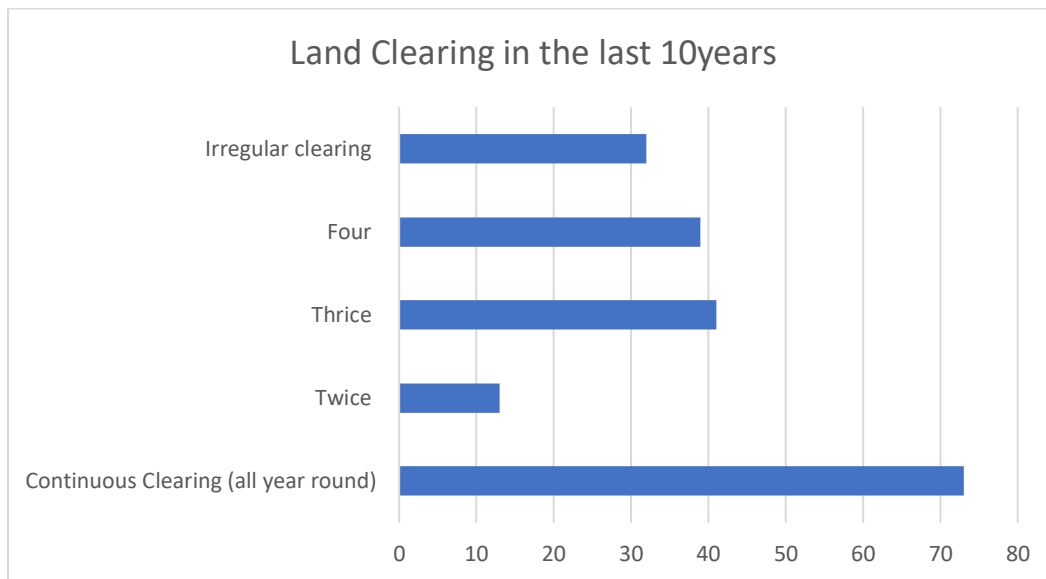


Fig 7.6- Summary of Land Clearing in the last 10years

Source: Author, 2023.

7.12.2 Levee and Housing Construction

Levees serve as essential tools for managing floodwaters and preventing the overflow of water into wetlands. However, when levees are constructed, they effectively separate floodplains from the main river, channelling the river's flow into a confined pathway and altering the natural flow into the floodplain. In response to the threat of flooding, different countries have adopted climate action plans aimed at protecting properties and human activities from the destructive impacts of climate hazards, as observed by Busayo and Kalumba (2020). Alternatively, as noted in the study by D'Oria et al. (2019), some nations have focused on systemic protective measures like the construction of levees. Paradoxically, the construction of levees, rather than alleviating the issue, can lead to prolonged flooding in downstream communities, turning levee construction into an ongoing process that ultimately contributes to environmental degradation and unintended consequences for river-dependent communities.

In the case of the Lower Niger River, the engineering construction has not provided the desired protection because it lacks accompanying non-structural actions, such as zoning and land use planning. To investigate the level of compliance with the regional Master plan, interviews were conducted. Participants indicated a heavy reliance on traditional arrangements set forth by the community. One participant highlighted, *"I don't go for approval; I only pay a community development fee, and if you don't pay, the community will stop you from developing."* Furthermore, the questionnaire analysis revealed that over 40% of respondents were developing infrastructure in the area which often results in the occupation of flood-prone areas, putting more people and property at risk during floods. Respondents cited high costs as a reason for non-compliance with set standard. In contrast, 13.8% of respondents acknowledged developing houses in alignment with established standards to mitigate flooding risks through engineering interventions. This suggests that many developers in the region do not rely on official development permits, exacerbating flood risks in the community. This aligns with the findings of Sayers et al. (2012), highlighting that while engineered structural measures will continue to play a crucial role in building resilient communities, they must be complemented by a variety of non-structural measures and instruments to effectively address challenges and enhance resilience. As depicted in Plate7.8 the development of a building on a floodplain significantly affects the residents.



Plate 7.8: Flood Affecting Residents in the Study Area

Source: Author, 2023

7.12.3 Gendered Land Rights: Challenges and Impacts

In most African countries has granted limited access on the right of women to secure and use land. This is a violation of human right. Although such right in the lower Niger is often achieved through husband, we argue that such practice is marginalization and exclusion of women to access natural resources. Consequently, vulnerability is linked to unequal power relations existing between groups and society and is impacting negatively on socioeconomic characteristic of people. There are different social groups of which are not homogenous and can experience vulnerability in different ways due to the nature of marginalization and exclusion in the community. It is important to understand how vulnerability is associated with socioeconomic characteristics, politics of exclusion.

7.12.4 Lack of Post-Harvest Infrastructures

Smallholder farmers, with a particular emphasis on women, confront heightened vulnerability to the detrimental impact of flooding due to their limited access to post-harvest infrastructure (Stathers et al., 2013). This deficiency in essential facilities, particularly for highly perishable goods like tomatoes and other fresh produce, magnifies the risk of post-harvest losses. The consequence of this is significant, compelling farmers to sell their harvests at lower prices, directly jeopardizing their livelihoods (Giller et al., 2021). When flooding happens, it inflicts widespread damage upon farmlands, inundating crops and, in many cases, even submerging farmers' homes and essential agricultural infrastructure. Consequently, farmers face substantial losses of capital, severely undermining their capacity to sustain agricultural production. This dual blow of lost crops and damaged property precipitates food shortages and substantial income reductions among smallholder farmers, consequently propelling them further into the clutches of poverty. Furthermore, the inundation caused by floodwaters results in contamination or damage to the crops that have been harvested (Ashraf et al., 2013). This predicament is especially challenging for smallholder farmers, notably women, who predominantly harvest highly perishable commodities such as tomatoes. These farmers, lacking the requisite knowledge and facilities for proper preservation, frequently resort to selling their products at significantly reduced prices to middlemen traders. This practice engenders the perilous risk of substantial capital loss, ultimately pushing these farmers further into the quagmire of poverty. Moreover, flooding can wreak havoc on transportation routes, rendering them impassable or severely disrupted. This makes it immensely challenging for farmers to transport their produce to market. In some dire instances, their products may remain stranded or rendered unsellable. The inability to access markets intensifies the multifaceted vulnerabilities that farmers, especially smallholders, grapple with, rendering them exceedingly susceptible to the adverse repercussions of climate-related disasters like flooding. As a result,

addressing the vulnerability of smallholder farmers to such calamities necessitates concerted efforts in improving their access to post-harvest infrastructure, facilitating market access, and fortifying their resilience in the face of these daunting challenges.

7.12.5 Farmers/Herders' Conflict

The recurring farmers/herders' conflict in Nigeria, primarily driven by the invasion of farmlands by pastoral herders and their cattle, significantly contributes to increased vulnerability for farmers and further compounds the impact of climate change, especially in relation to flooding as shown in Plate 7.9.

In Nigeria, the population is ethnically diverse, with various groups such as the Hausa/Fulani, Igbo, and Yoruba (Kollehlon, 2003). The Hausa/Fulani ethnic group predominantly resides in the northern part of the country and is involved in both farming and cattle rearing, while the Igbo and Yoruba ethnic groups are concentrated in the southern regions, relying primarily on farming as their main livelihood source. Climate change has resulted in vegetation loss in northern Nigeria, leading pastoral communities to move their herds southward in search of greener pastures (MOSES-OJO et al., 2023). This movement of Fulani herders and their cattle to the southern regions directly impacts the farming practices of the local communities, thus resulting in conflict between farmers and herders. One significant impact of this conflict is the alteration of farming practices. For instance, the predominantly practiced shifting cultivation methods are disrupted, with farmers unable to access land for farming. This restriction leads to a decline in agricultural production, thus affecting the food security and livelihoods of the farming households.

Moreover, farming households, particularly women, often lack the capacity to confront Fulani herders for fear of violence, leading to a heightened vulnerability (Effiong, 2017). This fear can be paralyzing, as the herders may resort to violence when confronted, pushing women to

refrain from using their lands for farming. As a result, these women lose their source of income and access to farmland, which not only affects their economic stability but also takes a toll on their emotional and physical well-being(Nanama and Frongillo, 2012). With a changing climate, these conflicts intensify the frequency of climate-related hazards, further restricting farming activities, disrupting socio-political and economic stability, and driving households into poverty and hunger. Additionally, these conflicts contribute to disruptions such as flooding, which alters farming practices and reduces agricultural productivity. This undermines community resilience, leaving them increasingly vulnerable to the impacts of flooding and other climate-related disasters.



Plate 7.9: Farmland Invaded and Destroyed by Animals

Source: Author, 2023

7.12.6 Non-State Actors Interfere with Governance.

The non-state actors do interfere with governance to create an unstable political climate in the South-eastern part of Nigeria. The Indigenous People of Biafra (IPOB) has a long history of struggle to restore independent state in South-eastern Nigeria (Owoeye et al., 2022). Although, they have existed as a Republic between 1967 and 1970 of which their struggle led to Nigerian civil war that lasted for 3years and ended in 1979 with signing of treaties (Ogunode and

Chijindu, 2022). The current protest by IPOB is triggered by the federal government neglect and continuous marginalization of the region in form of political alienation, extra judicial killing and lop-sidedness in resource allocation (Ogunode and Chijindu, 2022). The Monday ‘sit at home’ order is a strategy by IPOB to protest the continuous detention of Nnamdi Kanu by Federal government of Nigeria since June 2021. The ongoing sit-at-home measures, typically enforced as a response to various social or political issues, have detrimental consequences for farmers in the affected areas. These measures hinder their access to farmlands, disrupt their agricultural routines, and significantly increase the risk of economic and food security challenges. The restrictions on access to farmlands coincide with changing patterns of rainfall, which are already influenced by the ever-shifting climate conditions.

The alteration in rainfall patterns can be particularly problematic for farmers because it directly impacts their agricultural productivity. With restricted access to their fields due to the sit-at-home orders, they might miss crucial planting or harvesting periods. These timing disruptions can lead to reduced crop yields, which is especially concerning as many farming households as possible, including those headed by women with limited income, heavily rely on their harvests for sustenance and income.

As productivity declines and incomes dwindle due to these challenges, farming households become more vulnerable to the impacts of climate change. Diminished resources and economic stability make it difficult for them to cope with climate-related issues, such as extreme weather events, changing disease patterns, or crop failures. Ultimately, the continuous sit-at-home orders not only affect farmers' immediate livelihoods but also have a longer-term compounding effect on their ability to adapt to and mitigate the impacts of climate change. This, in turn, exacerbates the cycle of poverty and vulnerability in these communities.

7.13 Conclusion

The intricate interplay between climate and non-climate factors plays a pivotal role in generating livelihood stress, which, in turn, can have profound implications for various livelihood activities and overall production. Climate properties encompass a range of elements, including the region's elevation, the types and duration of extreme climate events. In contrast, non-climatic factors involve the behaviour of farmers in resource utilization, the seasonal variations, and geographical assets. The perceptions of respondents provide valuable insights into how climate stress affects the residents of the Lower Niger. It's worth noting that the extent of exposure to climate stress, as suggested by the Murray and Ebi (2012), should be assessed based on the scale, frequency, and intervals of these events.

Climate change exerts a direct impact on livelihoods, especially for those activities that are highly sensitive to climate fluctuations, such as rainfed agriculture, seasonal labour recruitment for farming, fishing, tourism, and pastoralism. Conversely, it also affects households that rely on wages or engage in informal livelihoods by leading to increased food prices in the market, unreliable payment systems, and migration.

This study specifically delves into the effects of climate stress on farming and fishing activities in the Lower Niger. For instance, the study classifies the extent of livelihood damage resulting from flooding into five categories: not affected at all, slightly affected, neutral, moderately affected and destroyed or extreme loss. This classification system shapes the overall findings and influences how respondents perceive the extent of damage to their livelihoods.

The exposure of livelihoods to climate uncertainties and the disparities in socio-economic characteristics have been widely documented. However, we argue that the patterns of resource use and the social-ecological components of a system play a significant role in amplifying climatic stress. The results of our study reveal that wetland agriculture is the predominant form of farming in the Lower Niger, with vegetables and cereals being the dominant crops cultivated.

The impact of climate uncertainties varies, subjecting farmers and fishers to different degrees of vulnerability based on their livelihood groups.

Furthermore, the results demonstrate that while crop loss in wetlands is not a routine occurrence, unexpected climatic stress can lead to severe losses, hampering the growth and productivity of farmers and fishers in the study area. By examining community perceptions, we were able to measure the extent of extreme rainfall and the consequences of flooding on livelihoods by distinguishing between stress and extreme conditions. Stress perception proved to be context-specific, defining the pattern of adaptation processes necessary to mitigate livelihood vulnerability.

The results also unveil specific time frames that necessitate adaptation planning, particularly considering the impact of climate change. For example, we identified the duration of flood or extreme rainfall, intervals between such events, the intensity of climatic stress, and the ability of crops to survive under extreme conditions.

An interesting observation from the results is the extent to which reliance on a primary source of livelihood can limit an individual's ability to explore alternative livelihood opportunities, rendering them more vulnerable under extreme climatic conditions. Moreover, the findings suggest that the dredging of river channels increases the likelihood of flooding in the Lower Niger. This implies that relying solely on historical climate data for policy action in the face of climate uncertainties may be insufficient. Therefore, as suggested by Ren et al. (2019), providing spatial information that includes land use and land cover data is essential for effective monitoring and policy development.

CHAPTER EIGHT

NATARAJAN ET AL'S SUSTAINABLE LIVELIHOOD FRAMEWORK

CATEGORIES

8.0 Introduction

In the previous chapter, we examined the complex factors that heighten vulnerability to flooding in the Lower Niger River region, focusing on climatic and socio-economic impacts on local farming communities. In this chapter, we apply Natarajan et al.'s Sustainable Livelihood Framework (introduced in Chapter Two), analysing farmers' coping strategies through a multi-scalar lens. Natarajan's framework divides analysis into three scales—micro, meso, and macro—to assess the interconnected factors that influence adaptation across individual, community, and institutional levels.

At the **micro scale**, this analysis focuses on individual and household-level adaptations, such as land management, crop diversification, and local cooperative societies that enable farmers to share resources and knowledge. At the **meso scale**, we examine how community organizations and regional networks enhance resilience, facilitating resource-sharing and supporting collective responses to climate-related stressors. Finally, the **macro scale** encompasses broader institutional and policy factors, including government support for climate adaptation, access to financial resources, and regional infrastructure that either enable or constrain adaptive strategies at the local level.

This chapter further considers the **political economy** of adaptation, addressing how power dynamics, resource inequalities, and institutional inefficiencies shape the effectiveness of coping strategies across scales. For instance, marginalized groups often face barriers to accessing financial and infrastructural support due to socio-political exclusion or

discriminatory policies. Wealthier and politically connected communities, in contrast, are better positioned to leverage resources and influence decision-making processes. By integrating these political-economic dimensions into the analysis, we aim to provide a nuanced understanding of resilience and vulnerability in the Lower Niger River region.

8.1 Coping Strategies to Flooding

Flooding poses a significant threat to agricultural productivity and community livelihoods in the Lower Niger River region, impacting farmers' capacity to maintain consistent crop yields, safeguard livestock, and protect vital farmland from erosion. Farmers have developed a range of adaptive mechanisms leveraging the natural capital of their environment across multiple scales. These strategies address immediate flood impacts while fostering resilience over the long term. However, the ability to adopt these coping strategies is deeply influenced by political-economic structures that shape resource access, institutional support, and systemic inequalities.

At the **micro scale**, individual farmers adopt land management, crop diversification, and agro-processing innovations to maximize productivity and minimize loss. Yet, access to these practices is not uniform, with marginalized groups often excluded due to unequal land tenure systems or limited financial resources. At the **meso scale**, community-level adaptations play a critical role as farmers engage in cooperative societies to share resources, exchange knowledge, and strengthen resilience. However, the efficacy of these cooperatives often depends on the institutional environment, which may privilege some communities over others due to systemic governance failures or corruption. At the **macro scale**, national policies and institutional frameworks significantly influence adaptive capacity. Inadequate public investment in flood

management, weak disaster risk reduction (DRR) policies, and socio-economic inequalities hinder the broader implementation of effective coping strategies.

By analysing these responses through a political economy lens, we can better understand how structural inequalities, power dynamics, and exclusion shape farmers' resilience, providing insights for more inclusive and effective interventions.

8.1.1 Natural Capital

Farmers in the Lower Niger River region rely on natural resources and adaptive practices to manage land use and enhance crop resilience across micro, meso, and macro scales. However, these strategies are embedded within political-economic structures that often perpetuate inequalities in access and outcomes.

At the **micro level**, individual farmers rent additional land to counter the constraints of inheritance-based land divisions. This strategy sustains agricultural productivity but disproportionately benefits rich households who can afford rental costs, leaving poorer farmers more vulnerable to land scarcity (Colin, 2008).

At the **meso level**, cooperative societies facilitate access to shared resources and market networks, enhancing collective resilience (Collazos et al., 2020). However, political favouritism and inadequate institutional support can limit the reach and effectiveness of these cooperatives, particularly for women and minority groups.

At the **macro level**, policies on land access and agricultural subsidies influence farmers' adaptive capacity. Inequitable distribution of subsidies and corruption in land administration often undermine the resilience of the most vulnerable households (Jones et al., 2010). Natural capital strategies, such as agro-processing innovations in fisheries, demonstrate how resource

utilization sustains livelihoods under climate stress. However, these practices are constrained by broader systemic issues, including underinvestment in rural infrastructure and lack of institutional support for small-scale producers.

8.1.1.1 Crop Diversification

Crop diversification is a strategic, multi-scalar response to environmental challenges, enabling farmers to cultivate a variety of crops within a single farm or cropping system. This approach mitigates risks and enhances resilience against pests, diseases, and adverse weather conditions. However, the ability to diversify is shaped by systemic inequalities and institutional dynamics: At the **micro level**, individual farmers rotate flood-resistant crop varieties to protect against seasonal flooding and maintain yields (Effiong, 2017). While this strategy protects against climate risks, poorer farmers often lack the financial means to purchase high-quality seeds or invest in adaptive practices, exacerbating disparities in resilience.

At the **meso level**, cooperative societies play a crucial role by facilitating access to diverse seed varieties and providing technical support to farmers. These collaborative efforts strengthen collective resilience but are often hindered by socio-political hierarchies that exclude marginalized groups, such as women and landless farmers, from fully benefiting from cooperative programs.

At the **macro level**, government agencies and NGOs support cooperatives by providing agricultural subsidies and technical resources (Wilk et al., 2013). However, corruption and mismanagement often result in unequal distribution of these resources, reinforcing existing inequalities.

These multi-scalar practices highlight the potential for resilience but underscore the critical role of addressing power imbalances, exclusion, and governance failures to ensure equitable adaptation outcomes. By situating crop diversification within the broader political-economic

context, we can better understand the barriers to implementing sustainable and inclusive adaptation strategies in the Lower Niger River region.

8.1.2 Physical Capital

Physical capital, including infrastructure, tools, and equipment, is essential for farmers in the Lower Niger River region to adapt to climate-related challenges such as flooding, drought, and erratic rainfall. Investments in assets like storage facilities, irrigation systems, and flood control structures enhance agricultural productivity and strengthen resilience across individual, community, and regional levels (Bello et al., 2018). However, access to and the effectiveness of physical capital are often shaped by political-economic factors, including resource distribution, institutional capacity, and systemic inequalities as shown in Table 8.1.

At micro level, Individual farmers rely on localized tools and techniques to meet specific needs. For example, livestock farmers use cooling buckets to preserve perishable goods, minimizing spoilage and ensuring income stability. Irrigated farms leverage boreholes to maintain a steady water supply during droughts or inconsistent rainfall (Bello et al., 2018). These interventions are critical for sustaining livelihoods but are not equally accessible. Marginalized groups, including women and ethnic minorities, often face barriers such as limited financial resources or exclusion from credit systems. These disparities are further exacerbated by discriminatory land tenure policies and underrepresentation in decision-making processes.

At meso level, collective initiatives, such as bamboo embankments, play a key role in flood risk management and reducing soil erosion (Adhikari and Taylor, 2012). These shared resources enable communities to pool efforts and build resilience collectively. However, the success of these projects often depends on external funding and institutional support, which are unevenly distributed. Communities with stronger political connections or socio-economic status are

more likely to secure funding for infrastructure projects, leaving disadvantaged groups—such as non-indigenous populations—more vulnerable. This reflects the broader influence of governance structures and institutional dynamics on equitable access to physical capital. As noted by Brondizio et al. (2009), institutional frameworks and power relations significantly shape how resources are allocated and accessed, often perpetuating inequalities in adaptation capacities.

At Macro level, national and regional institutions significantly influence the availability and distribution of physical capital. Government policies supporting irrigation systems, drainage infrastructure, and flood control measures create an enabling environment for local adaptation. However, systemic issues like corruption, elite capture, and bureaucratic inefficiencies undermine these efforts. Subsidies and infrastructure investments often fail to reach the most vulnerable farmers due to favouritism and mismanagement. Additionally, large-scale infrastructure projects sometimes prioritize urban or industrial needs over rural farming communities, further widening the resilience gap. These governance failures limit the ability of physical capital to effectively enhance adaptation across scales.

Table 8.1: Response of climatic risk among farming group

| Scale | Rich Farmers | Medium Farmers | Poor Farmers (Disproportionate Impacts) |
|--------------------|---|---|--|
| Micro Level | <ul style="list-style-type: none"> - Access to modern machinery, high-quality seeds, and irrigation systems. - Can invest in flood control and soil conservation. | <ul style="list-style-type: none"> - Limited access to some machinery or basic irrigation systems. - Faces constraints in upgrading infrastructure. | <p>Lack of Tools and Infrastructure: Rely on manual labour and rudimentary tools, reducing productivity.</p> <p>- Inadequate Irrigation: Vulnerable to climate shocks like flooding due to lack of irrigation or flood protection.</p> |
| Meso Level | <ul style="list-style-type: none"> - Dominates community-based infrastructure initiatives, ensuring access to shared | <ul style="list-style-type: none"> - Can participate in community projects but faces competition for resources. - May struggle with | <p>- Exclusion from Collective Resources: Limited access to community-led infrastructure projects due to financial constraints or marginalization.</p> |

| | | | |
|--------------------|---|--|---|
| | resources like irrigation and mechanized tools. - Influences community development projects. | access to shared infrastructure due to limited influence. | - Lack of Extension Services: Struggles with accessing support to maximize physical capital, reducing adaptation effectiveness. |
| Macro Level | - Benefits from national policies that provide subsidized infrastructure (roads, irrigation, flood-control). - Can influence infrastructure development through political connections. | - Can access government programs, but the assistance may be less comprehensive. - Benefits from infrastructure investments, though limited. | - Policy Exclusion: National infrastructure projects often overlook smallholders. - Underinvestment in Rural Areas: Poor farmers lack access to the infrastructure necessary for resilience, as projects prioritize large-scale farming regions. |

Source: Author, 2023.

8.1.2.1 Adaptive Infrastructure for Resource Management

Physical infrastructure tailored to local needs is a cornerstone of resilience in the Lower Niger River region, enabling farmers to better manage resources in the face of climate challenges. Farmers have constructed elevated granaries and storage units from locally sourced materials such as bamboo and palm wood. These structures, designed to withstand flooding, protect critical agricultural assets like crops and seeds from water damage during peak flood seasons. Bamboo embankments, for example, regulate water intake on farmland, addressing issues like soil erosion and rising sea levels (Yasmeen et al., 2024).

Micro Level:

Individual farmers rely on coping mechanisms such as constructing elevated granaries from inexpensive materials like bamboo and palm wood. These structures safeguard personal harvests and seeds during flood seasons, ensuring that essential resources are preserved for consumption or replanting. As noted by Yorose (2019), poor farmers often depend on these low-cost solutions because they lack the financial means to invest in more advanced adaptive

infrastructure, such as irrigation systems or flood-resistant seeds. This disparity highlights the resource constraints faced by poorer farmers in building resilience against climate-induced challenges.

At Meso Level, Communities pool resources to implement shared coping strategies, such as constructing drainage systems and building communal elevated storage units. These initiatives help reduce the collective risk of post-harvest losses while fostering collaboration and resource-sharing among farmers. By working together, communities strengthen their ability to weather climate-induced shocks. Adhikari and Taylor (2012), such collective efforts play a critical role in enhancing resilience and ensuring that resources are utilized efficiently at the community level.

At Macro Level, regional and national policies play a vital role in scaling up these efforts. Government investment in flood-resistant infrastructure and financial support for local adaptations enhance the resilience of farming communities across broader geographic areas. However, systemic barriers, such as inequitable resource distribution, limited political representation, and bureaucratic inefficiencies, often hinder access for marginalized groups. For instance, communities with limited political representation may face barriers in accessing government-funded infrastructure, highlighting the need for more inclusive policy frameworks.

8.1.2.2 Water and Irrigation Management

Efficient water management is critical in the Lower Niger River region, where erratic rainfall and prolonged dry spells threaten agricultural productivity. Farmers are employing innovative irrigation techniques to optimize water use and sustain farming under increasingly variable climatic conditions. Affordable options, such as drip irrigation systems that deliver water directly to the root zones of crops, have proven effective in reducing water wastage. Solar-

powered and mobile irrigation pumps are also gaining traction as sustainable solutions, especially in areas with limited access to electricity (Okomba et al., 2023).

At Micro Level, Individual farmers adopt water management tools to maintain crop yields during periods of inconsistent rainfall. For instance, small-scale drip irrigation systems ensure precise water delivery, helping farmers minimize wastage and maximize efficiency, even in upland or remote areas. These solutions are particularly valuable for resource-constrained farmers seeking to improve productivity while conserving water.

At Meso Level, the community scale, shared irrigation systems enhance water distribution and reduce the financial burden on individual farmers. Collaborative initiatives, such as pooled investments in community-owned irrigation pumps or networks, promote equitable access to water resources. These systems foster collective resilience by enabling farmers to work together to address water scarcity and its associated challenges. As Barron et al. (2008) note, community-led irrigation projects strengthen social cohesion and improve overall water resource management.

At Macro Level, regional and national policies play a vital role in scaling up water management solutions. Government programs that subsidize irrigation equipment or promote water-saving technologies can significantly enhance adoption rates among farmers. Furthermore, investments in large-scale water infrastructure, such as dams and reservoirs, can support local irrigation efforts and ensure more consistent water availability. However, socio-political inequalities and institutional inefficiencies often hinder the equitable distribution of these resources, leaving marginalized and remote communities at a disadvantage.

8.1.2.3 Post-Harvest Storage and Community Support

Post-harvest storage systems are essential for preserving agricultural yields and maintaining food security in flood-prone regions like the Lower Niger River area. Farmers employ various strategies to safeguard their crops and ensure sustainability, including investing in facilities such as community seed banks, drying racks, and ventilated storage rooms to minimize losses and maintain crop quality (Ajeigbe et al., 2008).

At Micro level, Individual farmers benefit from affordable and practical storage solutions designed to meet their specific needs. For instance, drying racks and ventilated storage rooms help reduce post-harvest losses and maintain the viability of seeds for future planting. Additionally, drainage systems around individual farms play a vital role in protecting stored crops by preventing waterlogging and reducing soil degradation. These interventions ensure that farmers can secure their harvests and sustain livelihoods during periods of flooding.

At Meso level, resource pooling enables the establishment of shared storage facilities, such as community drying centres and seed banks. These collective efforts reduce post-harvest losses for multiple farmers while fostering collaboration and social cohesion. Community-based organizations often spearhead these initiatives, ensuring equitable access to infrastructure and technical knowledge. These shared resources are especially beneficial in addressing collective challenges, such as climate-induced crop losses, by creating a supportive network of resilience.

At Macro Level, support from government agencies, NGOs, and international organizations enhances the availability and quality of post-harvest storage infrastructure. Investments in regional food storage systems, such as large-scale granaries and flood-resistant warehouses, amplify the resilience of farming communities. However, inequitable access to these resources, particularly for marginalized or remote groups, highlights systemic barriers that must be

addressed. Chapman et al. (2003) emphasize the importance of targeted policies and equitable resource allocation to ensure that the benefits of post-harvest storage solutions reach the most vulnerable farmers.

8.1.3 Financial Capital

Financial capital plays a pivotal role in strengthening the adaptive capacity of farmers in the Lower Niger River region. It enables them to manage risks linked to climate change, irregular agricultural yields, and economic volatility. Without access to financial resources, farmers are often unable to invest in improved agricultural techniques, adopt new technologies, or recover from the financial strain caused by environmental challenges. Key strategies, such as savings networks, off-farm employment, and income diversification, are crucial for stabilizing household incomes and building resilience against climate-induced risks (Adeola et al., 2022).

At micro level, Individual farmers employ financial strategies such as savings networks and off-farm employment to stabilize their incomes and buffer against agricultural losses. These approaches enable them to manage economic risks and sustain their livelihoods during climate-induced shocks. However, poor farmers often struggle with limited financial capacity, reducing their ability to invest in adaptive measures like irrigation systems or resilient crop varieties. In contrast, wealthier farmers can access higher-quality inputs and resources, widening resilience disparities.

At meso level, Community-based financial initiatives, including savings groups and shared resource pools, enhance collective resilience by fostering collaboration and resource-sharing. Such strategies reduce the collective impact of economic and environmental shocks. However, power dynamics within these groups can create inequities, as wealthier participants often contribute more and may wield disproportionate influence over decisions. This can limit the

benefits for poorer members, highlighting the need for equitable governance structures within these initiatives.

At Macro Level, a broader scale, policies, NGO programs, and microfinance institutions play a crucial role in supporting farmers by providing access to credit, insurance, and subsidies. These measures enable farmers to adopt climate-smart technologies, recover from losses, and invest in long-term resilience. However, systemic issues such as corruption, bureaucratic inefficiencies, and unequal resource distribution often hinder the effectiveness of these programs. Addressing these challenges is essential to ensure that financial resources reach the most vulnerable farmers and contribute to equitable adaptation across the region.

8.1.3.1 Participating in Saving Schemes

Community-based savings groups, such as Osusu and cooperatives, serve as vital coping mechanisms for farmers in the Lower Niger River region, providing a financial safety net to navigate climate-induced risks. These schemes allow farmers to pool small contributions into collective funds, which can be accessed during times of need, such as crop losses caused by flooding or other extreme weather events(Adeola et al., 2022).

At Micro Level, individual households, savings schemes offer a buffer against financial shocks, enabling farmers to manage unforeseen expenses and emergencies. These funds help ensure that critical needs, such as food security or reinvestment in farming, are met after adverse events. However, poor farmers as described in chapter 7 often struggle to contribute regularly due to limited income, restricting their access to emergency funds. Wealthier farmers, on the other hand, can contribute consistently and withdraw larger sums when needed, further consolidating their economic stability.

At the community level, savings groups enhance resilience by fostering collective action, sharing financial knowledge, and increasing bargaining power. These dynamics align with Natarajan et al. (2022), who emphasize the role of collective action in strengthening community adaptation. However, power imbalances within these groups can lead to inequities, as wealthier farmers may dominate decision-making processes, leaving poorer members with fewer benefits and a diminished sense of agency.

Macro Level, Financial institutions and government policies supporting informal savings networks can significantly amplify their impact. By providing technical assistance, financial literacy programs, or matching funds, these entities can help extend the reach of savings schemes to underserved communities. Nonetheless, systemic barriers such as corruption, bureaucratic inefficiencies, and limited infrastructure disproportionately exclude marginalized groups from these opportunities. Addressing these inequities is critical to ensuring that savings schemes serve as inclusive tools for building resilience across socio-economic divides.

8.1.3.2 Investing in Income-Generating Activities

Income diversification is a vital strategy for reducing reliance on agriculture, especially in the face of climate-induced uncertainties. Farmers engage in activities such as small-scale trading, fish processing, or producing handicrafts to create supplementary income streams. These activities help stabilize household finances and provide funds for farm reinvestment and household needs (Hallegatte, 2014).

At the **micro level**, farmers use additional income from diversification to invest in agricultural inputs, such as improved seeds or irrigation systems, increasing productivity and resilience. However, poor farmers may face barriers like limited capital, markets, and credit access, which restrict their ability to benefit fully from diversification. Rich farmers as described in chapter

7, on the other hand, have more resources and flexibility to improve their farms and household infrastructure.

At the **meso level**, community-wide entrepreneurial activities foster local economic growth, creating jobs and reducing dependence on external markets. These activities help distribute economic risks, enhancing overall community resilience. However, poor farmers may lack the skills or capital to participate, leaving wealthier farmers with greater opportunities.

At the macro level, government and NGO support for income-generating initiatives—such as microfinance and training programs—promote rural economic development and help farmers adapt to climate change. However, structural inequalities persist, with poor farmers often having limited access to resources and markets. Addressing these disparities is key to fostering inclusive resilience.

8.1.3.3 Seeking Off-Farm Labour

Off-farm employment offers farming households a crucial alternative source of income, reducing their vulnerability to agricultural shocks caused by climate variability. Women often engage in domestic labour, retail, or construction, while men frequently migrate to urban areas or other agricultural zones for seasonal work. The income generated from off-farm labour contributes to meeting household needs, investing in farming activities, and building infrastructure resilience (Omirin and Okpara, 2018).

At the **micro level**, off-farm labour acts as a financial safety net for individual households during lean agricultural periods, helping them sustain their livelihoods (Ulrich et al., 2012). It provides an additional income stream that enables families to stabilize their consumption, fund agricultural investments, or save for future shocks. Poor farmers are disproportionately affected

at this level, as they often lack the resources or connections needed to access off-farm opportunities. They may also face barriers such as limited skills, discrimination, or high transportation costs that reduce their ability to participate in off-farm labour markets effectively.

In contrast, medium and rich farmers as described in chapter 7 are better positioned to leverage off-farm employment opportunities. They may have the education, networks, or financial resources to secure higher-paying jobs, and their households can often afford to spare labour without severely compromising farm productivity. These advantages allow them to reinvest earnings into their agricultural practices, further enhancing their resilience.

At Meso level, off-farm labour fosters economic mobility and supports local development. Remittances sent by those engaged in off-farm work contribute to community infrastructure improvements, such as schools, clinics, and transportation networks, which benefit the broader population. However, the benefits of these contributions are often unevenly distributed. Poor farmers may lack access to the same opportunities due to social and economic barriers, such as low literacy levels or exclusion from community decision-making processes.

Medium and rich farmers are more likely to benefit from the indirect effects of off-farm labour at the meso scale, as their higher economic standing enables them to take advantage of improved infrastructure and services. In some cases, these groups may even dominate local leadership structures, influencing the allocation of resources derived from community-wide remittances.

At the **macro scale**, policies that promote rural labour market development, vocational training, and skill-building programs can significantly expand off-farm employment opportunities. Such policies enhance regional economic stability and resilience by creating alternative income

sources for farming households. However, the unequal distribution of these opportunities often reinforces existing disparities. Poor farmers, particularly women and marginalized groups, are less likely to access government programs or benefit from national-level investments in rural development.

Medium and rich farmers are better positioned to capitalize on macro-level initiatives (Ulrich et al., 2012). They may have greater access to education and training programs or possess the resources to migrate to regions with better opportunities. Additionally, systemic inequities in policy implementation often favour more affluent or influential groups, leaving poorer farmers at a disadvantage.



Plate 8.1: Women working on Construction Site to Support Family.

Source: Author, 2022.

8.1.3.4 Prudent Spending and Financial Management

Prudent spending practices are emerging as a crucial financial strategy for enhancing resilience among farming households in the Lower Niger River region. Faced with the uncertainties of climate change, fluctuating crop yields, and economic instability, farmers are adopting careful financial management practices to safeguard their resources. These practices involve prioritizing essential needs, limiting discretionary expenditures, and planning budgets to ensure households can withstand periods of financial strain (Giupponi et al., 2022).

At Micro level, prudent spending helps families maintain stability during times of economic hardship. Farmers focus on essential expenditures, such as food, healthcare, and education, while minimizing costs related to non-essential activities. This deliberate allocation of resources enables households to stretch their budgets, ensuring they can meet basic needs even during crises. As Carney (2003) notes, such financial discipline strengthens households' adaptive capacity by allowing them to adjust their consumption patterns to match available resources. For example, some families compensate for income shortfalls by increasing their labour supply—either involving more family members in farming activities or hiring external labour. However, this strategy is influenced by household-specific factors, such as labour availability, soil fertility, and land size, which determine vulnerability to climate risks (Nkonya et al., 2015).

At Meso level, collective efforts to share knowledge and resources further enhance resilience. Farmers often collaborate to exchange financial management strategies, pool resources, and reduce costs. This sharing of best practices strengthens the broader community's ability to cope with economic and environmental stressors, fostering a culture of mutual support and collective resilience.

At macro level, policies and programs aimed at improving financial literacy and encouraging disciplined spending are critical(Ogujiuba and Okafor, 2013). Government initiatives and NGO programs that offer training on budget management, savings, and investment planning can empower farmers to make informed financial decisions. Additionally, policies that promote access to affordable credit and financial services can help farmers build a financial cushion, enabling them to better manage risks associated with climate change.

8.1.4 Human Capital

Human capital, encompassing skills, knowledge, and health, is a foundation of farmers' adaptive strategies. Local knowledge about planting techniques and environmental cues plays a key role in helping farmers adapt to climate variability. For instance, adaptive techniques like early planting enable farmers to mitigate risks of crop loss during unpredictable flood events, thereby sustaining yields (Cairns et al., 2012). Skill-building and health initiatives also contribute to human capital, equipping farmers with expertise in climate-smart practices and reducing productivity losses due to health issues related to climate impacts(McDermott and Grace, 2012).

8.1.4.1 Early Planting

Early planting is one of the most effective adaptive strategies employed by farmers to mitigate the impacts of flooding and unpredictable weather patterns. By planting crops ahead of traditional schedules, farmers can avoid peak flood periods, thereby reducing the risk of crop losses traditional schedules to avoid peak flood periods, thereby reducing the likelihood of crop losses (Cairns et al., 2012). However, the benefits of this strategy are unevenly distributed across socioeconomic groups, with poor farmers facing significant barriers at the micro, meso, and macro levels.

At the micro scale, individual farmers adopt early planting techniques to safeguard their livelihoods against climatic shocks. This involves adjusting planting schedules and, where possible, using improved crop varieties such as drought-resistant or early maturing seeds. However, poor farmers often lack the financial resources needed to purchase such seeds or the tools required for early planting. Consequently, they remain reliant on traditional seeds that are less resilient to climate variability, leaving their crops vulnerable to flooding or drought (SeinnSeinn et al., 2015).

At the meso scale, community networks and agricultural extension services play a crucial role in supporting early planting practices. These initiatives provide training on climate-smart agricultural techniques, distribute resources like seeds or fertilizers, and foster knowledge sharing among farmers. However, access to these resources is often inequitable.

Poor farmers may face financial barriers to joining farmer cooperatives or participating in extension programs, which sometimes require membership fees or attendance at training sessions. Additionally, medium and wealthier farmers are more likely to benefit from shared infrastructure such as communal irrigation systems or seed banks, which poorer farmers cannot afford to access or contribute to. This creates a structural imbalance, leaving poorer farmers reliant on less effective traditional practices while wealthier farmers capitalize on modern, community-supported resources.

At the macro scale, government initiatives and agricultural policies aim to promote early planting and adaptive farming practices through subsidies, research funding, and agricultural loan programs (Keshavarz and Sharafi, 2023). These programs often prioritize improving

access to climate-resilient seeds, enhancing irrigation infrastructure, and promoting agricultural mechanization to mitigate climate impacts.

However, systemic inequalities limit poor farmers' ability to benefit from these policies. For example, subsidies and loans often require formal documentation or collateral, which many poor farmers lack. As a result, wealthier farmers, who have the financial stability and social connections to meet bureaucratic requirements, are more likely to access government loans, improved seeds, and large-scale adaptive technologies.

8.1.4.2 Engaging in Community Health Support Systems

Health is intrinsically linked to agricultural productivity, and strengthening community health support systems is a vital coping strategy for building resilience to climate change. Farmers' well-being directly affects their capacity to work efficiently and implement adaptive farming practices, positioning health as a key aspect of human capital development. This section explores how farmers and farming communities engage with health systems at the micro, meso, and macro scales to address climate-induced health risks, while highlighting the disparities that limit equitable access to healthcare.

Micro Scale

At the micro scale, individual farmers and households engage with localized health initiatives designed to mitigate climate-induced illnesses. These include preventive measures such as malaria education campaigns and the provision of mosquito nets to combat vector-borne diseases, which often spike during flooding (McDermott and Grace, 2012). Additionally, farmers are trained in water purification techniques to prevent waterborne illnesses, a frequent consequence of poor water quality during floods.

Poor farmers face significant challenges at this level, as they often live in remote areas with limited access to healthcare facilities or cannot afford medical care. Illnesses caused by extreme

weather events reduce their ability to work, compounding their vulnerability to food insecurity and income loss. In contrast, medium and wealthier farmers are better equipped to cope; they have greater access to healthcare services and can invest in preventive measures like private health consultations or water filtration systems. These disparities underscore the unequal burden of climate-related health impacts on poorer households.

At the meso scale, collective health systems, supported by community health workers, non-governmental organizations (NGOs), and local institutions, play a significant role in addressing health challenges (Samuels et al., 2014). Initiatives such as health screenings, vaccination drives, and mobile clinics aim to provide essential healthcare to farming populations during high-risk periods. These programs are particularly valuable in reaching remote communities that lack permanent healthcare infrastructure. However, poorer farmers often struggle to fully benefit from these programs due to logistical and social barriers. They may reside in harder-to-access areas or lack awareness about available services. In contrast, medium and wealthier farmers are typically more connected to community networks, enabling them to access these resources more easily. Additionally, community-based health programs are sometimes skewed in favour of wealthier individuals, who may exert influence within local governance structures to direct resources to their regions.

At the macro scale, national health policies and infrastructure are critical in shaping resilience to climate-induced health risks. Government programs integrating health and climate adaptation—such as rural healthcare funding, disease surveillance systems, and emergency response plans—are essential for addressing vulnerabilities in farming communities (Mosadeghrad et al., 2023). However, systemic inequities often leave poor farmers underserved. Limited investment in rural health facilities means that healthcare centres in these

areas frequently lack essential staff, medicines, and diagnostic tools. This forces poorer farmers to rely on less effective informal health systems, leaving them more vulnerable to health shocks.

Medium and wealthier farmers, on the other hand, are better positioned to benefit from national health policies. They can afford to travel to better-equipped urban healthcare centres or access private health services, ensuring quicker recovery and sustained agricultural productivity. Wealthier farmers also often have greater political influence, enabling them to advocate for healthcare investments in their regions, further exacerbating the disparity in healthcare access.

8.1.4.3 Utilizing Traditional Knowledge for Adaptive Planting Techniques:

Traditional knowledge, passed down through generations, provides essential insight into managing the natural cycles of the Lower Niger River. At the **micro scale**, individual farmers use this knowledge to adjust their planting schedules based on seasonal patterns, river behaviour, and local environmental cues (Jellason et al., 2021). For example, farmers may time rice planting to coincide with the receding floodwaters, ensuring the crops benefit from the nutrient-rich silt left behind. This adaptive planting technique reduces the risk of crop failure due to unpredictable floods and erratic rainfall.

During the interviews, participants were asked about the community responses to the recurrent flooding events in the area. A noteworthy response highlighted by many was the establishment of community-led early warning systems. One participant explained, "Our early warning systems are built on the wealth of local knowledge we possess. They enable us to predict floods and alert one another quickly. This proactive approach empowers us to take necessary precautions and make informed decisions ahead of flooding, which is crucial for our disaster preparedness (Reid et al., 2014, Ostojic).

Participants identified various indicators that signal the likelihood of imminent rainfall and potential flooding. One participant shared, "We've noticed that when frogs begin to croak louder and more frequently than usual, it serves as an early warning sign. It's like an alarm for us, telling us something significant might happen soon." The croaking of frogs thus becomes an auditory cue that prompts community members to prepare for potential flood events. Similar observations have been noted in other studies, emphasizing the importance of local ecological knowledge in disaster preparedness (Berkes et al., 2000).

In addition to frog behaviour, respondents discussed other prediction strategies based on local observations. One participant mentioned, "We also watch for changes in the colour of the river. When we see it altering, it usually indicates that flooding might be on the way." Another added, "The behaviour of animals is important too. If they suddenly change their homes, we know something is off with the weather." These findings align with the notion that traditional ecological knowledge plays a significant role in risk assessment (Johnson et al., 2022, Ellis, 2024). Furthermore, participants emphasized the importance of rainfall duration in their early warning systems. "By keeping an eye on how long the rain lasts, we can gauge how severe the flooding might be," one respondent noted. This reflects the insights of previous research, which underscores the significance of monitoring weather patterns as part of community preparedness strategies (Kais and Islam, 2016).

At the **meso scale**, local farming communities exchange knowledge and practices, strengthening collective resilience. Community-based farmer groups and cooperatives play a significant role in disseminating traditional knowledge across wider areas, ensuring that more farmers can apply these adaptive techniques.

At the **macro scale**, institutions such as the government and academic researchers work to recognize and preserve traditional knowledge while integrating it into national climate adaptation policies and agricultural programs. These efforts at the macro level help promote

the use of indigenous knowledge as a core component of broader climate adaptation strategies, ensuring that this valuable resource is not lost and continues to inform resilience-building efforts across the region.

Together, these strategies highlight the importance of human capital at multiple levels. The micro-level practices of individual farmers, supported by meso-level community efforts and macro-level policy and institutional frameworks, work in tandem to build resilience and adaptive capacity in the face of climate change. These multi-scalar approaches ensure that farmers not only cope with immediate challenges but also have the tools and support necessary to thrive in the face of ongoing climate uncertainty.

8.1.5 Social Capital

Social capital, forged through networks, associations, and community institutions, is a critical resource in building collective resilience to flooding and climate change. It enables farmers to access support, share knowledge, and strengthen their capacity to adapt to environmental stresses through cooperation. Operating at multiple scales—micro, meso, and macro—social capital ensures that communities, particularly marginalized groups, are better equipped to face the challenges of a changing climate (Woolcock, 1998).

At the micro scale, individual farmers heavily rely on their immediate social networks—family, friends, and neighbours—to navigate climate-induced challenges. These informal networks provide essential support during climate shocks, acting as safety nets that offer resources such as financial assistance, food, shelter, and shared labour. The role of these networks in building resilience is well-documented, as they provide a buffer against the negative impacts of environmental stressors (Skaalsveen et al., 2020). For example, in times of flooding, families

and neighbours may come together to rebuild homes, share food, or temporarily support income-generating activities, enabling the household to recover more quickly.

At the meso scale, community-based organizations (CBOs), such as agricultural cooperatives, savings groups, and local support networks, play a pivotal role in strengthening collective responses to flooding and other climate-related stressors. These organizations enable communities to pool resources, share knowledge, and coordinate collective action in times of need. For example, agricultural cooperatives may facilitate bulk purchasing of flood-resistant seeds or provide a platform for farmers to exchange strategies for coping with floods.

At the macro scale, government policies that promote social inclusion and community resilience are vital for amplifying the benefits of social capital on a broader scale. When governments prioritize inclusive policies—such as funding community-led initiatives, supporting local cooperatives, and providing equitable access to resources—communities are better positioned to leverage their social capital to adapt to climate change. These policies ensure that vulnerable groups, including marginalized farmers, are not excluded from important resources and decision-making processes.

Additionally, supportive institutional frameworks enable local networks to thrive, further reinforcing social capital at the grassroots level. For example, policies that support social safety nets, such as food security programs or disaster relief efforts, can strengthen the collective ability of communities to respond to flooding and other climate shocks. By fostering cooperation across different social groups, these policies broaden the support networks available to vulnerable individuals and enhance the capacity for collective action in times of crisis (MacGillivray, 2018).

8.1.5.1 Leveraging Social Networks and Community-Based Organizations for Climate Adaptation

Social networks, including informal relationships between family members, neighbours, and community groups, are vital for supporting farmers during times of crisis as shown in Table 8.2. At the micro scale, these networks act as immediate lifelines in times of flooding, providing farmers with emergency resources such as financial assistance, food, and temporary shelter. In many cases, remittances from relatives working in urban centres are a significant source of financial support for rural households. These funds help farmers cope with the direct costs of flooding, such as repairing damaged infrastructure or purchasing seeds and tools for the next planting season (Bowen et al., 2020). Through mutual trust and solidarity, these networks foster an environment where resources are shared freely during critical periods.

At the meso scale, community-based organizations (CBOs) such as agricultural cooperatives and savings groups offer a more formalized mechanism for pooling resources. These organizations enable farmers to invest in climate adaptation strategies collectively, such as acquiring flood-resistant seeds, installing water storage systems, and improving farming practices. CBOs also provide a platform for knowledge exchange, where farmers share successful strategies and learn from one another. By coming together, members can secure access to agricultural support from external sources, such as NGOs, government initiatives, and private organizations. This collective action strengthens the community's capacity to adapt to climate impacts by ensuring a broader, more coordinated response.

At the macro scale, government policies and institutional frameworks that support social capital—such as promoting social inclusivity and community participation in disaster preparedness—are crucial (Meyer, 2018). These policies help ensure that marginalized groups,

such as women, ethnic minorities, and non-indigenous populations, are integrated into climate adaptation strategies. By fostering an environment that encourages the formation of community organizations and networks, these macro-level policies create the conditions for strong, resilient social structures that can support farmers during climate crises.

Together, these multi-scalar approaches—ranging from micro-level social networks to macro-level institutional policies—highlight the importance of social capital in fostering adaptive capacity and resilience. The role of social networks, community-based organizations, and supportive policies ensures that farmers are not only equipped to cope with the immediate impacts of flooding but also have the collective strength to build long-term resilience against climate change. Through these social mechanisms, farmers in the Lower Niger River region are better able to share resources, gain access to support, and strengthen their adaptive capacities in the face of environmental stresses.

Table 8.2 – Type of Capital, Vulnerability and Response Strategies

| Type of capital | Vulnerability | Response Mechanism |
|-------------------------|---|---|
| Natural Capital | Land fragmentation limits access, while flooding risks damage to crops and livestock. | <i>Land Renting and Crop Diversification:</i> Farmers rent additional land and diversify crops to manage fragmented land access and reduce climate risks. <i>Agro-Processing Techniques:</i> Use of drying and ice storage methods to preserve fish and seafood harvests. |
| Physical Capital | Limited access to infrastructure for storage, preservation, and water management. | <i>Enhanced Storage and Boreholes:</i> Farmers create post-harvest storage structures and dig boreholes to ensure water availability. <i>Bamboo Embankments:</i> Local infrastructure is adapted (e.g., bamboo embankments) to control water levels. |

| | | |
|--------------------------|--|--|
| Financial Capital | High vulnerability to income loss from crop failure; limited access to formal credit services. | <i>Savings Groups and Income Diversification:</i> Farmers join savings groups (e.g., cooperatives, "Osusu") for financial stability and engage in off-farm labour (e.g., women in construction) to diversify income sources |
| Human Capital | Insufficient training in climate-smart practices and health impacts from flood-related diseases. | <i>Skills Development and Health Programs:</i> Farmers receive training in techniques like bamboo embankment construction and participate in health initiatives to maintain productivity and adapt to climate stressors. |
| Social Capital | Marginalized groups often face exclusion from resource access and decision-making. | <i>Community Networks and Inclusive Planning:</i> Social networks provide emergency resources, cooperatives enable collective access to support, and community associations promote inclusive disaster preparedness for all, including women and minorities. |

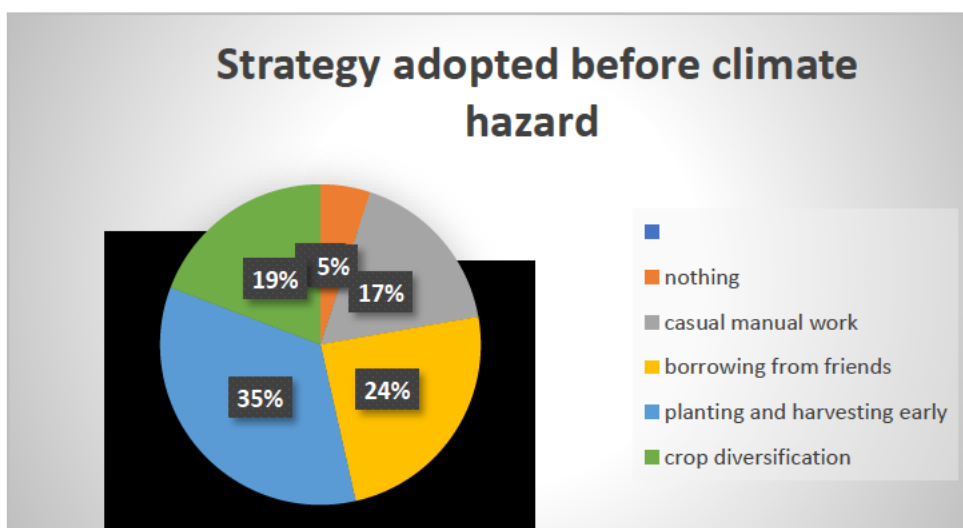


Fig 8.1 Coping Strategies.

Source: Author, 2023

8.2 Coping Strategies after Flooding

In the preceding section, we explored the various coping strategies employed by farming households in flood-prone areas, emphasizing the critical role of natural, physical, financial, human, and social capital in shaping their capacity to prepare for and respond to flood events. While these proactive mechanisms aim to mitigate flood risks and reduce vulnerabilities, the aftermath of flooding presents its own set of challenges, requiring households to adopt a range of coping strategies to rebuild their livelihoods and recover from the immediate impacts.

This section delves into the coping strategies employed by farming households in the aftermath of flooding, focusing on how they utilize the different forms of capital to manage the devastation. Financial capital plays a particularly important role, as many households must rely on available resources to address the urgent needs of food, shelter, and farming inputs. Simultaneously, human and social capital—through community networks, remittances, and labour contributions—are key to navigating the recovery process. The ability of farming households to adapt and recover depends not only on their existing resources but also on how they prioritize their responses in the face of limited financial means and the need for collective support. Through these adaptive responses, farming communities demonstrate their resilience and capacity to withstand climate-induced disruptions, reinforcing the significance of capital in building long-term climate resilience.

8.3.1 Increased Farm Labor: Human and Financial Capital

In the aftermath of flooding, farmers often increase their farm labour to recover from the devastation and restore their livelihoods. This response is primarily rooted in **human capital**, as it involves utilizing the labour available within the household or hiring additional workers to expedite the recovery process. The reliance on labour-intensive methods reflects a

combination of skills and local knowledge passed down through generations, helping farmers adapt to the challenges posed by floods (Nnadi et al., 2019b)

However, the ability to increase farm labour also draws upon **financial capital**, as households with sufficient financial resources are in a better position to pay for additional labour or invest in equipment to accelerate recovery. For instance, those with access to remittances or savings are able to engage labour forces and rebuild infrastructure more quickly, thus mitigating the long-term impacts of the flood on agricultural production (Peterson, 2018). Farmers with limited financial resources may face difficulties in securing labour and are forced to rely on available family members or cheaper labour options, which can extend the recovery period.

8.3.2 Reduced Daily Eating: Financial and Social Capital

In response to financial hardships following floods, many farmers adjust their daily eating habits to stretch their resources. This often involves reducing meals from three to two per day. This strategy primarily reflects **financial capital**, as limited funds force families to prioritize expenditures. In situations where income is significantly reduced, particularly after crops are lost, households must make tough choices about how to allocate available resources, often reducing food intake to ensure that other basic needs, such as shelter and clothing, are met (Peterson, 2018).

Furthermore, **social capital** plays a role in this response strategy. In many communities, extended family members and neighbours' step in to help, whether through sharing food or pooling resources to help each other get through difficult times. These networks provide an essential safety net, enabling families to better withstand food insecurity after a flood (Ahmodu, 2019).

8.3.3 Prioritized Spending: Financial and Social Capital

Farmers facing the aftermath of a flood must often prioritize spending to address the most pressing needs. This decision-making process is heavily influenced by **financial capital**, as households with more resources are better able to invest in the recovery of their farming activities. For instance, rich farmers may allocate funds toward purchasing new seeds, repairing equipment, or investing in flood-resistant infrastructure, ensuring that their agricultural activities can resume quickly and sustainably (Ndimele et al., 2024). In contrast, households with fewer financial resources might prioritize basic survival needs, such as food, while postponing investments in recovery measures.

Social capital is also important in shaping how spending decisions are made. Farmers who are part of community groups, cooperatives, or have strong family ties often leverage these networks to access shared resources or pooled funds for recovery efforts (Peterson, 2018). The sense of community and collective responsibility enables them to take a more strategic approach to managing limited resources, ensuring that recovery efforts are more inclusive and equitable.

8.3.4 Reliance on Remittances: Financial and Social Capital

Remittances are a crucial financial lifeline for many farming households, particularly after a flooding event. Farmers who receive money from relatives working in urban centres or abroad can rely on this influx of cash to cover daily expenses and invest in the recovery of their farms (Banerjee et al., 2011). This strategy is predominantly influenced by **financial capital**, as remittances provide the necessary funds to support the household's basic needs, pay for farm inputs, and rebuild after a disaster (Sikder and Higgins, 2017). The reliance on remittances also underscores the importance of **social capital**, as these funds are typically transferred within

family or community networks. Strong family ties and relationships with urban-based relatives enable farmers to secure these vital resources, which otherwise might be inaccessible. Families with strong social networks are often better able to weather the financial challenges posed by climate shocks such as floods(Banerjee et al., 2017).

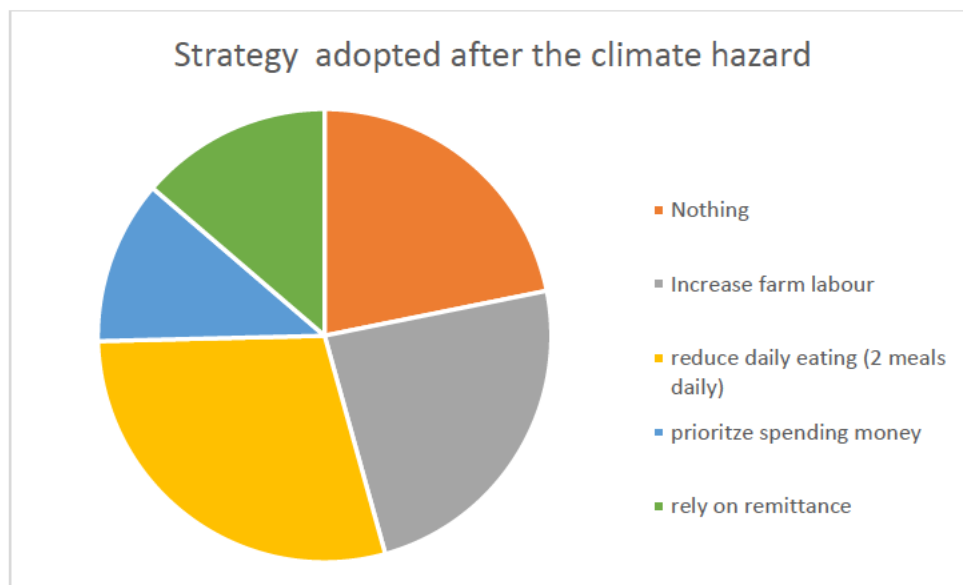


Fig 8.2- Strategy Adopted after Flooding.

Source: Author, 2023

8.3 Migration as Coping Strategies

Migration represents just one facet of the spectrum of adaptive responses individuals and households undertake in the face of environmental stressors or changing conditions. Different socio-economic systems display diverse levels of sensitivity to climate-related environmental changes, significantly influencing the likelihood of adaptive migration. Specifically, systems reliant on agriculture and natural resources, along with those situated in vulnerable environments such as low-lying coastal areas and small island states, are particularly prone to

fostering adaptive migration (McLeman and Hunter, 2010). These contexts, characterized by high exposure to climate-related risks such as flooding along with constrained livelihood opportunities, often compel people to seek migration as a means of coping with environmental challenges and securing sustainable livelihoods.

8.4 Ethnographic Insight into "Japa":

"Japa," a term with profound cultural and social significance, transcends its literal meaning. It encapsulates a collective yearning for enhanced living conditions and expanded opportunities, particularly among the younger generation. The concept of "Japa" signifies a deep-seated desire for a brighter and more promising future, driven by the numerous challenges and uncertainties faced by individuals and their communities. This aspiration embodies a sense of urgency, serving as a response to the evolving economic and environmental landscapes and reflecting the resilience and unwavering determination of those who consider it.

In the global context, the phenomenon of migration, particularly from sub-Saharan Africa to Europe, has been on the rise, with an estimated one million people making the journey in 2010, and the numbers increasing even further since 2016. Recent reports from the media indicate that Nigeria ranks among the top nationalities for migrants to the United Kingdom, alongside other countries like Bangladesh, Pakistan, China, and India, especially for sponsored study visas issued from September 2017 to 2022. This highlights the magnitude of the migration trend and the significant role it plays in people's quest for better opportunities and improved living standards.

While climate-related factors undoubtedly contribute to migration decisions, it is essential to recognize that non-climatic risks also influence household migration choices. In recent times, south-eastern Nigeria has grappled with security concerns stemming from regional neglect and agitation for change. The separatist groups in the region have instituted measures like the

weekly "sit-at-home" orders to draw government attention to the issues at hand. This situation has escalated tensions and crises, resulting in loss of life and property. It has disproportionately affected vulnerable groups such as women, children, and people with disabilities, who rely on natural resources for their livelihoods. Their limited access to these resources, due to the prevailing circumstances, has led to income loss hitherto increase in internal and international migration.

Migration abroad is driven by a multitude of complex factors that cannot be easily attributed to a single theoretical perspective (Buonfino, 2004). While various efforts have been made to explain migration through the framework of push and pull factors, Nigerians seek opportunities overseas for a wide range of reasons, including educational pursuits, employment prospects, and reuniting with family members. However, other critical factors also play a significant role in motivating migration, including climate disasters, changes in land use, fluctuations in food production, insecurity, land tenure issues, and food scarcity (Li and Samimi, 2022).

Economic opportunities emerged as the primary motivator for 'Japa' migration, reflecting individuals' desire to improve their financial prospects, which is consistent with neoclassical economics theory. Additionally, factors such as limited job prospects, desire for a better quality of life, and access to educational opportunities resonate with push-pull theory, highlighting the multifaceted nature of migration decision-making. The socio-economic characteristics of the respondents align with Asuah (2022), (Van Hear et al., 2020), which emphasize the interplay of economic opportunities, social factors, and environmental conditions in driving migration decisions. These theories suggest that individuals are motivated to migrate by a combination of factors, including the lure of better job prospects, the desire for improved living standards, and the need to escape adverse conditions such as political instability or environmental degradation. As evidenced by the survey findings, economic opportunities emerged as a primary motivator for 'Japa' migration, reflecting individuals' aspirations for enhanced financial

prospects and socio-economic mobility. Additionally, factors such as limited job prospects, political instability, and social unrest resonate with the push-pull theory, highlighting the complex interplay of push factors that compel individuals to leave their place of origin and pull factors that attract them to destination areas.

8.5 An Overview of the Types of Migration

Migration is a deeply ingrained human phenomenon, with historical roots that span across time and place. In Nigeria the intricacies of migration reveal distinct patterns shaped by various factors. Notably, both rural-to-rural and rural-to-urban migration patterns are significant (Akpuokwe et al., 2024). This is influenced by various factors such as economic opportunities, agricultural activities, and social dynamics within rural communities. Rural-to-rural migration often occurs due to factors like seeking better farmland, joining family members in rural areas, or escaping environmental challenges (Li et al., 2019). While urbanization has led to an increase in rural-to-urban migration due to the pursuit of better economic opportunities, education, and improved living standards in urban centres, rural-to-rural migration remains common, particularly in agricultural regions. Rural-to-rural migration is driven by the search for better farming prospects, access to land, and maintaining social and familial ties within rural areas. Intra-state migration, encompassing both rural-to-rural and rural-to-urban movements within the same state or district, is prevalent (Naidu and Benhura, 2015, Renzaho, 2016, Oyefara et al., 2022). Among these, rural-to-rural movements are frequent due to agricultural opportunities, while rural-to-urban shifts are increasingly common due to the attractions of urban life.

The dynamics of migration reflect a complex interplay of factors. Inter-state migration often involves a substantial portion of individuals moving from rural to urban areas, seeking better

opportunities and amenities available in urban centres. This phenomenon colloquially referred to as "Japa." signifies leaving a place to secure a better life representing the mass exodus of Nigerian households seeking refuge from poverty, insecurity, unemployment, kidnapping, and climate disasters. These factors, among others, contribute to the persistent movement of people from rural areas to urban centres in pursuit of enhanced economic opportunities, employment prospects, and improved living conditions. This internal migration trend endures due to factors like rural-urban disparities, the quest for employment, and access to educational opportunities in urban areas. Recent studies have indicated that more than 95% of the young population in Nigeria expresses a desire to migrate, driven by various motives including economic prospects, access to education, new experiences, concerns over corruption, security, personal freedom, religion, and other considerations (Laine, 2020). This migration dynamic profoundly influences the nation's livelihoods and economic development. Gender dynamics also play a significant role, with women constituting most of the migration flows within districts and states, while inter-state and international migration contexts often see a higher proportion of male migrants. However, gender patterns may vary based on specific regions and timeframes within Nigeria (Mitra and Murayama, 2009).

Seasonal migration in Nigeria is a temporary movement that occurs during specific times of the year, typically driven by agricultural or employment purposes (Nwobi, 2022). This type of migration involves individuals traveling to areas with seasonal work opportunities, such as agricultural harvesting or construction projects, and returning to their home regions afterward. Seasonal migration is often cyclical, with individuals moving to areas where their labour is in demand during seasons, such as planting or harvesting periods. In Nigeria, seasonal migration plays a significant role in the agricultural sector, where migrant workers may travel to rural areas to assist with planting, cultivating, or harvesting crops during peak seasons (Ayejoto et

al., 2023). Additionally, seasonal migration may also occur in urban areas, where individuals seek temporary employment opportunities in industries such as construction or hospitality during busy periods (Gwanshak et al., 2020).

Interestingly, in our study, overseas migration was notably lower compared to internal migration in the lower Niger region. The variance in migration patterns can be primarily ascribed to the region's proximity to major international markets, with Onitsha being a notable example. This proximity has given rise to a prevalent practice of cyclical labour migration to urban areas with capitalist opportunities. Specifically, within the scope of this study, which focuses on communities such as Odekpe and Umunankwo, it becomes evident that labour migration holds substantial prevalence. The data derived from the study illustrates that a noteworthy percentage of households in these communities, particularly Odekpe (22.2%), Umunankwo (31.8%), Oko (25.8%), and Okwe (20.2%), include at least one member engaged in long-term labour migration. To elucidate, "long-term migration" in this context refers to individuals who travel to other cities and reside there for an extended period, typically spanning five to seven years. Furthermore, the study indicates that 14.1% of respondents with small farm size said they have people who engaged in long-term migration; 19.2% of respondents with medium farm size said they have people engaged in long or seasonal migration while 15.7% of respondents with large farm size said they have people engaged in long or seasonal migration. The findings suggest that long-term labour migration is a prevalent phenomenon across households in the examined communities, regardless of farm size. It appears to be more common among households in Odekpe, Umunankwo, Oko, and Okwe, with a substantial percentage of families having at least one member engaged in long-term migration. Furthermore, the data indicates that farm size does not serve as a decisive factor in determining the occurrence of long-term or seasonal migration within households. This suggests that factors

beyond agricultural landholding, such as economic, social, or environmental considerations, may be driving individuals to engage in long-term migration.

The primary form of labour engagement for most migrants was found to be in casual jobs, particularly in markets and construction sites as shown in Plate 8.1 and 8.2. Significantly, women were also actively participating in the workforce, often involved in tasks such as carrying concrete, cement, and wood for building construction projects. For many, this served as an alternative source of livelihood, alongside their traditional roles in farming. Local labour opportunities mainly consisted of casual jobs in construction or semi-skilled trades, such as masonry and carpentry. Some household members also reported taking on roles as "Okada" (motorcycle taxi) drivers.

In the study area, a noticeable trend was the increase in family members working in urban areas over the past decade, driven by the aspiration of eventually establishing their own businesses or shops. This pattern was observed among males and has become a prevalent practice within many Igbo traditions. Typically, internal migration in the form of domestic servant serving a master for a period of five to seven years is common, with individuals being settled afterward. One participant shared the story of his son who had travelled to an urban center, served his master, and was subsequently settled. Now, he has individuals from their community serving him, with the intention of settling them after a similar period. This process has led to a significant movement of young people from the village to urban centres, and they often return to marry or bring other young people out of the village, perpetuating this migration pattern.



Plate 8.2: Farmer Taking on Bricklaying as Casual Work.

Source: Author, 2023

Table 8.4 Status of Migration

| N = 198 | | | | | | |
|--|--------|-----------|------|-----|-------|------|
| Migration status | Odekpe | Umunankwo | Okwe | Oko | Total | % |
| Long term labour migration (%) | 15 | 18 | 12 | 19 | 64 | 32.3 |
| Seasonal labour migration (%) | 8 | 10 | 7 | 12 | 37 | 18.7 |
| Family with Small farm (>0.5hac) by individual (%) | 5 | 9 | 6 | 8 | 28 | 14.1 |
| Family with Medium farm (0.5-1hac) (%) | 9 | 12 | 9 | 8 | 38 | 19.2 |
| Family with Large farm (>1hac) (%) | 7 | 14 | 6 | 4 | 31 | 15.7 |
| Total | 44 | 63 | 40 | 51 | 198 | 100 |

Source: Author, 2023.

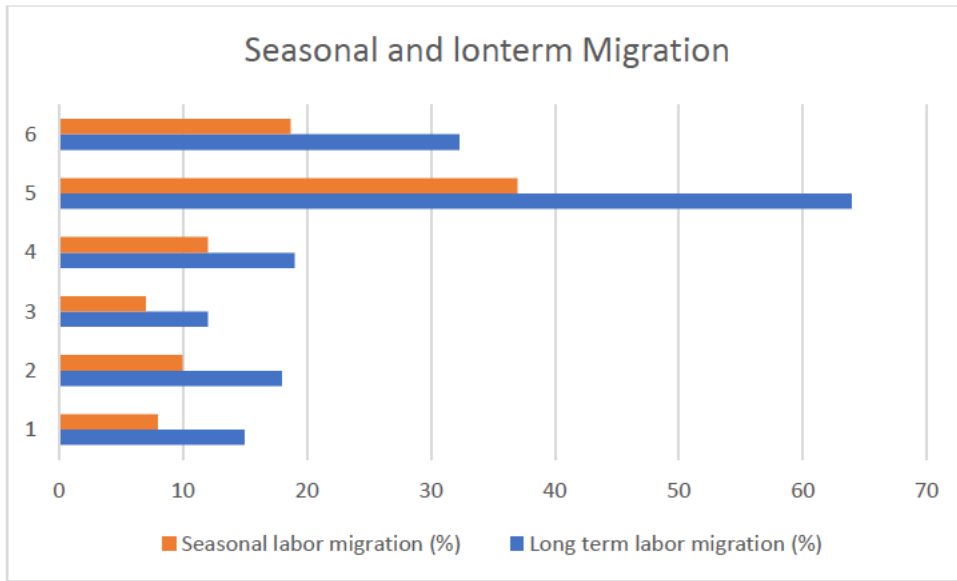


Fig 8.3. Seasonal and Long-term Migration

Source: Author, 2023.

8.6 Economic pressures which drive migration.

Nigeria, much like several other West African countries, has a rich history of migration, encompassing both internal and external movements. During the colonial era in Nigeria, which commenced in the late 19th century, colonial authorities implemented a range of economic and labour-related policies and practices (George et al., 2012). These policies aimed at serving various colonial objectives and had significant implications for migration dynamics. However, the methods and motivations for these policies often differed from one colony to another due to a myriad of influences, leading to the variation in their execution.

The overarching goal of colonial powers was economic exploitation of their colonies. Yet, how they pursued this objective exhibited substantial diversity, with the British colonial administration in Nigeria, for example, adopting distinct policies and practices compared to the French administration in neighbouring colonies. The specific conditions, available resources, and socio-political dynamics within each colony played a pivotal role in shaping the strategies

employed by colonial powers. These factors encompassed the presence of valuable resources, local population demographics, and pre-existing social structures, all of which influenced the approach taken by colonial authorities in labour recruitment and taxation.

Taxation and other economic policies were instrumental in generating revenue for the colonial administration. These policies occasionally acted as incentives for labour migration, as individuals sought employment opportunities in regions or sectors where they could better manage the tax burden. However, it is important to acknowledge the multifaceted impact of these policies on migration, as not all migration was directly linked to taxation.

Furthermore, the neglect of agriculture during the colonial period was part of a broader economic strategy that prioritized cash crops (such as cocoa, rubber, and palm oil) for export over food crops. This shift in agricultural focus resulted in significant changes in livelihoods, ultimately influencing migration patterns, as people explored alternatives to traditional subsistence farming.

The findings from the study reveals that pursuit of economic opportunities emerged as the primary motivator, with 29.8% of respondents citing this as their driving factor which underscores the significant role of economic factors in shaping migration decisions, reflecting the widespread desire for improved financial prospects among Nigerians. Other motivating factor driving 'Japa' migration is the political instability, with 16.2%, of respondents indicate as what influence their consideration of 'Japa' migration. This highlights the impact of governance and political dynamics on individuals' perceptions of security and stability within the country. According to Rudolph (2003) migration rests at the nexus of three dimensions of security, encompassing geopolitical interests, material production, and internal security. This suggests that aspirations for improved living standards and access to basic amenities motivate

individuals to explore migration as a means of achieving a better quality of life. Furthermore, governance issues, land tenure systems, and social inequalities contribute to individuals' perceptions of insecurity and instability, thereby driving migration aspirations. Rudolph's framework highlights the interconnectedness of economic, political, and social factors in shaping migration decisions and underscores the need for holistic approaches to address the root causes of migration. Social unrest and conflict were cited by 18 respondents (9.1%), underscoring the disruptive effect of societal tensions on decision-making. Additionally, limited job prospects were identified as a key determinant, with 41 respondents emphasizing the importance of employment opportunities in driving migration. The desire for a better quality of life also featured prominently, with 29 individuals expressing this sentiment.

8.7 Factors Mediating Migration Decision

The decision to migrate and enter the capitalist labour force is a multifaceted and intricate process. Respondents from four distinct communities of Odekpe, Umunankwo, Okwe and Oko. They expressed various reasons for family members' decisions to migrate. One common factor across these communities was financial insecurity, making it challenging to meet immediate food needs through traditional land-based livelihoods. However, these economic considerations were intricately connected to a web of secondary stresses, including the effects of climatic changes and political-economic shifts. Hence, attributing the decision to engage in wage labour solely to a single, proximate factor proves inadequate. Instead, this choice occurs against the backdrop of mounting agrarian and livelihood pressures. Moreover, the lack of effective governance systems often compels individuals to seek better opportunities abroad and, importantly, ensures that their children do not face similar challenges. Access to a quality educational system and broader opportunities is perceived as crucial for achieving these aspirations.

It is essential to recognize that the decision to migrate is a complex one influenced by both push and pull factors, as elucidated by De Haan and Zoomers (2005). For these individuals, livelihood decisions are a means of securing a living, and they employ everything within their capability to ensure a better future. Economic considerations, social networks, and personal aspirations all play significant roles in shaping migration decisions.

Another emerging narrative emerged across all socio-economic groups was increasing demand for cash to purchase an expanding array of products available in local shops. We align our argument with the work of Sugden et al. (2022), that the heightened demand for cash stems from the remarkable expansion of capitalist markets into regions that were once relatively isolated. This transformative process has increased the need for household cash, prompting many to turn to migration as a means of filling this financial gap. Farmers in particular expressed concerns about the rising cost of inputs, notably fertilizers, especially in regions where more input-intensive commercial cropping systems are prevalent. However, the overarching concern was the general rise in the cost of living which makes respondents across all communities allude to the fact of grappling with increased expenses related to education and medical care, particularly in the context of privatization. These rising costs have created a greater dependency on cash, further incentivizing migration as a strategy to meet these financial demands.

Access to family land plays a significant role in the decision for family members to migrate in Nigeria. However, when considering the increasing intergenerational disparities in accessing the means of production, a more complex picture emerges. This complexity arises from the prevailing issue of land fragmentation, which has implications for young people's ability to inherit land from their parents when they reach an age of independence. Often, these younger family members are left with smaller plots or, in some cases, without any land inheritance at

all. It's worth noting that it has been nearly three decades since the last land redistribution, and the population has significantly increased during this period.

The lack of access to land for young individuals was identified as a key factor in the decision to migrate by a noteworthy portion of the respondents. Specifically, 12% of respondents in Odekpe, 24% in Umunankwo, 30% in Okwe, and 34% in Oko pointed to this issue as a driving force behind their migration decisions. These findings underscore the importance of land access and its implications for migration patterns, particularly for the younger generation facing constraints related to land inheritance and fragmentation.

8.8 Climate and Flood Risk as Core Factors

Migration is significantly influenced by environmental factors, particularly climate change and flood risks. In regions vulnerable to extreme weather events, such as floods, communities often face devastating impacts that disrupt their livelihoods, infrastructure, and overall well-being. The increasing frequency and intensity of such events due to climate change compel many to relocate, either temporarily or permanently, in search of safer and more stable living conditions. However, migration cannot be reduced to climate and flood risks alone. It is inherently linked to a much more complex socio-economic and cultural context. Economic opportunities, access to education and healthcare, social networks, and political stability also play critical roles in the decision to migrate. Cultural ties, community support systems, and individual aspirations further shape migration patterns.

The perception of heightened climate-related stress was prevalent among nearly all respondents. Farmers expressed concerns about several climate-related issues, including reduced rainfall and an increase in flooding, which significantly impacts crop yields. Additionally, they noted the adverse effects of cold spells on crops, particularly tomatoes.

This highlights the interconnectedness of various environmental factors, such as land degradation, erosion, and changing weather patterns, which collectively contribute to the decision to migrate. These environmental challenges, when combined with other factors like economic insecurity and limited access to resources, further motivate individuals and families to seek opportunities elsewhere, both internally and internationally. Climate disasters act as one of the driving forces among a multitude of factors influencing migration in the region.

8.9 Socio-Economic Factors Shaping Migration Outcomes and Their Economic Impacts

Various socio-economic factors significantly shape migration outcomes in Nigeria, influencing both the economic benefits of migration and the capacity to cope with environmental challenges such as floods. Economic opportunities, social networks, and cultural ties are primary drivers of migration, determining the direction and nature of population movements. For instance, better job prospects, educational opportunities, and access to healthcare in urban areas drive rural-to-urban migration, while agricultural prospects and familial ties often encourage rural-to-rural migration.

Migration can bring economic benefits, such as increased income and improved living standards for migrants and their families. These benefits can enhance the capacity of households to invest in flood resilience measures, such as building more robust housing, creating savings for emergencies, and accessing better infrastructure. However, the economic impact of migration varies based on the socio-economic status of migrants. Wealthier migrants can more easily adapt and leverage economic opportunities, while poorer migrants might struggle to secure stable livelihoods, making them more vulnerable to environmental risks.

The 'Japa' migration in Nigeria recognizes that factors such as gender, ethnicity, socio-economic status, and geographic location intersect to shape individuals' migration experiences and opportunities. For Instance, women in the study area reported that during migration, they face gender-based violence including sexual harassment, assault, and exploitation, both during the journey and upon arrival in destination countries. Also, some of them especially the poor farmers may have limited capacity to access qualitative education and health care. In terms of ethnicity, the findings reveal that ethnic minority experience marginalization which impact on their access to education, employment, and social network. This findings aligns with the work of Pongponrat and Ishii (2018) which emphasises the pervasive nature of ethnic discrimination and its detrimental effects on individuals' opportunities and well-being. It highlights the importance of addressing systemic barriers and promoting inclusivity and diversity in policies and practices to ensure equitable outcomes for all members of society.

Furthermore, Individuals from lower socio-economic backgrounds may have fewer resources to migrate safely and may be more vulnerable to exploitation and poverty abroad. This highlight the finding of the work of Koser (2007), (Fischer et al., 2021), which underscore the disproportionate impact of socio-economic status on migration experiences and outcomes. It emphasizes the need for policies and interventions that address economic disparities and provide support for marginalized communities to ensure equitable access to opportunities and protection from exploitation in the migration process. Rich farmers who have the financial capacity can sponsor children abroad through educational migration while the poor farmers may face significant barriers in accessing such opportunities due to financial constraints. This disparity perpetuates existing inequalities in educational attainment and economic mobility, further marginalizing disadvantaged communities and reinforcing socio-economic stratification. As a result, educational migration often remains inaccessible to those from lower socio-economic backgrounds, exacerbating disparities in access to quality education and

opportunities for social advancement. This intersectionality highlights how environmental factors intersect with socio-economic status, geographic location, and other identity markers to shape migration decisions and experiences (Spitzer, 2016). For example, marginalized communities with limited resources may be disproportionately affected by climate change, exacerbating existing vulnerabilities and driving migration as a coping strategy. Therefore, the "Japa" migration trend among Nigerian youth could be a result of the compounding effects of socio-economic disparities, environmental degradation, political instability, and limited opportunities for economic advancement within the country. These intersecting factors create a complex web of push and pull factors that influence individuals' decisions to migrate in search of improved livelihoods, security, and opportunities abroad.

Another significant factor influencing migration decisions is the role of social networks. Respondents in our study frequently shared that families with members who have migrated abroad tend to have improved financial resources, which enables them to purchase additional land and support their parents and siblings. This financial stability fosters the creation of robust social networks within these families, which, in turn, serve as powerful encouragements for others to consider migration to different cities or abroad.

These social networks not only provide financial support but also offer guidance, connections, and knowledge about opportunities in other locations. They play a pivotal role in shaping the decision-making processes of potential migrants, influencing their aspirations, and reducing the perceived risks associated with migration. As a result, these networks act as vital mediators of migration decisions, reinforcing the idea that migration is not just an individual decision but often a family or community endeavour.

8.10 Impact of Migration on Household Community and Society.

The impact of migration on households, communities, and society is multifaceted and can have both positive and negative consequences. To effectively address the issues and maximise the advantages of migration, it is essential to comprehend these effects to establish effective policies and initiatives.

Firstly, 'Japa' movement reflect on the effect of population loss especially the young people and remittance dependency (Mberu, 2005). This undermines the social viability of community and represents underdevelopment of different community social amenities such as education, health, and electricity. Secondly, 'Japa' movement comprise of selected young population who are educated, energetic and innovative leaving behind inactive population made-up of children, elderly, illiterate and the infirm (Dhillon and Yousef, 2011, Oduor, 2021). Consequently, rural communities will be characterised with population made up of low social, economic, and educational status which are not productive and innovative. Migration is corresponding loss on field labour workers which is a threat to food security. Indeed, the 'Japa' movement and the mass exodus of people abroad have significant impacts on households, communities, and society at large (Sunam, 2017, Adhikari and Hobley, 2015). It is important to understand and consider these impacts beyond the initial euphoria of migration.

Firstly, the 'Japa' movement causes population decline, especially among the young population, which has several effects. As it depletes the workforce and shrinks the population pool of people who can contribute to community development, this population loss threatens the social viability of communities. Young people leaving the community frequently leaves it short on competent labour and innovative ideas. Moreover, the reliance on remittances from those who have migrated can create a dependency that may hinder the community's ability to develop its own social amenities, such as education, healthcare, and access to electricity.

Secondly, the 'Japa' movement tends to involve a selective group of young individuals who are educated, energetic, and innovative, leaving behind a population consisting primarily of children, elderly individuals, illiterate individuals, and the infirm. The surviving population may have poorer social, economic, and educational statuses, which might impede productivity and creativity. This demographic transition may result in imbalances in rural communities. Food security is also threatened by the loss of field labourers brought about by migration, as declining agricultural output may affect the availability of food resources.

Thirdly, because people borrow money from friends or sell up their assets, including property, in the belief that money sent back from overseas will help pay off the loan, the "Japa" movement frequently results in households accruing large amounts of debt. However, in cases where remittances do not materialize or are insufficient, the remaining family members are left to shoulder the burden (Gartaula et al., 2012).

“Since my husband left abroad, we have been managing the little resources; we sold our land to support his travel and now we do menial jobs to support our feeding and welfare”.

We argue that while this process serves as empowerment for household, it calls to question their morality as there is high policing of their behaviour which may result in self-restriction of mobility.

This can result in increased financial strain and the need for additional labour to support the family's basic needs and welfare. This situation might be particularly difficult since family members could be forced to work hard jobs or perform labour-intensive duties to make ends meet. Additionally, the reliance on borrowed funds and the associated financial pressures can have ethical implications and raise questions about the morality of such migration decisions. The need to repay debts and the societal policing of behaviour may impose restrictions on the mobility and choices of individuals, limiting their freedom and agency.

Fourthly, the workload of the remaining family members often increases as they bear the responsibility of managing household tasks and essential services in the absence of the migrant. Studies conducted in various countries, such as Thailand, the Philippines, and Vietnam, have shown that when remittances are not available to cover the costs of agricultural inputs, the workload on the remaining family members, particularly in rice farming households, intensifies which can have adverse effects on the well-being and quality of life of farmers. Moreover, the research conducted by He and Ye (2014), on the impact of migration on left-behind elderly individuals in China highlights that migration leads to a reduction in the available wage workforce, consequently placing a significant workload on the elderly population. This increased burden on the elderly can lead to a degradation of their well-being and overall welfare. The study emphasizes the need for institutional interventions that go beyond the traditional family roles and prioritize the care and support for all individuals involved, recognizing their inherent value as human beings.

In addition to the effects on households and communities, the 'Japa' movement also highlights and reinforces power dynamics and disparities between the global South and the global North. The migration trend underscores the stark differences in governance and opportunities between these regions, with a substantial number of individuals seeking better lives and opportunities in the global North for themselves and their families. This dynamic has implications for global politics, as it positions the global South at a disadvantage, where public trust may be misused, neglected, or abandoned, while the global North is perceived as a rescuer or a place of hope and opportunity. The 'Japa' movement thus sheds light on the complex interplay of power, governance, and socio-economic disparities between different regions of the world, highlighting the need for more equitable and inclusive approaches to address these issues and bridge the gaps between the global South and the global North.

8.11 Conclusion

Migration serves as a crucial response to various hazards, including but not limited to flooding, by offering individuals and communities a means to mitigate risks and seek refuge in safer environments. However, it's essential to recognize that flooding is just one among many drivers of change that compel people to migrate. Factors such as economic instability, political unrest, conflict, and environmental degradation also contribute significantly to migration patterns.

While migration can provide temporary relief and opportunities for adaptation, it's important to acknowledge its broader implications for livelihoods and resilience to hazards. The intensification of migration trends adds additional stress to already vulnerable communities, as they contend with the challenges of displacement, integration into new environments, and loss of social support networks. Moreover, migration may exacerbate inequalities and deepen socio-economic disparities, particularly for marginalized populations who lack resources and access to support systems.

To enhance resilience to hazards in the face of increasing migration pressures, it's imperative to adopt a holistic approach that addresses the root causes of migration and strengthens communities' capacity to adapt and cope with environmental changes. This includes implementing sustainable development strategies that promote economic diversification, improve infrastructure, enhance social protection mechanisms, and foster inclusive governance. Additionally, investing in education, skills training, and livelihood opportunities can empower individuals to build resilience and thrive in the face of adversity, reducing their reliance on migration as a coping strategy.

CHAPTER NINE

INTERVENTIONS

9.0 Introduction

This chapter provides a comprehensive summary of the findings, reflections, and contributions of the study conducted, encompassing four key sections. Section 9.1 presents a summary of the background issues that led to the undertaking of this study. It provides an overview of the context and motivations that prompted the research.

In Section 9.2, reflections on the study findings are presented, focusing on how they align with the objectives outlined in the thesis. This section highlights the key findings and insights gained from the research, providing a cohesive analysis and interpretation of the data collected.

Section 9.3 delves into the methodological and conceptual contributions of the study to knowledge. It discusses the innovative approaches, methodologies, or frameworks employed in the research process, shedding light on the unique contributions and advancements made to the field of study. This section emphasizes the value of the study in expanding the existing knowledge base and addressing gaps in the literature.

Moving forward, Section 9.4 discusses the policy implications and recommendations that emerge from the study. It investigates how the conclusions might assist with decision-making and the formulation of policies in pertinent fields. The section offers suggestions for potential methods or actions that could be used to solve the identified difficulties or take advantage of the identified possibilities based on the research findings.

Section 9.5 critically considers the limitations of the research and offers suggestions for further study. It acknowledges any limits or issues that were present during the research process and considers how these issues might have affected the results. Additionally, this section identifies areas for future research, highlighting potential avenues for further exploration and expansion

of knowledge in the field. By contextualizing the recent global transformation in environment-development-governance interrelations and examining the impact of neoliberal policies on resource extraction in Nigeria, this chapter contributes to the broader understanding of resilience in river-based livelihoods in the Lower Niger River. It underscores the need for a comprehensive and multiscale approach that considers the capacities and interactions of various actors in fostering sustainable development and enhancing the resilience of river-based communities.

9.1 Summary of Findings

The Lower Niger River region is confronting increasingly intricate challenges due to hydrological changes influenced by human activities and climatic variability. These changes significantly impact the livelihoods and well-being of communities reliant on the river's resources. This study aims to elucidate these complexities by addressing four primary research questions that explore different facets of adaptation and vulnerability in the face of flood risks.

Research Question 1: Assessing the socioeconomic vulnerabilities of farming and fishing households to recurrent flooding

In research question one, we ascertained that the hydrology of the Lower Niger Basin has undergone notable changes because of various human and climatic factors. Available data indicates that significant alterations have occurred in the region's water system, highlighting the complex interplay between human activities and environmental dynamics. The hydrological patterns of the Lower Niger Basin have changed due to human influences such as population growth, urbanization, and agricultural practices. The construction of dams, reservoirs, and irrigation systems, driven by the rising need for water for domestic, industrial, and agricultural uses, has impacted the quantity, distribution, and quality of water resources in the basin by altering the natural flow of water.

Additionally, the hydrological cycle has been directly impacted by changes in land use, such as deforestation, urbanization, and the conversion of natural landscapes into agricultural areas. These alterations to the land surface can lead to increased surface runoff, reduced infiltration, and changes in evapotranspiration rates, consequently affecting the availability and distribution of water in the basin. Extreme weather occurrences, temperature changes, and changes in precipitation patterns have also been noted in the area. Changes in rainfall patterns, extended dry seasons, and more frequent and severe flood events are all brought on by these climate alterations. The hydrological dynamics in the basin are further exacerbated by these changes, which affect water availability, flood hazards, and all other aspects of water management techniques.

The impacts of these hydrological changes on people's livelihoods have been significant and wide-ranging. Farmers have been particularly affected by flooding, which has led to crop damage, loss of arable land, and soil erosion, thereby reducing their productivity and income. Variations in rainfall patterns disrupt planting and harvesting seasons, leading to decreased crop yields and heightened food insecurity. Small-scale farmers bear a disproportionate burden compared to their medium and wealthy counterparts. Women, who often play key roles in agriculture and water collection, are also disproportionately affected by water scarcity and the additional burdens caused by hydrological changes.

Other vulnerable groups include minority ethnic communities and people with disabilities, who face compounded challenges due to existing social and economic marginalization. These groups are more susceptible to the negative impacts of hydrological changes because of their limited access to resources and inadequate infrastructure. The repercussions of hydrological changes are interconnected and can trigger cascading effects, exacerbating poverty and restricting access to essential resources.

Addressing these challenges requires comprehensive monitoring, analysis of historical data, and the integration of scientific knowledge with local observations and traditional practices. Effective water resource management and flood prevention strategies are essential for mitigating the impacts of hydrological changes.

Research Question 2: Role of land tenure inequalities in shaping households' capacity to respond to and recover from flood-related risks.

In research *question three*, we focused on examining how inequalities rooted in land tenure impact responses to flooding and vulnerability among river-dependent communities in the Lower Niger River region. Through our research, we aimed to shed light on the intricate relationship between land tenure disparities and the ability of communities to effectively respond to flooding events.

Our findings indicate that inequalities in land tenure significantly exacerbate the vulnerability of river-dependent communities to flooding in the Lower Niger River region. Specifically, marginalized groups such as tenants and landless farmers face heightened risks due to insecure land rights, which limit their access to resources and support necessary for effective flood response and recovery.

One key aspect of our research involved analysing the impact of insecure land tenure on the ability of communities to implement resilience measures. We found that without secure land rights, marginalized groups struggle to invest in land improvements and infrastructure needed to mitigate flood risks. Additionally, the lack of legal recognition of land rights hampers access to credit and government support for flood mitigation efforts, further exacerbating vulnerability.

We are aware that Nigeria's existing land policy discourages exclusive ownership of land, which makes it challenging for farmers to engage in large-scale farming and investment.

The Land Use Act of 1978 was enacted by the Federal Government of Nigeria in response to the challenges posed by the plural land tenure system and the difficulties in acquiring land for development and personal use. This has serious implications for livelihood as most households are landless while others are changing livelihood sources. The sad reality is that the current land policy undermines the land tenure system and creates restricted access to land.

Understanding the relationship between livelihood stress and flood risk is crucial for developing effective strategies to enhance resilience and reduce vulnerability. It is feasible to lessen the effects of floods and improve the resilience of communities in flood-prone areas by addressing livelihood stresses, putting sustainable land and resource management practices into practice, and offering assistance and resources to vulnerable groups.

Furthermore, our research highlighted the role of inclusive land governance frameworks in addressing inequalities in land tenure and enhancing community resilience. By involving local communities, especially women and minority groups, in decision-making processes, land policies can better reflect the needs and priorities of all stakeholders, thus promoting more equitable responses to flooding.

Research Question 3: Livelihood strategies employed by different groups (e.g., gender, socioeconomic status) to adapt to flood impacts, and assess their long-term sustainability.

To understand and assess the risks of damage from flooding, individuals and communities in the Lower Niger Basin rely on various indicators. These indicators help measure vulnerability and enable informed decisions regarding safety, livelihoods, and property. Through the examination of climate data encompassing temperature, precipitation, and runoff over a 30-year period, we have observed a changing climate that has impacted the region's hydrology. Additionally, a thorough examination of changes in land use and land cover during the same 30-year period (1991-2021) revealed considerable shifts in the landscape.

Between 1991 and 2001, the built-up area increased by 31.26% of the total land area, while the floodplain grew by 18.74%. Water bodies shrank by 1.44%, and vegetation was reduced by 48.56%. Over the subsequent decades, built-up land saw significant increases: 50.0% during the second study period (2001–2011) and 38.72% during the third study period (2011–2021). Using GIS, we built a flood susceptibility map by superimposing five indicators—land use/land cover, precipitation, elevation, slope, and drainage. This map shows various flood levels and locations, providing valuable insights for targeted strategies and interventions.

By combining traditional knowledge with scientific data, communities can better assess flood risks and develop effective adaptation measures. Indicators such as water levels, rainfall patterns, land use, and infrastructure vulnerability are critical in these evaluations. These assessments significantly influence livelihood decisions, including agricultural practices, housing, economic activities, and community preparedness. Effective water resource management and flood prevention strategies are essential for mitigating the impacts of hydrological changes, ensuring the sustainability of communities in flood-prone areas of the Lower Niger Basin.

Research Question 4: Community perceptions of flood risks influence adaptation decision

Research Question 4 focused on examining the response mechanisms adopted by households and communities to address the impacts of climate change, particularly the strategies employed to cope with the increasing risks of flooding. The analysis utilized a multiscale framework, as adopted by Natarajan et al., to assess coping strategies at the micro, meso, and macro levels. This approach provided a nuanced understanding of adaptation processes, while a political economy perspective was used to examine the power dynamics and patterns of exclusion affecting different social groups.

A key finding was the significant migration of individuals and families, commonly referred to as '*Japa*', to areas offering greater opportunities as a form of adaptation to climate-related challenges. This migration underscores the critical role of mobility as an adaptive response to environmental stressors, reflecting both the agency of affected communities and the structural inequalities that shape their choices. By integrating these frameworks, the study highlights how perceptions of risk, access to resources, and socio-political factors influence the strategies adopted to mitigate the impacts of flooding.

Response Strategies Adopted by Farmers Before Flooding

Before the occurrence of floods, farmers in the Lower Niger River region employ proactive strategies aimed at mitigating risks to their livelihoods from potential flood events. These strategies encompass a variety of approaches designed to enhance resilience and minimize the impact of flooding on agricultural productivity and economic stability.

One of the primary proactive strategies adopted by farmers is the establishment of early warning systems. These systems leverage local knowledge and observations to predict impending floods, enabling farmers to take timely preventive measures. Farmers closely monitor weather patterns, river levels, and other indicators to anticipate flood risks and prepare accordingly. Early warnings allow them to safeguard crops, livestock, and infrastructure, reducing the potential for damage and losses during flood events. Another key strategy involves crop diversification. Farmers cultivate a variety of crops with different growth cycles and flood tolerance levels. By diversifying their crop portfolio, farmers mitigate the risk of complete crop loss due to floods. Some crops may be more resilient to waterlogging or have shorter growth cycles, enabling farmers to maintain a steady income despite flood impacts on specific crops. Additionally, farmers engage in soil conservation practices aimed at enhancing soil structure and water retention capacity. Techniques such as contour ploughing, terracing, and mulching

help to reduce soil erosion and improve soil fertility, which is crucial for sustaining agricultural productivity in flood-prone areas. These practices not only mitigate the physical impacts of flooding but also contribute to long-term soil health and resilience against climate variability.

Ex Post Risk Management Strategies (After Occurrence of Hazard)

Following the occurrence of flood hazards, communities in the Lower Niger River region engage in ex post risk management strategies aimed at recovery and rebuilding in the aftermath of disaster. These strategies encompass a range of immediate responses and longer-term efforts to mitigate future risks and enhance community resilience.

Immediately after a flood event, communities prioritize emergency responses to ensure the safety and well-being of affected populations. This includes emergency evacuation of vulnerable individuals, rescue operations to retrieve those stranded or in danger, and providing temporary shelters for displaced families. These measures are critical in addressing immediate humanitarian needs and protecting lives during the initial stages of the disaster response.

Community Response

Community responses to flooding in the Lower Niger River region are characterized by collective action and mutual support networks, highlighting the resilience ingrained within these communities. In times of flooding, residents unite to mobilize resources and manpower swiftly, aiming to mitigate the impacts and aid those affected. Key aspects of these responses include community-based flood monitoring initiatives, which draw upon indigenous knowledge and local observations to predict and prepare for flood events before they escalate. This proactive approach not only enhances early warning capabilities but also empowers communities to take timely precautions to safeguard lives and livelihoods.

Additionally, community efforts often focus on establishing evacuation routes and emergency shelters, ensuring that vulnerable individuals have safe havens during flood emergencies. These

measures are crucial for enhancing community preparedness and reducing the potential for loss of life and property damage. Moreover, communities collaborate closely with local authorities and humanitarian agencies, fostering coordinated responses that optimize the distribution of relief supplies and support services to those in need. This collaborative approach leverages collective strengths and resources, reinforcing community resilience and adaptive capacity in the face of recurrent flooding challenges

Migration as an Adaptive Response

The study found that 'Japa,' or migration to more favourable regions, is a prominent strategy among households and communities facing the adverse effects of flooding and other climate-related challenges in the Lower Niger River region. Migration provides a means for individuals and families to seek better economic opportunities, more stable living conditions, and improved access to resources and services. This movement is driven by the need to escape areas that are increasingly uninhabitable due to recurrent flooding and other environmental hazards.

The study highlighted that migration could have complex implications for livelihoods, both for migrants and those remaining in flood-prone areas. In rural agricultural communities, where seasonal migration of skilled labourers is common, the departure of individuals in search of employment or improved living conditions can disrupt local livelihood strategies. This migration may lead to labour shortages, loss of local knowledge, and reduced agricultural productivity in flood-affected regions. Furthermore, the migration of skilled workers, particularly youth, from flood-prone rural areas to urban centres can exacerbate existing stresses on livelihoods and community resilience. This phenomenon often results in a "brain drain," depleting communities of valuable human capital essential for resilience-building efforts. Moreover, the outflow of productive labour from rural areas may weaken local

economies and social structures, rendering communities more vulnerable to future flooding events.

9.2 Contribution of the Study to Knowledge

This study has significantly contributed to both physical and human geography, providing a comprehensive and multifaceted perspective on the assessment of livelihoods, the impact of climate change, and the vulnerability of river-dependent communities. By integrating environmental and socio-economic dimensions, the research offers valuable insights into how communities that rely on river resources navigate and adapt to hydrological changes, land use patterns, and governance issues. Below are the specific contributions to each area of geography:

9.2.1 Contribution to Human Geography

The study enhances the understanding of human geography by delving into the socio-economic factors that shape the resilience and vulnerability of floodplain communities. Key contributions include the incorporation of a participatory methodology, engaging key stakeholders such as community members and the All-Farmers Association of Nigeria. This ensures that local knowledge and experiences are central to the findings, providing a rich, qualitative understanding of how communities perceive and respond to flooding. Furthermore, by examining variations in landholding, income, ethnicity, and educational background, the study highlights the complex interplay of factors influencing vulnerability. This approach goes beyond a simplistic analysis, offering a detailed view of how different groups within the community experience and cope with environmental challenges. Additionally, the research explores the behavioural dynamics of farmers and fishers during extreme weather events, adding depth to our understanding of human responses to environmental stressors. This includes how socio-economic and cultural factors influence adaptation strategies.

9.2.2 Contribution to Physical Geography

In the realm of physical geography, the study makes substantial contributions through its detailed climatic and environmental analyses. Utilizing terra climate data from the Climate Research Unit (CRU) dataset, the research conducts a 30-year analysis (1991-2021) of precipitation, runoff, and temperature trends. This long-term perspective provides crucial insights into the changing climatic conditions of the Lower Niger River region.

Moreover, by analysing land use and land cover changes from 1991 to 2021, the study reveals significant environmental shifts. This aspect of the research enhances our understanding of how land use patterns influence and are influenced by climatic and hydrological changes. The study also examines the physical processes driving vulnerability, such as changes in river flow and flooding patterns, contributing to a comprehensive understanding of the environmental factors affecting river-dependent communities.

9.2.3 Contribution to Livelihood Dynamics and Land Inequalities

The study significantly contributes to understanding livelihood dynamics and land inequalities by highlighting disparities in vulnerability among farming groups and the impact of land tenure inequalities. Small farmers, who face constraints related to individual land ownership and limited resources, are at higher risk compared to medium and large farmers with diversified land holdings. This disparity underscores how land tenure shapes vulnerability to environmental hazards like floods. Furthermore, the research sheds light on the heightened vulnerability of marginalized groups such as women, non-indigenes, and people with disabilities, advocating for equitable resource distribution and inclusive policies. Examining the social, economic, and cultural dimensions that influence adaptive capacity, the study emphasizes the need for adaptive strategies that not only mitigate flood impacts but also

promote social equity. Through a participatory approach, marginalized voices are incorporated into discussions, contributing to a more inclusive understanding of climate change impacts. This inclusivity is essential for developing equitable disaster response and resilience-building measures. By focusing on the socio-economic aspects of environmental hazards, the research underscores the importance of addressing systemic inequalities to strengthen community resilience in flood-prone areas.

9.2.4 Contribution to Migration Studies

The study contributes to the field of migration studies by examining environmental migration dynamics. It explores the phenomenon of 'Japa' (mass migration) as a response to flooding, providing insights into how environmental stressors drive migration decisions. By showing that migration decisions are influenced by socio-cultural contexts and collective experiences, the study challenges the critical rational choice theory, which posits that migration is solely based on individual cost-benefit analyses.

Additionally, the research analyses the implications of migration for agricultural productivity and community sustainability, offering a holistic view of how environmental changes affect human mobility and socio-economic stability. This perspective is essential for understanding the broader impacts of environmental change on livelihoods and community structures.

9.3 Policy Implications and Recommendations

Based on the research findings, the study indicates the need for significant structural reforms in policy action for building resilience in vulnerable communities. The study offers several policy implications and recommendations. These are intended to help these communities overcome the obstacles they confront and improve their ability to deal with and adapt to

environmental changes. By enhancing river-based livelihoods' socioeconomic, environmental, and institutional components, these interventions hope to ensure their long-term viability in the face of problems like climate change.

9.3.1 Integrated Land Use Planning: Effective management and allocation of land resources require careful planning of land usage. This process involves considering the interests and objectives of various stakeholders. Integrated land use planning helps identify areas suited for specific purposes, such as agricultural zones, protected areas, urban development, and infrastructure corridors. It also enables the integration of environmental considerations and promotes sustainable land management practices. To ensure a comprehensive approach to resilience building, policymakers should foster coordination across various sectors, including disaster risk reduction, infrastructure development, water management, and agriculture.

9.3.2 Sustainable Agriculture Practices: Promoting sustainable agriculture practices is vital for ensuring food production while minimizing environmental degradation. Agroforestry, organic farming, precision agriculture, and water-efficient irrigation systems are a few examples of climate-smart farming practises that can be supported by the government. Providing training, access to resources, and financial incentives can encourage the adoption of sustainable agricultural practices in the Lower Niger River basins. Sustainable agriculture practices are designed to enhance the resilience of farming systems to climate variability and change. Crops are more resistant to droughts, floods, and other extreme weather events because to practises like agroforestry and organic farming that enhance soil health, water retention, and biodiversity.

9.3.3 Flood Management and Resilience: Given the increased flood risks in the region, robust flood management strategies are imperative. This involves implementing measures such as floodplain zoning, constructing flood control infrastructure, improving early warning systems, and promoting ecosystem-based approaches to flood mitigation. Enhancing community resilience through awareness campaigns, evacuation planning, and the development of flood-resistant infrastructure is also crucial.

9.3.4 Water Resource Management: Integrated water resource management is essential for ensuring water security in the Lower Niger River basins. This includes enhancing the water supply and storage infrastructure, such as dams and reservoirs. Other crucial interventions include the implementation of effective irrigation systems, encouraging water conservation methods, and setting up systems for fair water distribution among various users.

9.3.5 Climate Change Adaptation and Mitigation: The region should prioritize climate change adaptation and mitigation measures to address the impacts of climate change on land use. This includes promoting reforestation and afforestation efforts to sequester carbon, implementing renewable energy projects to reduce dependence on fossil fuels, and incorporating climate considerations into land use planning and decision-making processes.

9.3.6 Stakeholder Engagement and Collaboration: Effective interventions require active engagement and collaboration among various stakeholders, including government agencies, local communities, non-governmental organizations, and private sector entities. Involving local communities in decision-making processes, providing platforms for dialogue and knowledge exchange, and fostering partnerships can lead to more inclusive and sustainable land use practices.

9.3.7 Integrating Indigenous Knowledge: The local population, through their indigenous knowledge system, has developed and implemented extensive coping strategies that effectively reduce vulnerability to flooding. Building resilience to floods has been achieved through these organized coping strategies. It is imperative for policy makers to recognize the value of this indigenous knowledge and integrate it into adaptation plans. This inclusive approach ensures that these time-tested strategies contribute to comprehensive and effective strategies for reducing the community's vulnerability to flooding.

9.3.8 Strengthen Land Tenure Security and Land Registration System: To address the pressing issue of land tenure insecurity, the government should initiate inclusive legal reforms aimed at ensuring secure land tenure for all, with a particular focus on marginalized groups such as tenants and landless farmers. This inclusive approach will guarantee that tenants and landless farmers receive legal recognition and protection of their land rights. By doing so, the risk of displacement can be significantly reduced, empowering these groups to invest in land improvements and resilience measures, thus bolstering their ability to withstand challenges such as flooding.

Moreover, it is imperative for the government to establish inclusive land governance frameworks that actively involve local communities, especially women and minority groups, in decision-making processes. By including diverse voices in land policy formulation, these frameworks can ensure that land policies accurately reflect the needs and priorities of all stakeholders, thereby promoting fairness and equity.

In conjunction with these efforts, the government should prioritize the development of efficient and accessible land registration systems. This system plays a crucial role in formalizing land ownership and reducing conflicts. Through streamlined registration processes and user-friendly

platforms, landowners, including marginalized groups, can easily register their land rights, thus fostering transparency and minimizing disputes.

9.4 Limitations and Suggestions for Further Studies

The study presented valuable insights and findings; however, it is important to recognize and acknowledge its limitations. Although these limitations were not explicitly detailed, considering potential shortcomings is essential for understanding the study's applicability and interpretation of its outcomes.

One potential limitation lies in the data sources used. The research heavily relied on datasets from climate research units, questionnaires, and interviews. These sources might have inherent limitations in terms of comprehensively representing the full diversity of experiences and perspectives across the entire Lower Niger region. Data sources can be subject to biases or may not capture nuances present in the local context.

Furthermore, the size and diversity of the study's sample may not adequately capture the entire spectrum of viewpoints and encounters related to climate change, flooding, water scarcity, and temperature fluctuations in the Lower Niger region. A larger or more diverse sample might provide a more comprehensive understanding of the issues examined in the study.

Additionally, the study may not have accounted for external factors or events that could influence the perceptions and experiences of the study's participants. Climate change, flooding, livelihoods, and water scarcity are complex issues that can be influenced by a wide range of factors, including government policies, economic fluctuations, and other ongoing developments within the region. Failing to consider these external factors might limit the study's ability to provide a holistic understanding of the challenges and opportunities related to climate change and environmental issues in the Lower Niger region.

The research methodology employed in this study, which utilized a mixed research approach, has provided valuable insights into the livelihood-environment-vulnerability crossroads in the lower Niger river Basin. By combining quantitative and qualitative methods, the study was able to capture a diverse range of perspectives and experiences from various actors involved in river-based livelihoods. However, there is a need for additional study employing a thorough quantitative strategy to delve further into the subject. Conducting studies that focus on collecting real-time data from different stakeholders and river-based parameters can provide a more comprehensive and detailed understanding of the issues at hand.

Researchers can get more accurate measurements and quantifiable data on many elements of river-based livelihoods by using rigorous quantitative methods, such as surveys, data collecting from monitoring stations, and statistical analysis. This would make it possible to examine vulnerability, resilience, and the effects of environmental factors on livelihoods in a more thorough manner. Additionally, expanding the scope of quantitative research to include a larger sample size and diverse locations within the Lower Niger River region would enhance the representativeness and generalizability of the findings. This would make it possible for researchers to spot any possible patterns, trends, or correlations among many communities and sub-regions.

Incorporating an in-depth quantitative approach alongside the existing mixed research methods can provide complementary insights and strengthen the overall findings of the study. It would help to advance knowledge of the intricate dynamics and linkages between livelihoods, the environment, vulnerability, and resilience in communities based along rivers.

While this study has shed light on the resilience of river-based livelihoods in the Lower Niger River region, there are still several avenues for further research to deepen our understanding and address remaining knowledge gaps. Here are some suggestions for future studies:

One area of research could involve analysing the effectiveness of existing governance structures and policies in promoting resilience in river-based livelihoods. This examination would include looking at the functions and responsibilities of various governmental bodies as well as the participation of non-governmental and community-based organisations. Researchers can make suggestions for improving policy implementation and stakeholder cooperation by pointing out gaps and problems in the current governance structures.

Another important area of study would be to explore the gender-specific impacts of hydrological changes and climate variability on river-based livelihoods. Understanding gender roles, access to resources, decision-making processes, and gender-based vulnerabilities is essential in identifying strategies for promoting gender equality and empowering women in resilience-building efforts. By examining the gender dynamics in river-based livelihoods, researchers can develop interventions that address the specific needs and challenges faced by men and women. Additionally, future research might examine the efficiency of community-based strategies in boosting resilience in river-based livelihoods. By studying successful case studies of community-led initiatives, researchers can assess their impacts on improving livelihoods, reducing vulnerability, and promoting sustainable practices. Another area of research could involve exploring integrated water resource management as a means of building resilience in river-based livelihoods. This would entail looking at how water-related policies, such as water allocation, water quality management, and flood control measures, are coordinated and integrated with livelihood issues. By assessing the impacts of integrated water resource management approaches, researchers can propose strategies for improved water governance and more effective resilience-building efforts.

Lastly, future research might examine the efficiency of various climate change adaptation strategies in the context of river-based livelihoods. This would include assessing the adoption and impact of climate-smart agricultural practices, water management techniques, and livelihood diversification strategies. By identifying barriers and opportunities for implementing adaptation measures, researchers can provide insights into best practices for building resilience in the face of climate change.

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Appendices

Appendix 1

Consent form for interviews and focus groups

Can be also recorded instead of the paper form

This information is being collected as part of a research project 'Resilience of River-Based Livelihoods in Floodplains Covering the Lower Niger River in Nigeria' conducted by the School of Geography, Earth and Environmental Science of the University of Birmingham, the United Kingdom Tertiary Education Trust Fund (TETFUND). The information which you supply and that which may be collected as part of the research project will be entered into a

filing system or database and will only be accessed by authorised personnel involved in the project. The information will be retained by the University of Birmingham and will only be used for the purpose of research and statistical and audit purposes. By supplying this information, you are consenting to the University storing your information for the purposes stated above. The information will be processed by the University of Birmingham in accordance with the provisions of the Data Protection Act 2018.

Please answer the following:

| | |
|--|--------------------------|
| 1. I am willing to give an interview | <input type="checkbox"/> |
| 2. I understand that the information provided by me in this interview will be used as confidential and only for research purposes | <input type="checkbox"/> |
| 3. If I will change my mind I can withdraw from the survey before or 2 months after the interview, and I may ask for my data will be destroyed within 2 months after the interview | <input type="checkbox"/> |
| 4. I consent the data from my interview will be stored by the University of Birmingham for 10 years | <input type="checkbox"/> |
| 5. I agree the interview will be electronically recorded | <input type="checkbox"/> |
| 6. I consent to take part in this study | <input type="checkbox"/> |

Signed by:

_____ Participant's name _____ Signature

In the presence of:

_____ Interviewer's name _____ Signature

Date _____

Appendix 2

PARTICIPANT INFORMATION AND CONSENT FORM

Title of the project: Resilience of River-Based Livelihoods on Flood Prone Areas covering the Lower Niger River in Nigeria.

Organisers: School of Geography, Earth and Environmental Science of the University of Birmingham, UK.

We would like to invite you to take part in a research study. Before you decide you need to understand why the research is being done and what it would involve for you. This Participant Information Sheet will help you decide if you'd like to take part. It sets out why we are doing the study, what your participation would involve. We will go through this information with you and answer any questions you may have. You do not have to decide today whether you will participate in this study. Before you decide you may want to talk about the study with other peoples. Feel free to do this.

What are the objectives of this research?

The aim of the research is to explore the impacts of livelihood and risks associated with flooding and see how these relate to coping strategies that people put in place to limit their vulnerability to flooding. The work will attempt to increase the capacity of local actors in designing and implementing adaptation program based on the context of local/river dependent communities.

What kinds of questions will be in the interview?

We would like to hear about your experience as a farmer/fisher in a river dependent community, what coping strategy is in place during flooding.

What will you have to do if you agree to take part?

1. We will arrange a time and a place to meet, which is convenient for you.
2. There will be one, single interview from a research assistant where he/she will ask you questions. The interview is expected to last 40-60 minutes and is a one-off event.
3. When we will have completed the study, we will produce a summary of the findings which will be more than happy to send you if you are interested.

How much of your time will participation involve?

One interview lasting 40-60 minutes.

Will your participation in the project remain confidential?

If you agree to take part, your name will not be recorded and the information which you supply and that which may be collected as part of the research project will be entered into a filing system or database and will only be accessed by authorised personnel involved in the project. The information will be retained by the University of Birmingham and will only be used for the purpose of research and statistical and audit purposes.

Will data received in interview will be published?

Results will be published in academic journals, policy papers, and mass-media.

What are the advantages of taking part?

You may find the project interesting and enjoy answering questions about your experiences. We will suggest recommendations for local and central authorities and international organizations how better support river dependent communities. We would appreciate if you will recommend what you think can be done to improve in a policy towards the river dependent communities.

Are there any disadvantages of taking part?

It could be that you are not comfortable talking about your experiences, but if you feel so you can withdraw any time of the interview, or you cannot answer questions which you find most sensible for yourself.

Do you have to take part in the study?

No, your participation in this project is entirely voluntary. You are not obliged to take part. If you do not wish to take part, you do not have to give a reason, and you will not be contacted again.

If I will change my mind to give an interview, can I withdraw?

You are free to withdraw before and at any time during the survey, interview, and focus group or up to one month after the survey.

What will happen if I withdraw?

If you withdraw from the study all the information and data collected from you, to date, will be destroyed. More so, a respondent has the right to request for their information if it is not used within a fixed period of one month after the interview.

How interview will be recorded?

We would like to take your permission to record you interview to the special recorder because it is important for us maximally follow the interview, but if you would prefer to do not record it electronically and just make notes you can ask for it.

The transcripts of the data will be undertaken by me at the University of Birmingham, the recordings will be deleted. The transcripts will be stored at the secure server of the University of Birmingham.

Where can I find more detailed information about your project and research team?

You can e-mail me [REDACTED]

What can I do if I am unhappy with any aspect of the study?

You can contact organizers of the study. If you have concerns about study in general, you can e-mail me

Consent

I am willing to participate in an interview for the project.

Appendix 3

QUESTIONNAIRE

Dear Sir/Madam

This questionnaire is designed to assess Resilience of River-Based Livelihood in Flood prone Areas Covering the Lower Niger River in Nigeria. I kindly request, that you provide the information required by placing a mark in the column and writing statement to answer that corresponds with your opinion of statements. I assure you that any information given shall be held in strict confidence and used for the purpose of this study.

SECTION A: IDENTIFICATION

1. Street Address.....
2. Name of Ward / Community.....
3. Name of Respondent (optional)

SECTION B: SOCIO-ECONOMIC AND DEMOGRAPHIC CHARACTERISTICS

4. Sex of the household head: (1) Male (2) Female
5. Age (in years): (a) less than 20 (b) 20 – 25 (c) 26 – 30 (d) 31 - 35 (e) 36 -40 (f) 41 -45
(g) 45 and above
6. Marital status: (1) Single (2) Married (3) Separated (4) Divorced (5) Widow
(6) Widower
7. Highest level of education: (1) No formal education (2) Primary/Standard (3) Secondary/Technical/Grade II (4) Post Secondary..... (5) Others
(specify).....
8. Religion (1) Christianity (2) Islam (3) Traditional (4) Others (specify).....
9. Ethnic Group: (1) Efik/Ibibio (2) Yoruba (3) Ibo (4) Ijaw (5) Others
(specify).....
10. Occupation (1) Fishing (2) farming (3) craftsmanship/self-employed (4) Civil Service

(5) Teaching (6) Trading (7) unemployed (8) others (specify).....

11. Average income of household head per month (in Naira): (1) Less than 10,000 (2) 10,000 – 19,999 (3) 20,000 – 29,999 (4) 30,000 – 39,999 (5) 40,000 – 49,999 (6) 50,000 and above.

SECTION C- RESILIENCE OF RIVER-BASED LIVELIHOODS

12. What are the hydrological changes observed in the study area? a) Reduction river Flow and river water b) Reduction in rain c) Changes in water quality d) Flooding
13. How many times have you experience flooding? a) no b) 1-3 times c) 4- 6 times d) 7- 10 e) 11and more
14. How many times have you experience flooding in the past 10years a) once b) Twice c) Thrice
15. To what extent has damage from flooding affected your livelihood a) Marginal loss c) Moderate d) Extreme
16. How can you measure the extent of damage from flooding of the following ecosystem service?

| Ecosystem Service | Marginal loss | Moderate | Extreme |
|--------------------|---------------|----------|---------|
| Water body/river | | | |
| Cultivated land | | | |
| Vegetation | | | |
| Floodplain/wetland | | | |
| Built-up area | | | |

17. What is the main source of livelihood a) Farming b) Fishing c) Trading?
18. How do you access support for farming a) Through government loan/grant b) Through co-operative c) Through fishers/farmers Union?

19. How many days can you're fishing or farming survive during flooding a) One week b) Two weeks c) Three weeks d) One Month e) One Month and a week
20. Do you agree that your livelihood can contribute to flooding? a) Yes b) No
21. Who owns the land that you cultivate? a) Individual b) Community c) Local Government
22. How do you access the land a) Buy from Individual b) Buy from Community c) Rent from Individual d) Rent from Community?
23. Do you use the same land all year round? a) Yes b) No
24. If no, how is it done a) renew rent yearly b) Wait for community to Subdivide land for rent c) Join farming/fishing groups to access land
25. How many times in the last 10years have you clear land for farming/ overgrazing on flood plain? a) once b) Twice c) Thrice d) All year round
26. How many occupations diversity do you have a) One b) Two c) Three d) Specify others-----?
27. How many types of crops do you cultivate, or do you fish subsistent or commercial? a) Single b) Mixed
28. Do you pay to fish on river? a) Yes b) No
29. If yes, who do you pay to a) community b) Fishers Union c) contribute to community development
30. Do you fish on common fishing ground, or do you cultivate mainly on flood plains or upland a) Common Fishing ground b) Flood Plains?
31. What strategy is in place to limit flooding a) Nothing b) Construction of embankment C) building away from the river?
32. What adaptation plan is provided during flooding No strategy a) Relocation b) Harvesting early c) Plant after the rains d) diversify livelihood to trade
33. **Section 1: Natural Capital**
34. How would you rate the availability of fertile farmland in your community? a) Very abundant b) Abundant c) Moderate d) Limited e) Very limited

35. Have you observed any changes in water quality in the river over the past few years?
a) Yes b) No c) Not sure

36. How frequently does flooding occur in your community? a) Very frequently?
b) Frequently c) Occasionally d) Rarely e) Never

37. **Section 2: Social Capital**

37. How well do community members collaborate and support each other in times of crisis or natural disasters? a) Excellent collaboration and support b) Good collaboration and support c) Moderate collaboration and support d) Limited collaboration and support e) No collaboration and support

38. Are there community-based organizations or groups that work together to address common challenges related to livelihoods? a) Yes, there are multiple active groups b) Yes, there is one active group c) There used to be groups, but they are no longer active d) No, there are no community-based organizations or groups

39. How well-connected is your community to external resources and networks, such as government agencies, NGOs, or markets? a) Well-connected b) Moderately connected c) Somewhat connected d) Minimally connected e) Not connected at all

40. **Section 3: Political Capital**

41. How satisfied are you with the governance and leadership in your community? a) Very satisfied b) Satisfied c) Neutral d) Dissatisfied e) Very dissatisfied

42. Do you feel that decision-making processes in your community are inclusive and participatory? a) Yes, decision-making is inclusive and participatory b)

Decision-making is somewhat inclusive and participatory c) Decision-making is limited to a few individuals d) Decision-making is centralized and exclusive d) Not sure

43. **Section 4: Economic Capital**

44. What is the primary source of income for your household? a) Farming b) Fishing
c) Livestock rearing d) Small business e) Other (please specify)

45. How easy or difficult is it for your household to access credit or loans for livelihood activities? a) Very easy b) Easy c) Moderately easy d) Difficult
e) Very difficult.

46. How do fluctuations in market prices impact your household's income and livelihood activities? a) Significantly impact b) Somewhat impact c)
Minimally impact d) No impact e) Not applicable

Appendix 4

Interview Questions for Research on Resilience of River-Based Livelihoods in Flood-Prone Areas of the Lower Niger River, Nigeria

Dear Sir/Madam

This Interview is designed to assess Resilience of River-Based Livelihood in Flood prone Areas Covering the Lower Niger River in Nigeria. I kindly request, that you provide the information required in the questions asked. I assure you that any information given shall be held in strict confidence and used for the purpose of this study.

Introduction

1. Can you please introduce yourself and describe your primary occupation related to the river?
2. How long have you lived and worked in this area along the Lower Niger River?

Impact of Flooding

3. How frequently do floods occur in your area?
4. Can you describe the most significant flood event you have experienced and its impact on your livelihood?
5. What are the main challenges you face during and after a flood event?

Livelihood Strategies

6. What types of activities do you engage in to sustain your livelihood (e.g., fishing, farming, trade)?
7. How do you adapt your activities during the flood season to mitigate losses?
8. Are there any traditional practices or knowledge that help you cope with floods?

Community and Social Networks

9. How does the community support each other during flood events?
10. Are there any local organizations or groups that assist with flood relief and recovery?
11. How important are social networks and community ties in building resilience against floods?

Government and External Assistance

12. What kind of support do you receive from the government during and after floods?

13. Have any NGOs or international organizations aided? If so, how effective was their support?
14. What improvements would you suggest for governmental or organizational support in flood management?

Economic Impact and Recovery

15. How do floods affect your income and economic stability?
16. What strategies do you employ to recover economically after a flood?
17. Are there any financial tools or resources available to help you recover, such as loans or grants?

Environmental and Infrastructure Considerations

18. How do changes in the river's ecosystem impact your livelihood?
19. Are there any infrastructure developments (e.g., dams, levees) that have helped or hindered your resilience to floods?
20. What role does environmental conservation play in your approach to managing floods?

Future Preparedness and Adaptation

21. How do you prepare for the flood season each year?
22. What changes or improvements would you like to see in flood management and preparedness in your community?
23. Are there any new technologies or methods you are considering enhancing your resilience against floods?

Personal Perspectives

24. How do you perceive the future of your livelihood in relation to the increasing frequency and intensity of floods?
25. What motivates you to continue living and working in this flood-prone area despite the challenges?

Closing

26. Is there anything else you would like to share about your experiences and resilience strategies related to floods?

27. Do you have any questions for me or additional insights you believe are important for this research?

These questions are designed to capture a comprehensive understanding of the resilience strategies employed by individuals and communities living along the Lower Niger River in Nigeria, emphasizing their experiences, adaptive strategies, and the support systems available to them.

Appendix 5

Untitled

Nodes

| Name | Description |
|---|--|
| Adaptation | How they are coping to the changes and what is needed for them to be able to respond and limit vulnerability to flood |
| Compensation | Any form of payment given to farmers/ fishers to offset for the damage and loss incurred during flood situation |
| government | |
| Individual | |
| NGOs | |
| Farming group (small, Medium and Large) | Farmers are categorized into distinct groups based on farm size. Also, how they get land for farming |
| Fishing and equipment | Fishing on open or common ground |
| Fishing gear | Big river used for communal fishing |
| open ground | Small river |
| hydrological changes | Noticeable changes that affect behaviour of farming and fishers. This could be in terms of rising temperature, changes in land use runoff and precipitation. |
| Precipitation | |
| Runoff | |
| Temperature | |
| Coping strategies | This includes various strategies during and after flooding |
| Impact of hydrology changes | What negatively affect them because of the changes in the hydrology |
| Duration of stay | Number of years living in the community |
| Flood situation | |
| Frequency | Number of times experience flood |
| Frequency (Years) | Year of flood occurrence |
| Impact | Impact of flooding on livelihood |
| In the last 10years | Number of times experience flood in the last 10years |

| Name | Description |
|---------------------------|--|
| Severe flood year | The year that they experience severe flooding |
| Intervention | What is needed to be in place to solve the problem |
| Location of farming | Knowing if they Cultivate on wetland or highland or both |
| livelihood change | |
| Source of livelihood | What the depend on for livelihood. if they have additional source of livelihood. It could be the main or alternative source. |
| Alternative | Any other site source of income |
| main | The main work of respondent |
| Risk assessment | What can be used to assess vulnerability of the people to flood in the community |
| Types of cropping | The type of plant cultivated in the farm, if single/mono cropping is cultivated to mixed cropping |
| Mixed | |
| Single crop | |
| Risk Indicators | What is used to determine vulnerability or risk to flood |
| Risk of Livelihood | Understanding the extent of livelihood loss or damage. What makeup the damage. It could be hot weather, sea level rise, low rainfall |
| flooding | |
| Social group | Mention of any support from friends, church, farming/ fishing association and community groups |
| Vulnerability | The position at which a person or community is negatively impacted, deprived and marginalized. It could be no land tenure |
| climatic | |
| changing rainfall pattern | |
| type of loss and damage | What is damage or loss during flood situation |
| pollution | |
| Rising temperature | |
| Individual | The class or gender that is most affected during flood situation and includes children, women, physically challenged, men, migrant, |
| land | Land overuse Land clearing |

| Name | Description |
|---------------------------------------|--|
| Non-climatic | |
| gender inequality and marginalization | |
| IPOB sit at home | |
| land fragmentation | |
| post-harvest infrastructure | |
| Type of support | Any form of support that they receive to help the family and farming |

Appendix 6

Resilience of River Based Livelihoods in Flood Prone Areas Covering the Lower Niger River in Nigeria.

Data description

What types of data will be used or created?

Both Primary and Secondary data will be used. Primary data will source through questionnaire, Interview and Focus Group Discussion. Also, GPS will help capture coordinates of the area to delineate the study area. Time series data will show changes in hydrology and land use.

Secondary data will be sourced through government agencies and parastatal, textbooks, journals and other related publications

How will the data be structured and documented?

Data will be structured and documented using Computer software. The first one will be spread sheet which will document all reading titles, and the second one will be SPSS. using SPSS will ensure that all collected data are coded and stored for analysis. Furthermore, I will comply with archive guidelines in using archive work for my research

Data storage and archiving

How will your data be stored and backed up?

All paper data shall be coded and stored in an encrypted memory stick thereafter transferred into a password secured computer system. More so, I will ensure that all data are send to the cloud and a routine backup in USB and University of Birmingham Research store.

Is any of the data of (ethically or commercially) sensitive nature? If so, how do you ensure the data are protected accordingly?

Participant names will not be used at any time during the write up of data to ensure they remain anonymous. Also, the written thesis, including publication or output in the public domain which include participant stories and experience will be treated as confidential. If necessary, pseudonyms will be used.

Where will your data be archived in the long term?

Data will be stored in a secured folder in the University of Birmingham server which can be retrieved anytime and used for an alysis. All paper data shall be coded and stored in an encrypted memory stick thereafter transferred into a password secured computer system. when I published any paper, I will transfer it to the research Data Archive at the University of Birmingham to be set to prevent damage of data.

Data sharing

Which data will you share, and under which conditions? How will you make the data available to others?

Data will be shared through the University of Birmingham stored site at <https://edata.bham.ac.uk> where any datasets can be easily discoverable through search engines.

Appendix 7

School of Geography, Earth and Environmental Sciences Fieldwork Risk Assessment and Mitigation Plan (F-RAMP)



UNIVERSITY OF
BIRMINGHAM

Document updated 09-07-2020, for fieldwork under Covid-19 risk, to superceed previous versions

STAFF & DOCTORAL RESEARCH

Before commencing any field or practical work this form must be completed by the person undertaking the activity and approved by the Principal Investigator or Project Supervisor.

Where the residual risk (RR) score for an individual hazard is ≥ 8 , initial (Level 1) approval must be given by the Principal Investigator or Project Supervisor before referral to the GEES School Health, Safety & Environment Committee (SHSEC) for secondary (Level 2 and 3) approval - gees-safety@contacts.bham.ac.uk. The GEES SHSEC may consult subject matter experts and HoS before approval or refer up to H&S Manager/CHSEC.

All final approved forms should be submitted with any supplementary information to gees-safety@contacts.bham.ac.uk

| Fieldwork summary | |
|--|--|
| Project and/or Research Title: | The Resilience of River Based Livelihoods on Flood Plains Covering the lower Niger River in Nigeria. |
| Fieldwork dates (s) (or pattern of repetition): | January 2022- March, 2022 |
| Location (including country): | Anambra- Delta States, Nigeria |

| | |
|--|---|
| <p>Activity description: <i>(Broadly describe the activity in a paragraph or so. Full detailed methods/activities should be listed in a Safe System of Work at the end of the document)</i></p> | <p>The work will be composed of field data collection, observation, focus group discussion and interview.</p> <p>The first approach of data collection will involve administration of questionnaire to household heads. Furthermore, key in-depth interview will focus on farmers and fishers to assess flooding and how they measure risk associated with flooding, climate change and coping mechanisms.</p> <p>Focus group discussion will be held, and participants shall be drawn from different socio-economic groups especially farmers, fishers and women, men, youth and community leaders. During the focus discussion participants will respond to questions covering livelihood groups and most affected during flooding, how they assess risk of damage from flooding, what indicators they use to assess risk, and the role of women in community development; adaptation measures that come into play.</p> |
| <p>Risk assessment file name:</p> | <p>GEES_RAMP_Student_Cyrl Nigeria fieldwork</p> |
| <p>Date of assessment:</p> | <p>3rd September, 2021</p> |
| <p>Risk assessment completed by: <i>(Assessor – usually person carrying out activity, or fieldwork leader)</i></p> | <p>Cyrl Joseph Effiong</p> |
| <p>Risk assessment sign-off. This is determined from the overall project risk that is a combination of Residual Risk (RR) Scores for individual hazards calculated at the end of this form, potential risks of reputational damage, and other factors (e.g., experience with the procedures, competence of researcher, location of work, etc.) as outlined in the UoB RAMP guidance.</p> | |
| <p>Level 1. Residual Risk Scores = 1-6 Project PI or Supervisor</p> | |
| <p>Level 2. Residual Risk Scores = 8-12 SHSEC Rep/subject matter expert (who may escalate to CHSEC if required).</p> | |
| <p>Level 3. Residual Risk Scores = 15-25 CHSEC Rep via SHSEC</p> | |
| <p>Major residual risks <i>Give details of any activity where RR = 12-25</i></p> | <p>N/A</p> |

| | |
|--|-----|
| Reputational damage. Does the planned activity present potential risk to the reputation of individuals or organisation(s) involved? | N/A |
|--|-----|

| Contact details | | |
|---|---------------|----------------|
| | Name | Contact number |
| Field party leader: | Cyril Effiong | |
| Group Members: Identify first-aiders – (FA)* | Nil | Nil |
| School office contact: | Nil | Nil |
| Field base/accommodation: | | |

** at least 1 trained Field First Aider per group is required on all fieldwork, including day trips, where 'work' is done if the activity is part of a group work. Daytrips that are classed as 'visits' to non-remote areas are exempt. If no individual undertaking fieldwork is a First Aider, this should be included as a separate entry in the Risk Assessment below.*

| International/air travel | | |
|--|--|--|
| Destination country(s): | Nigeria | |
| Are all your overseas destinations safe to visit as defined by the Foreign & Commonwealth Office? Give colour code designation from the FCO Website: http://www.fco.gov.uk/ You should include all areas you travel to or through, including airport stops, regardless of whether you are planning to work or stay there. Continue to monitor FCO advice in the days before you travel, and regularly during your trip abroad. | Orange (Advice against all but essential travel) | |
| Has University Travel Insurance been applied for? This is required if any part of your journey is by aircraft (both UK and international destinations) or abroad. Apply online: www.travel.bham.ac.uk | Yes | |
| Have you checked if you have the appropriate visa and/or authorization for research and/or field work in an overseas destination? Check entry requirements and visa types in the relevant official Consulate/Embassy website of the country you plan to visit. | yes | |
| Please tick to confirm you have read the University's 'Travelling and Working Abroad Guidance', and completed the checklists within (https://intranet.birmingham.ac.uk/hr/documents/public/hsu/hsuguidance/24twa.pdf) | Yes | |

| | |
|--|-----|
| If the location for your activity is an EU country, have you applied for a free European Health Insurance Card (EHIC)? An EHIC is in addition to travel insurance. Apply online at: https://www.ehic.org.uk/Internet/home.do | Nil |
| Please consider whether you/your group are likely to encounter significant cultural differences when <i>travelling, working, and living</i> in your destination country, which may affect the safety and wellbeing of you, and others in your field party. You should include any risks to personal safety in the risk matrix table at the end of this form. | |

| Vehicles and driving | | | |
|----------------------|-----------------------|--------------------------------|------------------------------|
| Driver(s)*/company: | Vehicle registration: | Listed on Driver's Register**? | Insured for business use***? |
| Nil | Nil | Nil | Nil |
| | | | |

*if you are driving as part of your job, you should complete a 'Driving at Work' risk assessment - <https://canvas.bham.ac.uk/courses/23891/pages/risk-assessment-and-incident-forms>

**if using school vehicle, driver's licence(s) must be checked and logged with Jamie Peart

***if using own vehicle, insurance must include cover for business use

| Medical and first aid needs | |
|---|-----|
| Have medical forms been completed for all staff? <i>(Forms are completed on a voluntary basis and are to be held in accordance with Data Protection law and destroyed at end of fieldwork)</i> | |
| Any action required? (e.g. emergency medication to be carried) | No |
| Number of first-aid kits required*: (Each first aid kit is suitable for 20–25 persons) | Nil |
| Special medical supplies or equipment needed*? | Nil |
| Number and type of emergency shelters required*: (for remote and/or mountain environments - 2, 4, 8 and 12 person shelters available) | |
| | |
| | |

*Requests should be sent to Bethan Philips [redacted] or David Tubbs [redacted]

Communication plan

Keeping contact and checking-in

[Provide details of how party members will maintain contact with each other and supervisors/school contacts, including schedules for any regular/safe-return check-ins which may be needed, and what follow up action should be taken. Requirements will vary according to trip personnel, the level of risk associated with the location and complexity of the work. **Lone working** requires regular check-ins (hourly text or call) with appropriate person (e.g. supervisor, project member, friend or family), who should hold a copy of this form.]

I intend to be sending email to my supervisors updating him of the turns of event twice weekly till the fieldwork is completed. Also, I will be making WhatsApp calls from time to time to keep my supervisors updated.

| S/N | Activity | Explanation | Duration | Remarks |
|-----|-----------------------------------|--|----------|---------|
| 1 | Recognisance | I intend to issue letters to relevant authority (village head, youth leader and women leader). I will inform them about the date I want to resume my field study | 1 week | |
| 2 | Pilot survey | A mock survey is carried out to check the relevant of the questions | 1 week | |
| 3 | Recruit field assistant | I intend to recruit field assistant from the selected communities, train them on data collection and what is expected of them. | 4days | |
| 4 | Focus group discussion /interview | A consent form will be given, and participants will voluntarily join the conversation in the identified communities | 3 weeks | |
| 5 | Questionnaire survey | Systematic random sampling technique applied in a ratio 1:6 any | 2weeks | |

| | | | | |
|---|----------|--|-------|--|
| | | senior/elderly member of household will be interviewed | | |
| 4 | Feedback | Willing participants are given feedback about the outcome of the research in a town hall meeting | 1 day | |
| | | | | |
| Is ANY lone working planned or likely during the trip? | | | | |
| Mobile phones | | | | |
| [provide details of mobile phone coverage in the field area and any contingency that may be needed (e.g. 2-way radios*, satellite phone*)]. | | | | |
| <div style="background-color: #cccccc; width: 100px; height: 15px; margin-bottom: 5px;"></div> <div style="background-color: #cccccc; width: 100px; height: 15px;"></div> | | | | |

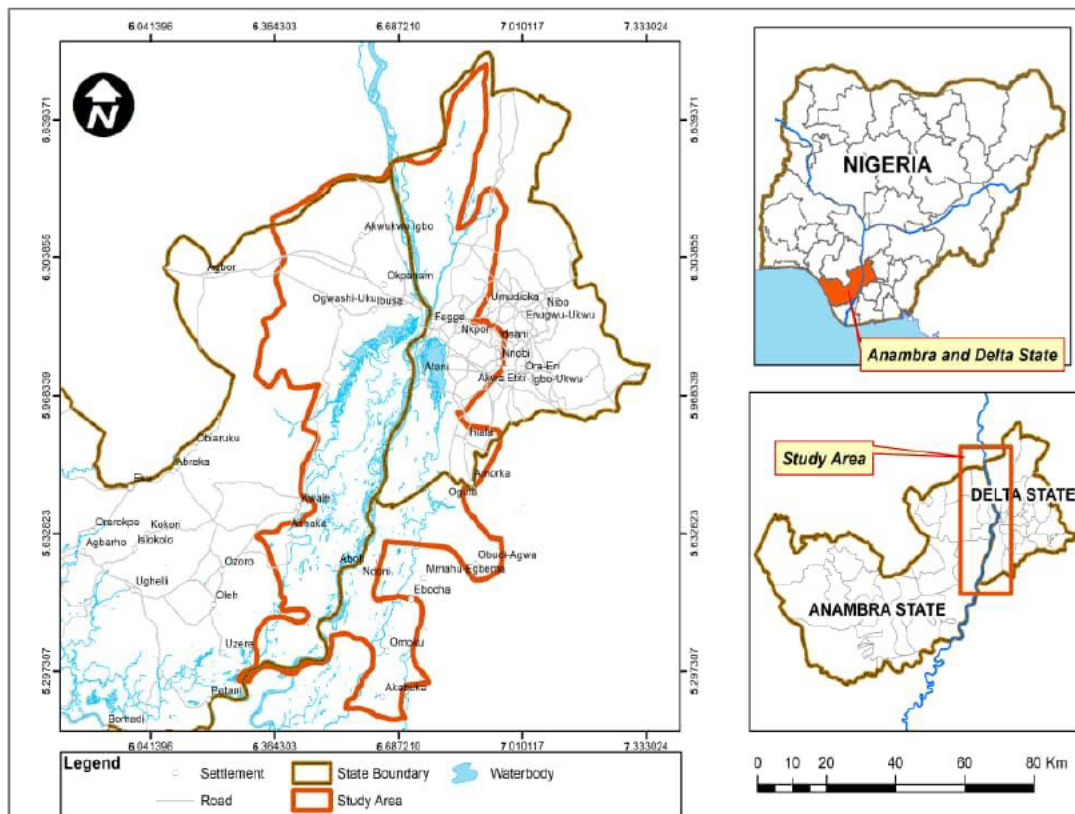
**Requests should be sent to Bethan Philips [redacted] or David Tubbs [redacted]*

Supporting local information

Description of location(s) and map(s):

Map of Nigeria showing the study area:

The study site is in two communities are Oko and Okwe of Oshmili South local government area of Delta State. The other two communities are Odekpe and Umunankwo located in Onitsha South, Anambra State, Nigeria.



Land use permission (as applicable):

[owner/manager name and contact details] Nil

Other (as applicable: N/A

Local emergency services (as applicable)

| | |
|---|---|
| Local A&E department: | <p>Holy Rosary Specialist Hospital and Maternity holyrosarysh@yahoo.com +234 (0)902 625 4435 Mission Road, Onitsha, Anambra State</p> <hr/> <p>Further list of international standard medical facilities is found below</p> <p>https://www.gov.uk/government/publications/nigeria-list-of-medical-facilitiespractitioners/nigeria-list-of-medical-facilities</p> |
| Local GP: (residential trips only) | N/A |
| e.g. mountain rescue: | N/A |
| e.g. Coastguard: | N/A |
| ... | |

Emergency response procedures

[Provide details of any procedure to be taken in the event of emergency including casualty evacuation...]

Emergency services to be contacted in the event of any emergencies. Holy Rosary Specialist Hospital and Maternity hospital (noted above) also has an ambulance service 234 (0)902 625 4435

Specific hazard reporting

| | |
|--|-----|
| Do you need to collect/return items from university buildings before/after fieldwork? | No |
| If yes, requests for access to buildings should be directed to Nick Kettridge [redacted] and Eimear Orgill [redacted] and should be made at least 48 hours in advance. This may require a separate Risk Assessment. Do not enter university Campus or buildings without prior permission. | N/A |
| Do manual handling activities take place? | No |

| | |
|--|-----|
| If yes, have you completed a manual handling assessment? (assessment must be appended to this form) | N/A |
| Will dangerous or hazardous equipment be used? | No |
| If yes, have you completed a Standard Operating Procedure? (SOP must be appended to this form) | N/A |
| Are chemical hazards involved? | No |
| If yes, have you completed a <u>C</u> hemical <u>H</u> azard and <u>R</u> isk <u>A</u> ssessment (CHRA)? (assessment must be appended to this form and approved by lab manager) | N/A |
| Are biological hazards involved? (e.g. sewerage works, farms, microbiological samples) | No |
| If yes, have you completed a Biological Hazard Risk Assessment? (assessment must be appended to this form and approved by biological safety officer) | N/A |
| Are compressed gasses to be used? | No |
| If yes, have you completed a COSHH and online safety course? (assessment must be appended to this form and approved by lab manager) | N/A |
| Will prohibited plants, plant pests, pathogens or soils be imported from outside of the UK? | No |
| If yes, have you arranged authorisation from the Animal and Plant Health Agency? (contact lab manager Eimear Orgill for further information and details of designated labs in GEES) | N/A |

| Hazard and Risk Scoring | | | | | | |
|-------------------------|---|----------------|------------|------------|----------|------------------|
| | | Likelihood (L) | | | | |
| | | 1 Rare | 2 Unlikely | 3 Possible | 4 Likely | 5 Almost certain |
| Severity (s) | 5 Catastrophic death or permanent/ irreversible health effects | 5 | 10 | 15 | 20 | 25 |
| | 4 Major injury long term incapacity and/or >14 days off work | 4 | 8 | 12 | 16 | 20 |
| | 3 Moderate injury requiring intervention and/or 4-14 days off work | 3 | 6 | 9 | 12 | 15 |
| | 2 Minor injuries requiring first aid and/or <3days off work | 2 | 4 | 6 | 8 | 10 |
| | 1 Negligible minimal injury not requiring first aid | 1 | 2 | 3 | 4 | 5 |

For **EVERY ACTIVITY**, you must identify the **POTENTIAL HAZARD**, the **HAZARD EFFECT**, and the **PERSON AT RISK**.

For **EVERY HAZARD EFFECT**, you must calculate the **RISK RATING**.

Initial Risk Rating (IR)
= Severity (S) x Likelihood (L)
Control measures required where $IR \geq 3$.

Residual Risk Rating (RR) is calculated after control measures. The highest RR contributes to the sign-off level.

Level 1 (RR = 1-6) PI/supervisor
Level 2 (RR = 8-12) SHSEC
Level 3 (RR = 15-25) CHSEC

Potential hazards may arise from your travel, your working environment, the operation/activity, equipment being used, substances, interaction with others, access to sanitation and personal facilities, tiredness, illness, hunger, or personal and cultural issues. Combinations of hazards may increase the hazard effect. Control measures may include safety equipment, communication plans, training and education, or method management such as Standard Operating Procedures or Safe System of Work. Examples of areas of risk are given at the end of this document.

The form includes pre-populated sections on Risks from COVID-19 that affect all fieldwork activities at the present time. However, it remains the responsibility of the individual(s) completing the form to assess all risks relating to the project including the pre-populated contents; you may need to revise these if they do not fit your planned activities.

Advice can be sought through subject matter experts (GEES Research Themes) or gees-safety@contacts.bham.ac.uk

USE YOUR RESIDUAL RISK SCORE (RR) TO COMPLETE THE SIGN-OFF SECTION AT THE START OF THE FORM

| Potential Hazard | Hazard Effect | Person At Risk Employee (E) Student (S) Visitor (V) Contractor (C) | Initial Risk Rating | Control Measures | Residual Risk Rating |
|--|---|--|---------------------|--|----------------------|
| (1) Psychological well-being in relation to Covid-specific activities | Anxiety and stress caused by concerns around returning to work and activities undertaken. | Employee, third parties | S2 x L2 = 4 | <p>1. Government: Coronavirus Guidance: Regular communication is in place (individual and group) via team meeting and one to one meeting to ensure staff and researchers are not ill-informed about returning to work safely.</p> <p>Advice is shared with staff members and staff have been fully briefed and kept up to date with current advice on staying protected through the University's lines of communications (i.e. line managers, Internal Comms) and shared with staff via team meetings and one to one meetings and the University's Coronavirus FAQs click here.</p> <p>Line managers are aware of how big changes to working arrangements may cause additional work-related stress and affect their employees' mental health and wellbeing.</p> | S2 x L2 = 4 |

| | | | | | |
|---|---|--------------------------------|--------------------|---|--------------------|
| <p>(2) Exposure from others due to:</p> <p>Living with someone with a confirmed case of COVID-19</p> <p>Have come into close contact (within 2 metres for 15 minutes or more) with a confirmed case of COVID-19</p> <p>Being advised by a public health agency that contact with a diagnosed case has occurred</p> | <p>Staff contract /transmit virus</p> <p>Staff do not report a member of their household has been confirmed positive for virus</p> <p>Staff are not displaying symptoms but have virus</p> <p>Staff do not report sickness</p> <p>Staff are unwell but attend work</p> <p>Staff absence</p> | <p>Employee, third parties</p> | <p>S4 x L2 = 8</p> | <p>2. PHE: Stay at home: guidance for households with possible coronavirus (COVID-19) infection</p> <p>3. PHE: Guidance for employers and businesses on coronavirus (COVID-19)</p> <p>4. PHE: COVID-19: guidance for employees</p> <p>All staff returning to work in any form have completed the University Mandatory Training on Canvas.</p> <p>Risk assessment shared with staff and an electronic copy is Retained on the GEEs shared drive for reference.</p> <p>Fieldwork can only be undertaken once written permission has been granted from the GEES SHSEC or College of LES CHSEC, depending on the level of residual risk.</p> <p>Where possible transport to fieldwork activities should be done so staff can remain separated e.g. lone travelling</p> <p>Do not come into work where someone you live with has been diagnosed or showing signs of virus</p> <p>Social Distancing - Reducing the number of persons in any work area to comply with the 2-metre (6.5 foot) gap recommended by the Public Health Agency on this link</p> <p>Taking steps to review work schedules including start & finish times / shift patterns to reduce number of workers at fieldwork site(s) at any one time.</p> <p>Redesigning processes to ensure social distancing in place, particularly in the use of vehicles and welfare facilities. Working back-to-back or side to side, rather than face to face.</p> <p>Line managers hold discussions with their staff to identify those considered in 'at risk' groups - which include those who are 70 or over, have a long-term condition, are pregnant or have a weakened immune system, are living/caring for someone in these groups or people in emerging risk groups e.g. ethnicity and will ensure additional measures are put in place to protect them including working from home.</p> | <p>S4 x L1 = 4</p> |
|---|---|--------------------------------|--------------------|---|--------------------|

| | | | | | |
|--|--|--|--|---|--|
| | | | | <p>Always Follow good hygiene measures (Potential Risk (4) Poor hygiene).</p> <p>Social gathering amongst employees have been discouraged whilst at work including meetings where alternative arrangements have been provided e.g. virtual meetings.</p> <p>Managers perform frequent evaluation against social distances controls. Staff are reminded daily of the importance of social distancing both in the workplace and outside of it.</p> <p>Where the social distancing guidelines cannot be followed in full in relation to a particular activity, consideration has been given to whether that activity needs to continue, and, if so, all the mitigating actions possible to reduce the risk of transmission between staff have been included in a task specific risk assessment and are being taken. Mitigating actions include:</p> <ul style="list-style-type: none"> • Further increasing the frequency of hand washing and surface cleaning. • Keeping the activity time involved as short as possible. • Using screens or barriers to separate people from each other. • Using back-to-back or side-to-side working (rather than face-to-face) whenever possible. • Reducing the number of people each person has contact with by using 'fixed teams or partnering' (so each person works with only a few others). • Re-engineering the technical activity. • Face coverings/visors and visors where appropriate <p>Large gatherings have been cancelled or postponed or alternative IT solutions provided. (Critical Training courses may still be performed but only following the Covid-19 guidance.)</p> <p>People who feel unwell should stay at home and should not attend work.</p> <p>Communicate to staff the importance of following national guidelines in staff briefings, email and share copies of risk assessment with staff.</p> | |
|--|--|--|--|---|--|

| | | | | | |
|---|---|---------------------------------|---------------------|--|--------------------|
| | | | | <p>Staff to inform the employer immediately of contact with anyone who has symptoms of virus or self-isolating or positive diagnoses.</p> <p>Emergency Procedures reviewed and revised including:</p> <ul style="list-style-type: none"> ▪ Communication: people have been made aware that in an emergency, for example, an accident or chemical spill or fire, people do not have to stay 2m apart if it would be unsafe. ▪ First Aid: First aid needs assessment reviewed to take into account any new Guidelines issued by the University or HSE, and first aid information including the location of first aid kits and first aider contact information up to date. ▪ Hygiene: Washing facilities with soap/gel should be identified where appropriate. | |
| <p>(3) Travel from other areas, including foreign travel</p> <p>– If you have recently been in/travelled through several areas you may be at greater risk of being exposed to coronavirus. There are some areas where travellers may be asked to self-isolate even if you have no symptoms, and other areas where we ask you to self-isolate if you experience symptoms, even if mild. Some areas might also be quarantined.</p> | <p>Staff do not report travel plans to / from a category 1 / category 2 area or a member of their household who has travelled to a category 1 / category 2 area. Staff contract / transmit virus.</p> | <p>Employee , third parties</p> | <p>S4 x L3 = 12</p> | <p>1. PHE: Stay at home: guidance for households with possible coronavirus (COVID-19) infection</p> <p>2. PHE: Guidance for employers and businesses on coronavirus (COVID-19)</p> <p>3. PHE: COVID-19: guidance for employees</p> <p>4. PHE: Guidance on social distancing for everyone in the UK and protecting older people and vulnerable adults</p> <p>5. Government: https://www.gov.uk/foreign-travel-advice/nigeria</p> <p>6. Government: FCO guidance on areas safe to travel to with appropriate precautions, and those unsafe to visit. https://www.gov.uk/foreign-travel-advice/nigeria</p> <p>Conduct PCR test 48hrs prior to travelling to Nigeria if fully vaccinated.</p> <p>Nigeria was removed from the red list countries by UK government which means upon returned you conduct PCR test 48hrs prior to departure. This is to further checkmate the spread of omicron virus.</p> <p>7. University's Coronavirus FAQs click here</p> <p>Report any travel plans to employer.</p> | <p>S4 x L2 = 8</p> |

| | | | | | |
|------------------|-----------------|--------------------------|--------------|---|-------------|
| | | | | <p>Follow guidance from relevant authority at time of travel, including University, Government and FCO. (Particularly because the advice will change, and we cannot monitor and update specifics here – see Potential Risk (8) below).</p> <p>Conduct PCR test 48hrs prior to travelling to Nigeria if fully vaccinated.</p> <p>Nigeria was removed from the red list countries by UK government which means upon returned you conduct PCR test 48hrs prior to departure. This is to futher checkmate the spread of omicron virus.</p> | |
| (4) Poor hygiene | Spread of virus | Employee , third parties | S4 x L2 = 12 | <p>1. PHE: Stay at home: guidance for households with possible coronavirus (COVID-19) infection</p> <p>2. PHE: Guidance for employers and businesses on coronavirus (COVID-19)</p> <p>3. PHE: COVID-19: guidance for employees</p> <p>4. PHE: Guidance on social distancing for everyone in the UK and protecting older people and vulnerable adults</p> <p>Wash your hands thoroughly and regularly (particularly when arriving on site, periodically throughout the day and when leaving site). Use soap and water for at least 20 seconds. Use alcohol-based hand sanitiser if soap and water is not available. Stringent hand washing taking place. Paper towels/hand dyers for drying of hands. See hand washing guidance.</p> <p>Avoid touching your face/eyes/nose/mouth with unwashed hands and cover your cough or sneeze with a tissue then throw it in the bin – Follow: “Catch it, Bin it, kill it” and to avoid touching face, eyes, nose or mouth with unclean hands.</p> <p>To help reduce the spread of coronavirus (COVID-19) reminding everyone has been made aware of the public health advice.</p> <p>Industrial antibacterial wipes for working outdoors and alcohol-based hand sanitising gel should be used where appropriate.</p> | S4 x L1 = 4 |

| | | | | |
|--|--|--|---|--|
| | | | <p>Staff advised to carry disposable tissues and if they need to do so, to cough/sneeze into a tissue and then to throw away in a suitable bin or bag for correct disposal (for example, disposing of solid waste from cleaning in yellow bins on campus)</p> <p>All staff are reminded not to shake hands, elbow bump etc.</p> <p>Vehicles will be cleaned by users with anti-bacterial wipes before and after use, this is to include frequently touched part e.g. steering wheel, gear stick, handbrake and door handles</p> <p>Lunch and refreshments should be brought from home where possible, to minimise non-essential travel.</p> <p>Staff are to be discouraged from wearing neck buffs or similar. These are often not washed frequently and can easily collect and transmit germs when working near colleagues.</p> <p>Proximity working (<2 m) should be avoided as much as possible, but in instances including heavy lifting, or first-aid, face covering, and disposable gloves must be always worn.</p> <p>Hand tools and instruments shall be allocated to individual staff members to reduce the risk associated with cross contamination. Where this is not possible, users access communal or shared equipment will be responsible for ensuring it is cleaned before / after each use.</p> <p>Cleaning rota for facilities and equipment used established where appropriate, using sterilising products and disposable wipes, notably of any high contact points such as doors, handles, work surfaces etc.</p> <p>Advice is shared with staff members and staff have been fully briefed and kept up to date with current advice on staying protected through the University's lines of communications (i.e. line managers, Internal Comms) and shared with staff via team meetings and one to one meetings and the University's Coronavirus FAQs click here</p> | |
|--|--|--|---|--|

| | | | | | |
|---|------------------------|---------------------------------|---------------------|---|--------------------|
| <p>(5). Staff show virus symptoms whilst at work</p> | <p>Spread of virus</p> | <p>Employee , third parties</p> | <p>S4 x L3 = 12</p> | <p>1. PHE: Stay at home: guidance for households with possible coronavirus (COVID-19) infection</p> <p>2. PHE: Guidance for employers and businesses on coronavirus (COVID-19)</p> <p>3. PHE: COVID-19: guidance for employees</p> <p>4. PHE: Guidance on social distancing for everyone in the UK and protecting older people and vulnerable adults</p> <p>Staff must inform their line manager if they develop symptoms. Absence will be managed in accordance with the University guidance provided. All staff are to understand the symptoms of COVID-19</p> <p>Line managers will maintain regular contact with staff members during this time and monitor for signs of symptoms in the remaining workforce and keep Senior Managers informed of the situation whilst following the Government’s guidance for contact tracing: contact with co-workers.</p> <p>Where possible, staff member displaying symptoms moved to identified clean & ventilated rooms / area until collected and 2 metre distance maintained from all other staff</p> <p>Cleaning an area with sanitiser after someone with suspected COVID-19 has left will reduce the risk of passing the infection on to other people</p> <p>The area where a person with suspected COVID-19 has been will be cleaned in accordance with the specific Government guidance and includes:</p> <ul style="list-style-type: none"> • Where possible the area will be closed and secured for 48 hours, before cleaning as the amount of virus living on surfaces will have reduced significantly by 48 hours • Disposable gloves, masks and aprons will be worn for cleaning. Deep clean of any rooms once evacuated. All waste that has been in contact with the individual – including tissues should be double bagged. The bag will be marked and securely stored for 72 hours then thrown away in the regular rubbish after cleaning is finished. | <p>S4 x L1 = 8</p> |
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| | | | | <p>Staff to self- isolate – journey home by car</p> <p>Report incident to line manager</p> <p>Staff have been encouraged to download the government COVID-19 contract tracing app.</p> | |
| <p>(6) Vulnerable third parties are exposed to illness</p> | Spread of virus | Employee , third parties | S5 x L2 = 10 | <p>1. PHE: Stay at home: guidance for households with possible coronavirus (COVID-19) infection</p> <p>2. PHE: Guidance for employers and businesses on coronavirus (COVID-19)</p> <p>3. PHE: COVID-19: guidance for employees</p> <p>4. PHE: Guidance on social distancing for everyone in the UK and protecting older people and vulnerable adults</p> <p>Where possible, travel to and from locations alone, to minimise direct contact in an enclosed space.</p> <p>Works planning ideally focuses on the use of media platforms/telephone therefore minimising any possible contact.</p> <p>Maintain 2 metre distance from colleagues when there is need to discuss work in person.</p> <p>When unavoidable or deemed necessary, wear a face covering when colleagues need to work closely together (i.e. within the 2-meter distance).</p> <p>Where appropriate, update all task specific Risk Assessments and Method Statements to address social distancing measures and submit to facility of buildings manager in advance of work date.</p> | S5 x L1 = 5 |
| <p>(7) Overnight stays</p> <p>Only possible when permitted by government guidance and has received permission from the university</p> | Spread of virus | Employee , third parties | S4 x L2 = 8 | <p>Government: what you can do after 4th July</p> <p>4. PHE: Guidance on social distancing for everyone in the UK and protecting older people and vulnerable adults</p> <p>Follow news for updates regarding potential changes to permissions for what you can do, and for potential local-scale lockdowns related to virus hotspots.</p> | S4 x L1 = 4 |

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| | | | | <p>Overnight stay permitted as an individual or with your own household or support bubble, or with member of one other household.</p> <p>In accommodation and venues for eating, follow guidance (above) on Potential Hazards due to:</p> <ol style="list-style-type: none"> (1) Psychological well-being in relation to Covid-specific activities. (2) Exposure from others... (3) Travel from other areas... (4) Poor hygiene. (5) Staff show virus symptoms whilst working. (6) Vulnerable third parties exposed to illness. (8) Changing virus situation where activities undertaken | |
| (8) Changing virus situation where fieldwork activities are undertaken | <p>Staff contract / transmit virus</p> <p>Staff enter area with restrictions due to Covid-19</p> <p>Staff working in an area that becomes locked down</p> | Employee, third parties | S3 x L3 = 9 | <p>Follow daily news updates about changing virus situation and changes to government advice.</p> <p>Check internet sites daily for changing guidance before undertaking activity, specifically:</p> <p>Government: Coronavirus Guidance: Government: Travel advice: coronavirus (Covid-19) https://www.gov.uk/foreign-travel-advice/nigeria</p> <p>Government: FCO guidance on areas safe to travel to with appropriate precautions, and those unsafe to visit. University's Coronavirus FAQs click here.</p> <p>Do not enter a locked down area for fieldwork; if work is undertaken in an area that becomes locked down, arrange to remain in the lockdown area until permitted to leave. Inform family and Line manager, as well as others involved in fieldwork project. Where possible, follow guidance above for (1) Psychological well-being in relation to Covid-19, (2) Exposure from others, (3) Travel from other areas, (4) Poor hygiene, (6) Vulnerable third parties.</p> <p>If develop symptoms whilst in lockdown, seek advice from local authorities (NHS direct or dial 111, or 999 for emergency).</p> | S3 x L2 = 6 |

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| (9) Road accident | Serious Injury | Employee third parties | S4 x L2 = 8 | Avoid travel when it rains or at night Check vehicle before any travel | S3 x L2 = 6 |
| (10) Flooding /sea level rise heavy rainfall | Serious Injury | Employee third parties | S4 x L2 = 8 | Stay in accommodation which is in a safe location and structurally sound. Always be aware of surroundings and a safe place to go to. Avoid travelling when it rains I understand the terrain, I will avoid flooded areas | S4 x L1 = 4 |
| (11) Political Instability/conflict | Serious injury | Employee third parties | S4 x L2 = 8 | Avoid going on field site when during conflict or demonstration. Research assistant will inform them that the study is strictly for academic purpose. Notify village head and community leaders before embarking on the fieldwork Avoid travelling to site during election, cultural festivals etc Choose research assistant that understands the culture of the area. | S4 x L1 = 4 |

| Safe System of Work: | | |
|-----------------------------|--|---|
| Possible Hazards | Details | Control Measures |
| Environment/location | Weather condition and language barrier | <ul style="list-style-type: none"> Be aware of flooding/fire escape routes and safe assembly points Use mobile phone satellite to know the weather. Hire research assistant to interpret to local communities Maps/sat-nav/directional aids Dial police contact number |
| Operational/activity | Travelling to and from site | <ul style="list-style-type: none"> Use rented/public vehicle Face coverings, Disposable gloves Weatherproof jacket & trousers Vehicle check and maintenance |
| Equipment | N/A | N/A |
| Substances | N/A | N/A |
| | | |

[Add rows as needed]

Checklist of possible hazards

| Environment/location | Operational/activity | Equipment | Substances |
|--|---|---|---|
| <ul style="list-style-type: none"> Weather conditions: – cold, hot, rain, snow, sun, wind Mountain, remote or wild country Cliffs, pits and quarry faces Steep or high banks On/in/near flowing or standing water Coastal or tidal areas Roadside working Urban or industrial areas Contaminated ground Wild animals, livestock or insects Access to welfare facilities Working in public spaces Socio-political differences and stability Language differences Accommodation | <ul style="list-style-type: none"> Travelling to and from site Driving off-road Use of taxis, car hire Health, individual health and fitness, stamina Manual handling (lifting heavy items or repetitive tasks) Lone working Proximity of plant or machinery Slips and trips Falling from heights/falling objects Working with contractors Failing light Public protests or demonstrations | <ul style="list-style-type: none"> Augers Digging tools Rock hammers Generators and electrical equipment Lifting equipment Machinery Operation of vehicles | <ul style="list-style-type: none"> Biological hazards including viruses Chemical hazards Contaminated samples (water, soils etc) Dust Explosive materials Flammable materials Radiation (ionising or non-ionising) |

Checklist of possible control measures

| Communications & management | Personal protective clothing | Safety Equipment | Training |
|---|---|--|---|
| <ul style="list-style-type: none"> Mobile/satellite phone, radio Communication plan Maps/sat-nav/directional aids Emergency response plan (ERP) Emergency contact list Location of A & E/medical facilities | <ul style="list-style-type: none"> Face coverings, Disposable gloves Weatherproof jacket & trousers Protective/non-slip footwear Weatherproof hat Insulated gloves/gauntlets Overalls/disposable suits High-visibility wear Sun protection clothing Safety glasses/goggles Ear plugs/ear defenders Hard hat | <ul style="list-style-type: none"> Sterile wipes Sterilizing hand gels First-aid kit Food & drink Sun protection cream Insect repellent Torch/headtorch | <ul style="list-style-type: none"> Off-road driving Field first-aid Personal security 2-way radio Chemical Safety Training Manual Handling Training |

