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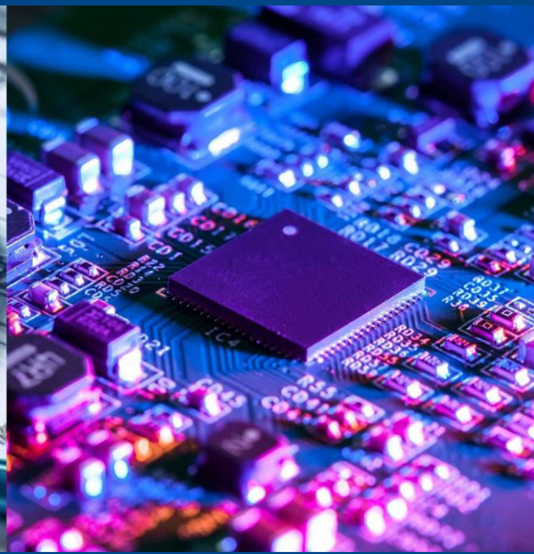

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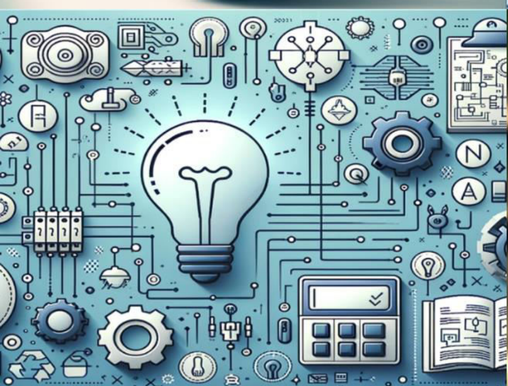

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Geospatial Assessment of Flood Vulnerability in the Lower Orashi Region, Rivers State

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ABSTRACT: Flooding remains a major environmental and socio-economic threat in the Lower Orashi Region, Rivers State, Nigeria, particularly in Abua/Odual and Ahoada West LGAs. The region's vulnerability is exacerbated by low-lying topography, poor drainage infrastructure, and proximity to river channels, leading to severe flood hazards that disrupt livelihoods and damage critical infrastructure. This study conducts a geospatial assessment of flood vulnerability using Geographic Information Systems (GIS) to identify high-risk areas and propose effective flood mitigation strategies. A mixed-methods approach was employed, integrating GIS-based flood mapping, hydrological analysis, and socio-economic assessments. Digital Elevation Models (DEM) and spatial interpolation techniques were used to classify flood-prone zones based on elevation and topography, while household surveys, key informant interviews, and field observations provided insights into socio-economic flood impacts and community resilience levels. The analysis identified low-lying communities (4–12m above sea level) as the most vulnerable to flooding, with settlements such as Odieke, Okarki, Egorbiri, and Digriga facing severe flood exposure due to flat terrain and inadequate drainage systems. The socio-economic assessment revealed that 50.7% of respondents experienced significant economic losses, particularly among farmers, traders, and informal workers, whose livelihoods are heavily dependent on land-based economic activities. Gender and age-based vulnerabilities were also observed, with women and young adults (20–30 years) disproportionately affected due to economic instability and caregiving responsibilities. Despite these challenges, 62.3% of respondents exhibited some level of resilience, while 14.5% reported low or no preparedness, highlighting gaps in flood disaster awareness and adaptive capacity. The findings underscore the urgent need for flood mitigation measures, including enhanced drainage infrastructure, the implementation of early warning systems, and the promotion of community-based flood adaptation programs. Additionally, continuous GIS-based flood monitoring is recommended to facilitate real-time risk assessment and proactive disaster response. This study advances GIS-based flood risk assessment methodologies by integrating spatial analysis with socio-economic indicators, providing a comprehensive framework for evidence-based policy interventions and improved flood resilience in the Lower Orashi Region.

KEYWORDS: Flood Vulnerability, GIS, Digital Elevation Model, Disaster Risk Management, Flood Risk Assessment, Lower Orashi Region.

I. INTRODUCTION

Flooding is one of the most devastating natural disasters, causing significant disruptions to lives, livelihoods, and infrastructure worldwide. The increasing frequency and intensity of floods, exacerbated by climate change, have heightened concerns about flood vulnerability and the need for effective disaster risk management (IPCC, 2014). Flood events occur due to excessive rainfall, poor drainage, river overflow, and anthropogenic factors such as deforestation and urbanization (Ward et al., 2015). In many regions, including Nigeria's Niger Delta, flood vulnerability is worsened by socio-economic factors, weak governance, and inadequate infrastructure (Adelekan, 2010; Nkwunonwo et al., 2016).

The Lower Orashi Region, located in Rivers State, Nigeria, is particularly susceptible to flooding due to its low-lying terrain, extensive river networks, and high seasonal rainfall (Ogba et al., 2016). The Orashi River and its tributaries frequently overflow, inundating surrounding communities and farmlands, leading to severe economic and environmental consequences. Many residents rely on agriculture and fishing, sectors that are directly impacted by recurrent flood disasters (Ajaero et al., 2017; Eze et al., 2017). Furthermore, rapid population growth and land-use changes have intensified flood risks, making vulnerability assessments and mitigation strategies essential for sustainable development

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(Mustapha, 2005). The socio-economic impacts of flooding in the region include displacement, loss of livelihoods, food insecurity, and health risks due to waterborne diseases (Birkmann, 2006; Cutter et al., 2003). Previous studies have highlighted the need for a holistic flood risk management approach that integrates both physical and socio-economic factors (Jongman et al., 2015; Mustapha, 2005). However, existing flood management strategies in the Lower Orashi Region remain reactive rather than proactive, with a heavy reliance on post-disaster relief rather than long-term mitigation planning (Tehrany et al., 2014; Ologunorisa, 2004). This research aims to bridge this gap by employing geospatial technologies to provide a comprehensive flood vulnerability assessment in the region.

The Lower Orashi Region is part of Nigeria's Niger Delta, a flood-prone area with a complex hydrological system that makes it particularly vulnerable to extreme weather events. The region's topography is characterized by low-lying plains, poor drainage systems, and frequent riverine flooding, especially during the peak rainy season between June and September (Akinyemi & Oladapo, 2015). The combination of natural and human-induced factors has increased the region's susceptibility to floods, affecting thousands of residents annually. Key factors contributing to flood vulnerability in the region include topography and hydrology, where the region's flat terrain and proximity to the Orashi River result in poor natural drainage, increasing flood susceptibility (Ogba et al., 2016). Climate change and rainfall patterns have led to increased rainfall intensity and unpredictable weather patterns, further escalating flood risks (IPCC, 2014). Land use and human activities such as deforestation, unregulated construction, and poor waste management contribute to increased surface runoff and clogged drainage channels, exacerbating urban and rural flooding (Eze et al., 2017). The region's predominantly rural population depends on agriculture and fishing, both of which are highly sensitive to flooding. Additionally, inadequate access to financial resources and flood mitigation infrastructure limits communities' ability to adapt and recover from flood disasters (Ajaero et al., 2017). Institutional and policy gaps, such as weak governance, lack of early warning systems, and limited investment in flood control measures, have further exposed communities to flood hazards (Tehrany et al., 2014). These challenges underscore the urgency of implementing comprehensive flood vulnerability assessments and developing data-driven mitigation strategies tailored to the region's specific needs.

Geospatial analysis has emerged as a crucial tool in disaster risk management, particularly for flood vulnerability assessments. The integration of Geographic Information Systems (GIS) and Remote Sensing technologies allows for high-resolution mapping of flood-prone areas, enabling decision-makers to develop targeted flood mitigation strategies (Sanyal & Lu, 2004; Tehrany et al., 2014). GIS-based flood hazard mapping utilizes Digital Elevation Models (DEM) to analyze topographical variations and determine areas most susceptible to flooding (Tehrany et al., 2014). This helps policymakers in land-use planning and disaster preparedness. By integrating hydrological, climatic, and demographic data, geospatial analysis provides a holistic understanding of flood risks, accounting for both physical and human factors (Cutter et al., 2003; Birkmann, 2006). Remote sensing technologies, such as satellite imagery and radar systems, allow for real-time flood monitoring and early warning system development, reducing response time during flood events (Altan & Kemper, 2010; UNESCO, 2020). Geospatial data enhances decision-making in emergency response planning and long-term flood mitigation policies by providing accurate, up-to-date information on flood exposure and community vulnerabilities (Jongman et al., 2015). Recent studies have demonstrated the effectiveness of GIS-based flood risk mapping in enhancing disaster preparedness and response, particularly in flood-prone regions like Nigeria's Niger Delta (Ologunorisa, 2004). The application of these technologies in the Lower Orashi Region will help improve flood management strategies, reduce disaster impacts, and enhance community resilience.

The growing flood vulnerability in the Lower Orashi Region demands a proactive, data-driven approach to flood risk management. Geospatial analysis provides an invaluable tool for assessing flood susceptibility, integrating environmental and socio-economic variables to develop effective mitigation strategies. This study aims to leverage GIS and remote sensing to provide a comprehensive flood vulnerability assessment, ultimately contributing to improved disaster resilience and informed policy-making in the region.

1.1 Statement of problem

Flooding has become an increasingly pressing issue in the Lower Orashi Region, largely due to its topography and hydrological characteristics. The region's low-lying terrain, coupled with an extensive network of rivers and tributaries, makes it highly susceptible to recurrent and severe flooding. The Orashi River, a major water body in the area, frequently overflows during the rainy season, inundating surrounding communities and farmlands. Poor natural drainage exacerbates this problem, as excess water remains stagnant for extended periods, leading to widespread destruction of property,

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displacement of residents, and disruption of livelihoods. Climate change has further intensified these challenges, with increasing rainfall variability and rising sea levels contributing to more frequent and severe flood events (IPCC, 2014). The absence of adequate flood control infrastructure, such as drainage channels and embankments, has left communities vulnerable to both flash floods and prolonged inundation, compounding socio-economic and environmental risks (Ogba et al., 2016).

Despite the persistent threat of flooding, there remains a significant gap in comprehensive flood vulnerability assessments that integrate both geospatial analysis and socio-economic data. Traditional flood risk management approaches in the Lower Orashi Region have primarily focused on reactive measures, such as emergency response and relief efforts, rather than proactive risk assessment and mitigation planning. Existing studies on flood risks in the region often rely on outdated or incomplete datasets, limiting the accuracy of flood risk maps and hazard assessments (Tehrany et al., 2014). Additionally, while Geographic Information Systems (GIS) and Remote Sensing have been widely recognised as powerful tools for flood risk analysis, their application in the Lower Orashi Region remains limited. The lack of high-resolution flood hazard maps and predictive modelling tools has hindered effective planning and disaster preparedness.
Beyond geospatial limitations, socio-economic factors play a critical role in shaping flood vulnerability, yet they are frequently overlooked in conventional risk assessments. Many communities in the Lower Orashi Region rely heavily on agriculture and fishing for their livelihoods, making them particularly susceptible to the economic disruptions caused by recurring floods (Ajaero et al., 2017). High poverty levels, inadequate infrastructure, and limited access to financial resources further weaken the region's resilience to flooding. Without an integrated approach that considers both physical flood risk factors and socio-economic vulnerabilities, flood management strategies will remain ineffective and unsustainable (Cutter et al., 2003). The absence of early warning systems and poor community engagement in flood mitigation efforts further exacerbate the problem, leaving residents unprepared and exposed to significant losses during flood events.

Addressing these challenges requires a shift from reactive flood response to proactive, data-driven flood risk management. A comprehensive flood vulnerability assessment that integrates GIS-based geospatial analysis with socio-economic indicators is essential for developing targeted mitigation strategies. By identifying high-risk areas and assessing community resilience levels, this study aims to bridge the knowledge gap and provide actionable insights for policymakers and disaster management agencies. The findings will contribute to more effective flood mitigation planning, improved early warning systems, and enhanced community adaptation strategies, ultimately reducing the devastating impacts of flooding in the Lower Orashi Region.

1.2 Aim of the study

This study aims to conduct a geospatial assessment of flood vulnerability in the Lower Orashi Region using GIS, identifying high-risk areas and proposing effective mitigation strategies to enhance community resilience and disaster preparedness.

1.3 Study Area Description

The Lower Orashi Region, located in Rivers State, Nigeria, is characterised by a low-lying topography and an extensive river network, making it highly prone to flooding. The region experiences a tropical monsoon climate with heavy rainfall, particularly between June and September, which exacerbates poor drainage and increases flood risks. Hydrologically, the Orashi River and its tributaries frequently overflow, inundating surrounding communities and farmlands.
Predominantly rural, the region relies on agriculture and fishing, both of which are severely impacted by recurrent flooding. Deforestation, unregulated land use, and inadequate infrastructure further heighten vulnerability. While these challenges persist, opportunities exist to enhance flood resilience through improved geospatial analysis, infrastructure development, and community-based mitigation strategies.

1.4 Significance of the Study

This study contributes to flood risk management by integrating GIS-based analysis with socio-economic data to develop targeted mitigation strategies. The findings will aid policymakers, urban planners, and disaster management agencies in strengthening community preparedness, improving early warning systems, and reducing the socio-economic impacts of flooding in the Lower Orashi Region.

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II. LITERATURE REVIEW

2.1. Flood Vulnerability Assessment

Flood vulnerability assessment is crucial in disaster risk reduction, as it identifies factors that contribute to a region's susceptibility to flooding. Vulnerability extends beyond physical exposure to include socio-economic, institutional, and environmental factors that influence a community's ability to withstand and recover from flood events (Cutter et al., 2003; Birkmann, 2006). It is often examined through three main components: exposure, sensitivity, and adaptive capacity (Turner et al., 2003). Exposure refers to the physical presence of people and infrastructure in flood-prone areas, sensitivity involves the degree to which these systems are affected by flooding, and adaptive capacity refers to the ability to mitigate or recover from flood impacts.

Flood vulnerability assessments rely on various theoretical models to quantify and map risks. The integration of socio-economic variables, such as income levels, housing conditions, and access to resources, is essential for a holistic understanding of vulnerability (Jongman et al., 2015). In regions like the Lower Orashi, where livelihoods depend on climate-sensitive activities such as agriculture and fishing, a failure to incorporate socio-economic factors into flood risk analysis can result in ineffective mitigation strategies (Ajaero et al., 2017).

2.2. Theoretical Foundations

2.2.1. Hazard-Exposure Models

Hazard-exposure models, such as Crichton's Risk Triangle, define risk as a function of hazard, exposure, and vulnerability (Crichton, 1999). This model suggests that reducing any of these three components can lower overall flood risk. Similarly, the Pressure and Release (PAR) model developed by Blaikie et al. (1994) focuses on root causes, pressures, and unsafe conditions that contribute to vulnerability, emphasising the role of socio-economic and political factors in disaster risk.

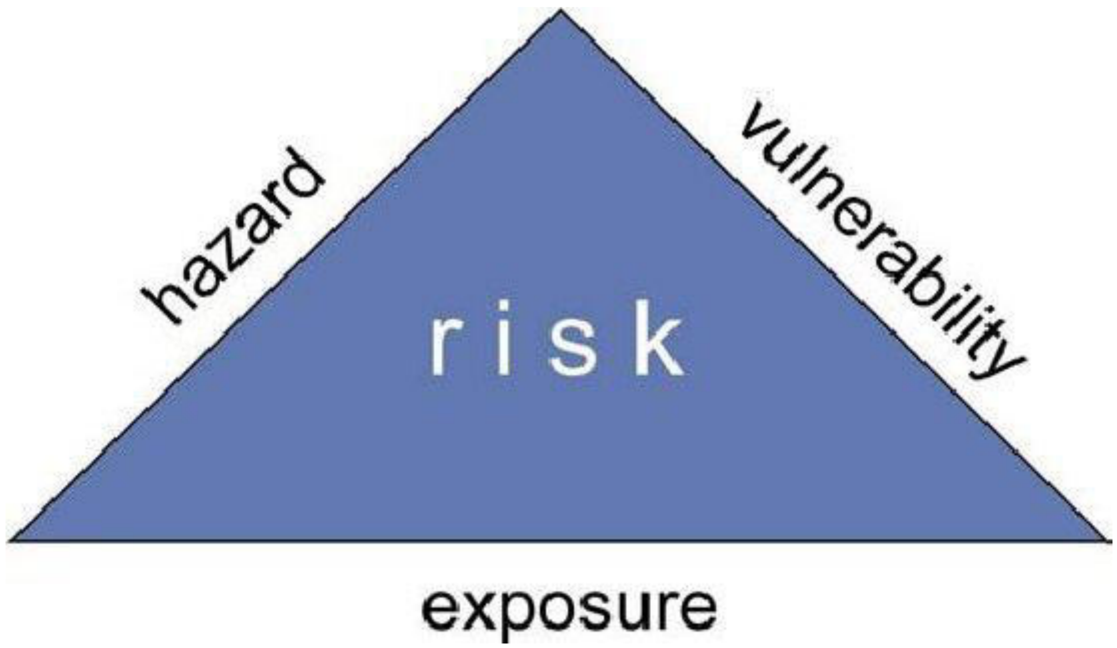

Figure 2:1 The "Risk Triangle" after Crichton (1999)

2.2.2. Hazard-Exposure Models and GIS-Based Flood Risk Assessment

Flood risk assessment is a fundamental component of disaster risk management, particularly in regions that are highly susceptible to recurrent flooding. Conceptual models provide structured frameworks for understanding how different factors contribute to flood risk and help in developing targeted mitigation strategies. Among the most widely used models are Crichton's Risk Triangle and the Pressure and Release (PAR) Model, both of which offer insights into the interplay between physical, social, and economic factors that drive disaster vulnerability. The integration of Geographic

Information Systems (GIS) and hydrological models further enhances flood risk analysis by incorporating real-time environmental and demographic data, thereby supporting evidence-based decision-making.

2.2.3. Crichton's Risk Triangle (1999)
2.2.3.1. Understanding the Model
Crichton (1999) introduced the Risk Triangle, a conceptual model that defines risk as the product of three interconnected components: hazard, exposure, and vulnerability. The model suggests that flood risk is not solely determined by the occurrence of a natural event but also by the extent to which people, infrastructure, and economic activities are exposed and how vulnerable they are to its impacts. The equation for this model is expressed as:

$$\boldsymbol{R = H \times E \times V}$$

where:
- H = Hazard (e.g., heavy rainfall, river overflow, coastal storm surge).
- E = Exposure (e.g., population, infrastructure, and economic activities in flood-prone areas).
- V = Vulnerability (e.g., weak flood defences, poor drainage systems, and socio-economic limitations).

The Risk Triangle suggests that reducing any one of these three components will lower overall flood risk. Unlike traditional views that focus only on controlling hazards (e.g., building dams or levees), this model emphasises a comprehensive approach, including:
1. Reducing Hazard (H) – Implementing measures to mitigate flood events, such as improving drainage networks, constructing flood barriers, and promoting reforestation to absorb excess runoff.
2. Reducing Exposure (E) – Limiting development in flood-prone areas through zoning regulations, resettlement programmes, and improved urban planning.
3. Reducing Vulnerability (V) – Strengthening community resilience through flood-resistant infrastructure, early warning systems, and disaster preparedness education.

2.2.3.2. Application of the Risk Triangle to Flood Management
Crichton's model is particularly useful for flood management because it highlights the interactive nature of flood risk factors. For instance, even if a hazard (H) occurs frequently, risk (R) can remain low if exposure and vulnerability are minimised. Conversely, in regions where settlements and infrastructure are poorly planned and resilience is weak, a moderate hazard can result in a major disaster.
For example, in the Lower Orashi Region of Rivers State, Nigeria, recurring floods are exacerbated by:
- High exposure (E) – Many settlements are located in low-lying floodplains, increasing their susceptibility to rising water levels.
- High vulnerability (V) – Limited drainage systems, poor housing structures, and low public awareness make communities more susceptible to flood damage.

Applying the Risk Triangle, policymakers can prioritise interventions that address all three dimensions of risk, rather than focusing solely on hazard reduction measures.

2.2.4. The Pressure and Release (PAR) Model
2.2.4.1. Conceptual Framework
While Crichton's Risk Triangle focuses on the physical aspects of disaster risk, the Pressure and Release (PAR) Model, developed by Blaikie, Cannon, Davis, and Wisner (1994), expands the analysis to socio-economic and political drivers of vulnerability. This model conceptualises disaster risk as the outcome of progressive vulnerability accumulation, categorised into three levels:

2.2.4.2. Root Causes
These are long-term structural factors that shape vulnerability, such as:
- Weak governance and poor policy enforcement.
- Economic inequalities and lack of investment in disaster risk reduction.
- Environmental mismanagement, such as deforestation and land degradation.

2.2.4.3. Dynamic Pressures

These are processes that transform root causes into increased vulnerability, including:

- Rapid and unregulated urbanisation leading to settlements in flood-prone areas.
- Weak institutional capacity and lack of disaster management resources.
- Poor infrastructure development, increasing susceptibility to flood hazards.

2.2.4.4. Unsafe Conditions

These are the direct risk factors that expose communities to disasters, such as:

- Settlements in high-risk flood zones with inadequate drainage.
- Lack of early warning systems and emergency preparedness.
- Insufficient access to disaster relief services.

The PAR Model suggests that addressing these pressures through policy reform, environmental protection, and socio-economic development can significantly reduce disaster risk (Blaikie et al., 1994; Wisner et al., 2004).

2.2.5. Coping Capacity in Flood Risk Assessment

While both Crichton's Risk Triangle and the PAR Model offer robust frameworks for assessing disaster risk, they do not explicitly account for a community's ability to cope with hazards. Recognising this limitation, Wisner et al. (2004) introduced coping capacity (C) into the risk equation, modifying the formula as follows:

$$\boldsymbol{R = \frac{H \times V}{C}}$$

where:

- C = Coping capacity, which includes early warning systems, emergency response preparedness, financial resources, and adaptive infrastructure.

Incorporating coping capacity, this model acknowledges that communities actively respond to hazards, meaning that two regions with similar hazard levels and vulnerabilities may experience different flood outcomes based on their resilience (Wisner et al., 2004).

For example:

- Higher coping capacity (C) – Cities with strong governance, early warning systems, and robust emergency plans (e.g., London, Tokyo) experience lower disaster impact despite exposure.
- Lower coping capacity (C) – Rural areas with poor infrastructure, weak institutions, and limited preparedness suffer greater damage and slower recovery from flooding.

Crichton's Risk Triangle and the PAR Model provide complementary frameworks for flood risk assessment. While Crichton's model emphasises the physical dimensions of flood risk, the PAR Model incorporates social and economic factors, offering a broader understanding of disaster vulnerability. The integration of coping capacity (C) further refines flood risk assessment by recognising the role of disaster preparedness and resilience.

Effective flood risk management requires a holistic approach that combines:

- Structural interventions (e.g., drainage systems, flood barriers).
- Policy reforms (e.g., land-use regulations, urban planning).
- Community-based resilience strategies (e.g., early warning systems, public awareness programmes).

By adopting an integrated, multi-disciplinary approach, flood-prone regions such as the Lower Orashi Region can reduce flood vulnerability, enhance preparedness, and build sustainable resilience against future disasters.

2.3. Resilience Theory

Resilience theory highlights the capacity of communities and ecosystems to absorb shocks, adapt, and recover from disturbances such as flooding (Holling, 1973; Walker et al., 2004). This framework emphasises proactive adaptation rather than merely responding to disasters. In flood-prone regions, resilience can be enhanced through infrastructure improvements, early warning systems, and community engagement (Folke, 2006).

The application of resilience theory in flood management involves strengthening adaptive capacity through policies that promote sustainable land use, disaster preparedness, and social safety nets. Research has shown that communities with diversified livelihoods and strong social networks recover faster from flood impacts (Cutter et al., 2008).

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2.4. Geospatial Assessment and Flood Mapping

2.4.1. GIS-Based Flood Risk Models

Geographic Information Systems (GIS) are widely used in flood risk assessment due to their ability to integrate spatial data and generate high-resolution flood maps. GIS models analyse elevation, land use, and hydrological patterns to identify flood-prone areas (Tehrany et al., 2014). By overlaying multiple datasets, GIS can provide a comprehensive picture of flood susceptibility, enabling decision-makers to implement targeted mitigation strategies (Longley et al., 2015).

The use of Digital Elevation Models (DEM) in flood hazard mapping allows for precise identification of low-lying areas vulnerable to flooding. In the Lower Orashi Region, GIS-based assessments have been instrumental in identifying high-risk communities and informing land-use planning (Ogba et al., 2016).

2.4.2. Remote Sensing Applications

Remote sensing technologies, including satellite imagery and synthetic aperture radar (SAR), provide real-time monitoring of flood events. These tools enhance early warning systems by detecting changes in water levels and land cover (Schumann & Di Baldassarre, 2019). Platforms such as MODIS and Sentinel satellites offer detailed insights into flood dynamics, enabling rapid response and damage assessment (Cohen et al., 2017).

Advancements in remote sensing have improved flood prediction models, allowing for better integration of climate variables and hydrological data (UNESCO, 2020). The combination of GIS and remote sensing enhances flood resilience by providing accurate, data-driven solutions for risk management (Kienberger, 2014).

2.5. Socio-Economic Perspectives on Flooding

2.5.1. Vulnerability and Social Theory

Social vulnerability theory suggests that disaster impacts are not distributed equally but are shaped by social structures, economic status, and access to resources (Cutter et al., 2003). Lower-income communities, often residing in flood-prone areas with inadequate infrastructure, face higher risks and slower recovery times (Oliver-Smith, 2004).

Research in the Niger Delta highlights how social inequalities influence flood vulnerability. Limited access to financial resources, weak governance, and lack of insurance exacerbate the impacts of flooding on marginalised populations (Adelekan, 2010). Addressing these vulnerabilities requires an integrated approach that includes social protection measures, capacity building, and participatory planning (Wisner et al., 2004).

2.5.2. Livelihood and Adaptation Strategies

The Sustainable Livelihoods Framework (SLF) emphasises that a community's assets financial, social, and environmental determine its ability to adapt to floods (DFID, 1999). Diversifying income sources, improving education, and strengthening social networks are key strategies for enhancing resilience (Scoones, 1998).

Studies have shown that flood-affected communities in Nigeria adopt various coping strategies, such as migration, temporary relocation, and reliance on informal support networks (Manyena et al., 2011). Strengthening adaptation strategies through policy interventions can significantly reduce long-term flood impacts (Bahadur et al., 2013).

2.6. Flood Risk Management Strategies

2.6.1. Integrated Flood Management (IFM)

Integrated Flood Management (IFM) combines structural and non-structural measures to reduce flood risks while maintaining ecosystem balance (GWP & WMO, 2015). This approach incorporates sustainable land-use planning, early warning systems, and stakeholder engagement to enhance flood resilience.

IFM principles advocate for managing floodplains and river basins holistically, ensuring that mitigation efforts do not disrupt natural hydrological cycles (APFM, 2006). The successful implementation of IFM strategies requires multi-sectoral collaboration and strong policy frameworks (Matczak et al., 2017).

2.6.2. National Policies on Flood Control (NESREA, NEMA, etc.)

Nigeria has established several agencies and policies to address flood risks, including the National Environmental Standards and Regulations Enforcement Agency (NESREA) and the National Emergency Management Agency (NEMA). NESREA enforces environmental regulations to control activities that contribute to flooding, such as deforestation and unplanned urban expansion (Oladipo, 2010).

NEMA is responsible for disaster preparedness and response, coordinating relief efforts and implementing early warning systems (NEMA, 2011). Despite these policies, flood risk management in Nigeria remains largely reactive, with limited emphasis on long-term prevention and adaptation (Jeb & Aggarwal, 2008). Strengthening policy implementation and integrating geospatial technologies can enhance flood resilience and reduce disaster impacts.

2.6.3. Research Gaps & Limitations

While significant progress has been made in flood risk assessment, several gaps remain. There is a need for interdisciplinary approaches that integrate hydrology, socio-economics, and governance in flood management (Merz et al., 2010). Many studies focus on physical flood hazards while neglecting the role of social vulnerability and community engagement in disaster resilience (Reed, 2008).

Additionally, most research is based on data from high-income countries, with limited studies on developing regions like the Lower Orashi, where unique socio-economic and environmental factors influence flood vulnerability (Garschagen, 2013). Addressing these gaps through participatory research and localised data collection can improve flood management strategies and ensure more effective disaster risk reduction (Hegger et al., 2013).

2.7 Empirical Review

Flood vulnerability assessment has been widely studied across different geographical regions, with researchers employing geospatial analysis, socio-economic indicators, and disaster risk management strategies to understand the impact of flooding on communities. Empirical studies have focused on GIS-based flood risk mapping, socio-economic vulnerability, community resilience, and policy interventions, providing insights into effective flood risk management.

Several studies have demonstrated the effectiveness of Geographic Information Systems (GIS) and Remote Sensing (RS) in flood risk assessment. Tehrany et al. (2014) conducted a flood susceptibility mapping study using GIS-based hybrid models, integrating topographic, hydrological, and meteorological factors to classify flood-prone areas. Their findings confirmed that low-lying regions with poor drainage and high rainfall intensities are the most vulnerable to flooding. Similarly, Jeb and Aggarwal (2008) applied remote sensing and GIS techniques to model flood inundation hazards in the Kaduna River Basin, Nigeria. Their study found that DEM-based topographic analysis effectively delineates flood-prone zones, providing valuable insights for flood risk management. The application of Synthetic Aperture Radar (SAR) and Normalized Difference Water Index (NDWI) in their study also highlighted the role of satellite imagery in real-time flood monitoring.

A study conducted by Adelekan (2012) in Lagos, Nigeria, mapped flood risk areas using spatial interpolation techniques and found that unregulated urban expansion and encroachment into wetlands significantly increased flood vulnerability. Nkwunonwo et al. (2020) further confirmed that urban development, weak drainage systems, and lack of enforcement of zoning regulations contribute to high flood susceptibility in Nigerian cities.

Empirical studies have also examined the socio-economic impacts of flooding, showing that low-income households, farmers, and informal workers suffer the most due to their economic dependence on flood-sensitive activities (Ajaero & Mozie, 2017). Cutter et al. (2003) explored social vulnerability to environmental hazards, identifying income levels, education, gender, and access to resources as critical determinants of flood resilience. Cutter et al. (2008) further found that women and elderly populations are more vulnerable to flood-induced displacement and economic shocks due to limited financial resources and mobility restrictions. Manyena et al. (2011) noted that communities with strong social networks and access to post-disaster recovery assistance demonstrate higher resilience to flood-related economic losses.

Research on community resilience has emphasised that effective disaster preparedness significantly reduces flood impacts. Reed (2008) found that localised early warning systems and community-led disaster response teams enhance adaptive capacity. Similarly, Bahadur et al. (2013) noted that integrating traditional knowledge with modern flood risk assessments improves disaster preparedness and response efforts. However, Ogba et al. (2016) observed that while many flood-prone communities rely on traditional coping mechanisms such as raised housing structures and migration, these strategies are insufficient in extreme flood events, necessitating governmental support and formal disaster planning.

Policy-focused studies highlight the need for stronger flood risk governance and policy enforcement. Hegger et al. (2013) examined flood risk governance strategies in the Netherlands, finding that integrated flood management approaches that combine structural measures (levees, embankments) with non-structural strategies (land-use planning, insurance

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schemes, and community engagement) are the most effective in mitigating flood risks. In contrast, Matczak et al. (2017) studied flood risk governance in Nigeria, revealing challenges in policy implementation, inadequate funding, and bureaucratic inefficiencies as major obstacles to effective flood management. Ologunorisa (2004) further found that poor enforcement of urban planning regulations and inadequate investment in flood control infrastructure exacerbate flood disasters in the Niger Delta.

Empirical studies consistently reinforce the importance of GIS-based monitoring, socio-economic vulnerability assessments, and multi-level policy coordination in managing flood risks. However, gaps remain in the integration of real-time flood prediction models with socio-economic disaster preparedness frameworks, highlighting the need for interdisciplinary research and proactive flood risk management approaches.

III. METHODOLOGY

3.1. Research Approach and Design

This study employs a mixed-methods approach using a Sequential Explanatory Design (SED), which integrates quantitative and qualitative data collection and analysis. The quantitative phase involves the use of GIS and remote sensing for spatial analysis of flood vulnerability, while the qualitative phase includes stakeholder interviews and community engagement to provide deeper insights into flood impacts and resilience strategies. This approach ensures a comprehensive assessment of flood vulnerability, combining geospatial analysis with socio-economic considerations

3.2. Population and Sampling

The study focuses on Abua/Odual and Ahoada West LGAs in the Lower Orashi Region, which have a projected population of 620,538 persons in 2024, based on the Exponential Growth Model with a 3.2% annual growth rate
A stratified and simple random sampling technique was used, clustering the study area into flood-vulnerable and non-flood-vulnerable communities. From 109 identified flood-vulnerable communities, 22 (20%) were randomly selected for sampling

3.3. Sample Size Determination

The sample size was determined using Taro Yamane's Formula (1967) with a 5% sampling error, resulting in a sample size of 400 respondents, which was proportionately distributed across the selected communities
. The table below summarises the sample distribution across the study area.

Table 3.1: Determination of Sample Size for the Study

S/No.	Sampled LGAs	Sampled Communities	1991 Population	2023 Population (at 3.2% Growth Rate)	Number of Households (5 Persons per HH)	No. of Households Selected for Sampling
1	Abua/Odual	Emesu	829	2,271	454	10
		Omonema	1,133	3,104	621	13
		Agada	1,315	3,603	721	15
		Odaga	2,718	7,447	1,489	32
		Okolomade	1,675	4,589	918	19
		Gambia	433	1,186	237	5
		Ogonokom	3,305	9,056	1,811	38
		Opugizogolo	220	603	121	3

		Egorbiri	359	984	197	4
		Emumema	444	1,217	243	5
		Anyu	1,584	4,340	868	18
		Digriga	1,927	5,280	1,056	22
		Akani	2,373	6,502	1,300	28
		Serebia	1,361	3,729	746	16
2	Ahoada West	Odieke	371	1,017	203	4
		Ochika	813	2,228	446	9
		Ogbedi	1,589	4,354	871	18
		Ubeta	3,689	10,108	2,022	43
		Oshiobele	341	934	187	4
		Emezi II	762	2,088	418	9
		Okarki	5,332	14,610	2,922	62
		Oyigba	1,796	4,921	984	21
	Total		**34,369**	**94,171**	**15,695**	**400**

Source: NPC, 1991; NBS, 2016; Researcher's Computation & Compilation, 2024

3.4. Data Collection Methods

3.4.1. Primary Data

Household Surveys Structured questionnaires were administered to collect data on flood experiences, impacts, and adaptation strategies.

Key Informant Interviews Semi-structured interviews were conducted with community leaders, flood experts, and government officials.

Field Observations – Physical assessments, photographs, and notes were taken to document flood-prone areas, drainage conditions, and infrastructure

3.4.2. Secondary Data

GIS and Remote Sensing Data – Satellite imagery, Shuttle Radar Topographic Mission (SRTM) data, and Digital Elevation Models (DEM) were used for flood risk mapping

Historical Flood Records – Government reports, environmental agency publications, and previous flood disaster data were reviewed

3.5. Analytical Techniques

3.5.1. Quantitative (Geospatial Analysis)

GIS-Based Flood Mapping was deployed, an advanced GIS software (ArcGIS, QGIS) was used for spatial interpolation, overlay analysis, and flood susceptibility mapping

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Topographic and Elevation Analysis was also deployed, DEM and remote sensing techniques were applied to identify low-lying areas and flood-prone zones

3.5.2. Qualitative (Stakeholder Engagement)

Thematic analysis was used to analyse interviews and focus group discussions, which were coded and categorised using Braun & Clarke's (2006) framework to extract insights on community flood resilience.

Validity and Reliability

To ensure the accuracy of data collection instruments:

- Validity – Expert review and supervisor vetting were conducted to ensure content validity.
- Reliability – A pilot survey was conducted, and Cronbach's Alpha test was applied, achieving a high reliability score of 0.962, indicating strong internal consistency.

This methodsology provides a rigorous, multi-dimensional approach to flood vulnerability assessment, integrating GIS-based geospatial analysis with qualitative stakeholder engagement to develop actionable flood risk management strategies in the Lower Orashi Region.

IV. RESULTS

This section presents the findings on flood vulnerability in the Lower Orashi Region, focusing on Abua/Odual and Ahoada West LGAs. The results are based on GIS analysis, household surveys, and key informant interviews, highlighting the extent of flood risk, socio-economic impacts, and community resilience strategies.

4.1. GIS-Based Flood Vulnerability Mapping

The GIS analysis utilised Digital Elevation Models (DEM) to assess flood-prone areas based on topography and elevation. Figures 4.1 and 4.2 display the reclassified DEM maps for Ahoada West and Abua/Odual LGAs, respectively, ranking vulnerability levels from very low to very high.

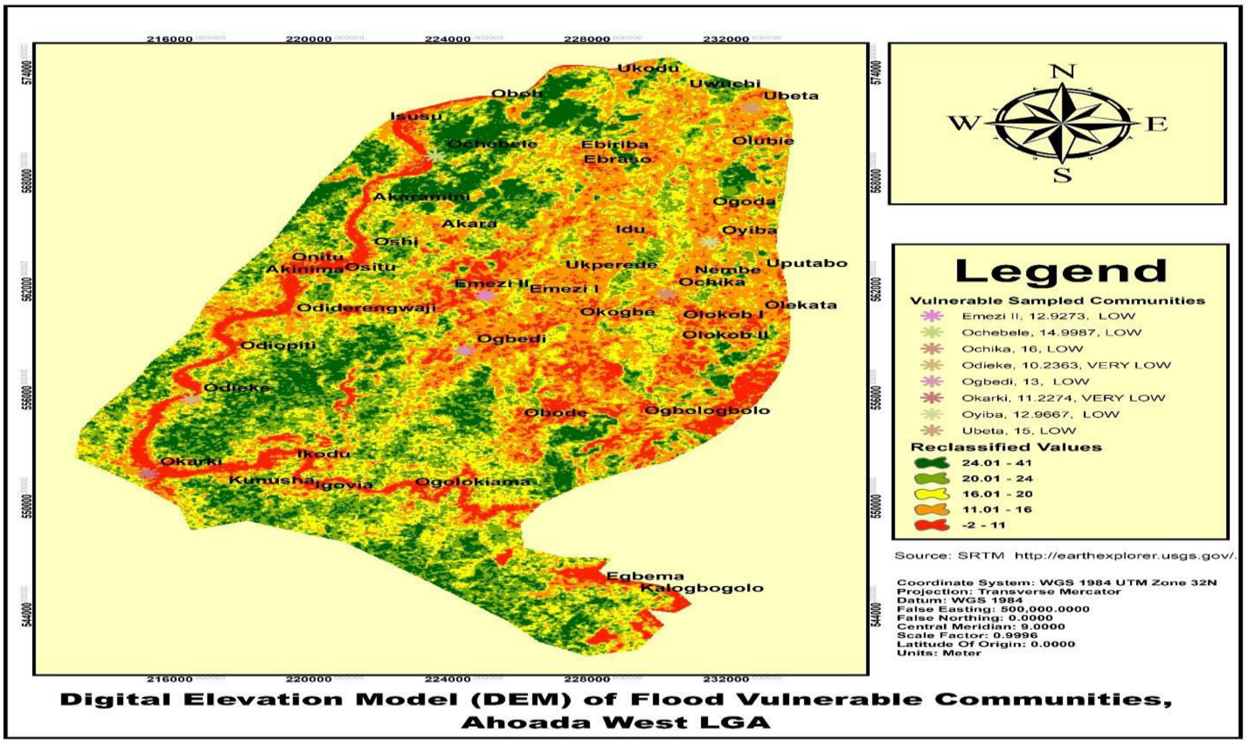

Figure 4.1: Digital Elevation Model (DEM) of Flood-Prone Areas in Ahoada West LGA

(Source: SRTM USGS, 2024)

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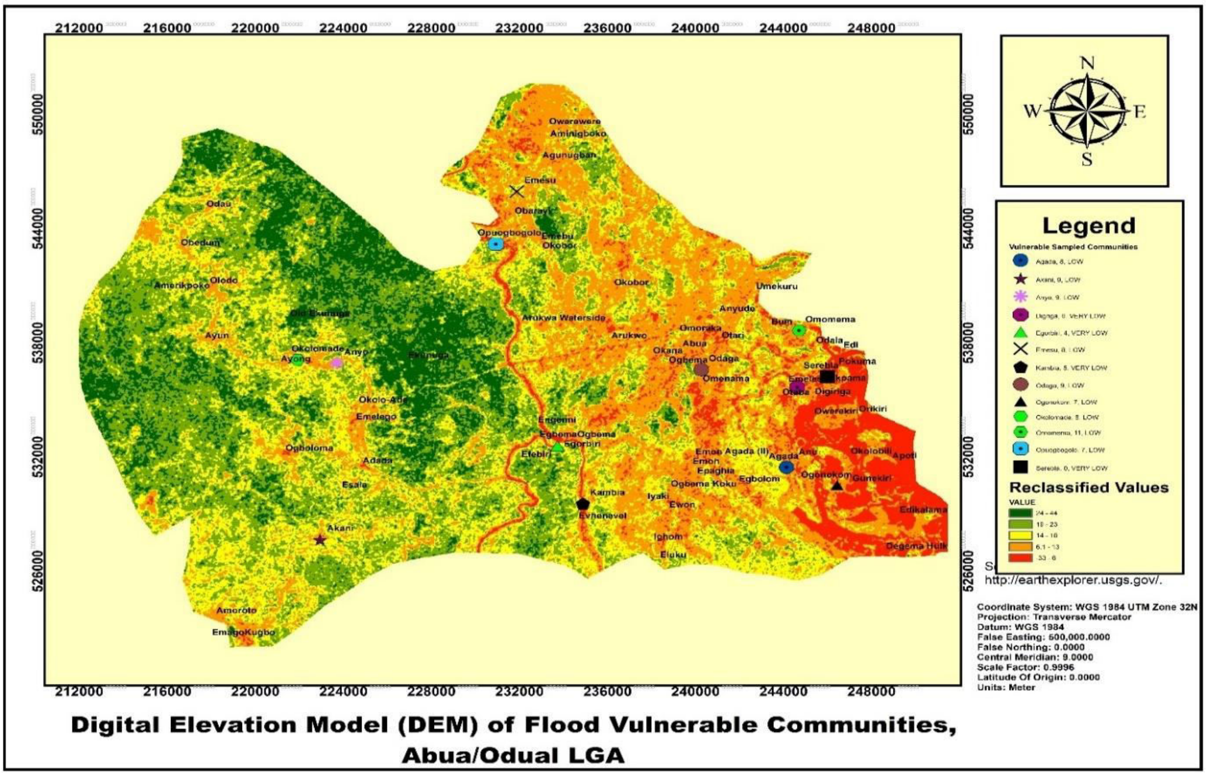

Figure 4.2: Digital Elevation Model (DEM) of Flood-Prone Areas in Abua/Odual LGA
(Source: SRTM USGS, 2024)

The analysis revealed that communities situated at lower elevations (4–12 metres above sea level), such as Odieke and Okarki (Ahoada West) and Egorbiri and Digriga (Abua/Odual), exhibited very high flood vulnerability due to their proximity to river channels and poor drainage systems. In contrast, settlements located at higher elevations (>15 metres above sea level) experienced significantly less flood impact.

The hydrological analysis further showed that areas with flat terrain and poor drainage infrastructure had higher water retention, exacerbating flood risks. This highlights the need for improved flood mitigation infrastructure, such as drainage channels and embankments.

Table 4.1 summarises the ranking system for flood vulnerability levels used in the DEM analysis.

Table 4.1: Ranking Order for Flood Vulnerability Hazard Assessment

Ranking	Vulnerability Level (Hazard)
1	Very High Vulnerability
2	High Vulnerability
3	Moderate
4	Low Vulnerability
5	Very Low

(Source: Author's Field Survey, 2024)

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4.2. Socio-Economic and Demographic Characteristics of Respondents

4.2.1. Gender Distribution

Table 4.2 presents the gender distribution of respondents, showing a relatively even male-to-female ratio across the study areas. The findings indicate that flood vulnerability affects both genders almost equally, but women in rural areas may face greater risks due to caregiving responsibilities and limited access to resources.

Table 4.2: Gender of Respondents

Gender	Abua/Odual (N=223)	Ahoada West (N=165)	Aggregate (N=388)
Male	107 (27.6%)	88 (22.7%)	195 (50.3%)
Female	116 (29.9%)	77 (19.8%)	193 (49.7%)

(Source: Author's Field Survey, 2024)

4.2.2. Demographic Characteristics and Flood Vulnerability

As presented in Table 4.3, the largest age group affected by flooding is 20-30 years (41.8%), followed by 31-40 years (33.0%). This indicates that flood vulnerability primarily affects young adults, who form the major workforce and economically active population. The 41-50 years age group (20.1%) also contributes significantly to the study population, while respondents above 50 years (5.1%) represent the least affected group. The dominance of younger populations in flood-prone areas suggests that targeted flood awareness and preparedness campaigns should focus on youth-led community engagement and disaster response initiatives.

Table 4.3: Age Distribution of Respondents

S/N	Age Brackets	Abua/Odual (N)	Abua/Odual (%)	Ahoada West (N)	Ahoada West (%)	Aggregate (N)	Aggregate (%)
1	20-30 years	100	25.8%	62	16.0%	162	41.8%
2	31-40 years	77	19.8%	51	13.1%	128	33.0%
3	41-50 years	38	9.8%	40	10.3%	78	20.1%
4	51-60 years	7	1.8%	9	2.3%	16	4.1%
5	60+ years	1	0.3%	3	0.8%	4	1.0%
Total	**-**	**223**	**57.5%**	**165**	**42.5%**	**388**	**100%**

(Source: Author's Field Survey, 2024)

4.3. Economic Characteristics and Flood Impact

Table 4.4 shows that 50.7% of respondents experienced significant economic losses due to flooding, particularly among business owners, farmers, and traders. An additional 29.3% reported moderate losses, while 14.7% suffered slight losses. The 5.3% of respondents who reported no significant impact may be those engaged in occupations less dependent on land-based activities, such as salaried jobs. These findings highlight the severe economic consequences of flooding, necessitating financial relief measures, alternative livelihood strategies, and flood insurance schemes to support affected households.

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Table 4.4: Economic Impact of Flooding on Residents

S/N	Economic Impact	Abua/Odual (N)	Abua/Odual (%)	Ahoada West (N)	Ahoada West (%)	Aggregate (N)	Aggregate (%)
1	Significant loss	100	50.0%	90	51.4%	190	50.7%
2	Moderate loss	60	30.0%	50	28.6%	110	29.3%
3	Slight loss	30	15.0%	25	14.3%	55	14.7%
4	No significant impact	10	5.0%	10	5.7%	20	5.3%
Total	**-**	**200**	**100%**	**175**	**100%**	**375**	**100%**

(Source: Author's Field Survey, 2024)

4.4. Community Resilience Strategies

As seen in Table 4.5, 62.3% of respondents (combined highly and moderately resilient groups) possess some level of coping capacity against flooding. However, 14.5% of respondents had low or no resilience, highlighting the need for interventions in disaster preparedness, community education, and support mechanisms. Flood resilience can be further strengthened by enhancing early warning systems, improving drainage infrastructure, and developing community-based disaster response plans.

Table 4.5: Community Resilience in the Face of Flooding

S/N	Resilience Level	Abua/Odual (N)	Abua/Odual (%)	Ahoada West (N)	Ahoada West (%)	Aggregate (N)	Aggregate (%)
1	Highly resilient	50	27.8%	45	27.3%	95	27.5%
2	Moderately resilient	65	36.1%	55	33.3%	120	34.8%
3	Slightly resilient	15	8.3%	15	9.1%	30	8.7%
4	Not resilient	10	5.6%	10	6.1%	20	5.8%
Total	**-**	**180**	**100%**	**165**	**100%**	**345**	**100%**

(Source: Author's Field Survey, 2024)

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4.5. Flood Risk Management and Mitigation Strategies

According to Table 4.6, improved drainage systems (43.5%) and flood barriers (39.1%) are the most common flood mitigation measures. However, only 11.6% supported community awareness programs, reflecting low participation in non-structural flood mitigation strategies. For sustainable flood management, emphasis should be placed on a combination of structural measures and community-based initiatives, including regular desilting of drainage systems, proper land-use planning, and environmental conservation programs.

Table 4.6: Measures to Mitigate Flood Impact

S/N	Mitigation Measures	Abua/Odual (N)	Abua/Odual (%)	Ahoada West (N)	Ahoada West (%)	Aggregate (N)	Aggregate (%)
1	Flood barriers	70	38.9%	65	39.4%	135	39.1%
2	Improved drainage systems	80	44.4%	70	42.4%	150	43.5%
3	Community awareness programs	20	11.1%	20	12.1%	40	11.6%
4	Other measures	10	5.6%	10	6.1%	20	5.8%
Total	-	**180**	**100%**	**165**	**100%**	**345**	**100%**

(Source: Author's Field Survey, 2024)

4.6. Importance of Community Engagement in Flood Management

The findings in Table 4.7 indicate that a majority of respondents (55.0%) consider community engagement to be very important in managing flood risks. This reflects a high level of recognition of the role that local involvement plays in disaster preparedness and response. Additionally, 34.8% of respondents rated community engagement as somewhat important, demonstrating a broad understanding of its significance but possibly indicating gaps in active participation or awareness programs. A smaller proportion (10.1%) viewed community engagement as not important, which may suggest a lack of trust in local initiatives or inadequate past experiences with community-led disaster management. This highlights the need for targeted awareness programs and training to enhance community involvement in flood risk reduction strategies.

Table 4.7: Importance of Community Engagement

S/N	Community Engagement	Abua/Odual (N)	Abua/Odual (%)	Ahoada West (N)	Ahoada West (%)	Aggregate (N)	Aggregate (%)
1	Very important	100	55.6%	90	54.5%	190	55.0%

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2	Somewhat important	60	33.3%	60	36.4%	120	34.8%
3	Not important	20	11.1%	15	9.1%	35	10.1%
Total	**-**	**180**	**100%**	**165**	**100%**	**345**	**100%**

(Source: Author's Field Survey, 2024)

4.7. Governmental Assistance in Flood Management

Table 4.8 evaluates the effectiveness of governmental aid, revealing that 44.8% of respondents found assistance effective, while 11.6% reported minimal assistance. The findings show mixed perceptions of governmental support, with some communities receiving relief materials, while others reported delayed or inadequate interventions.

Table 4.8: Governmental Assistance in Flood Management

Governmental Assistance	Abua/Odual (N=180)	Ahoada West (N=165)	Aggregate (N=345)
Effective assistance	80 (44.4%)	75 (45.5%)	155 (44.8%)
Moderate assistance	60 (33.3%)	55 (33.3%)	115 (33.3%)
Minimal assistance	20 (11.1%)	20 (12.1%)	40 (11.6%)
No assistance	20 (11.1%)	15 (9.1%)	35 (10.1%)

(Source: Author's Field Survey, 2024)

V. DISCUSSION

5.1. GIS-Based Flood Vulnerability Mapping

Flood vulnerability assessment through Geospatial Information Systems (GIS) plays a crucial role in understanding the spatial distribution of flood risks and identifying high-risk communities. This study utilised Digital Elevation Models (DEM) and hydrological analysis to classify flood-prone areas based on elevation, topography, and drainage characteristics.

The GIS analysis, as presented in Figures 4.1 and 4.2, classified low-lying settlements (4–12m above sea level) as the most vulnerable to flooding. These areas, including Odieke and Okarki (Ahoada West) and Egorbiri and Digriga (Abua/Odual), are highly susceptible to both seasonal and extreme flooding due to their proximity to river channels, poor drainage systems, and flat terrain. The ranking system in Table 4.1 categorised these settlements under Very High Vulnerability, meaning they experience frequent and severe flood events with little natural drainage or infrastructure to mitigate impacts. In contrast, settlements located at higher elevations (>15m above sea level) exhibited significantly lower flood risks, as elevated terrain facilitates natural runoff and reduces flood stagnation.

The hydrological analysis further revealed that flat terrains with poor drainage infrastructure had higher water retention, exacerbating flood risks in the region. Several key hydrological and topographical factors contributed to flood susceptibility. Settlements below 12m elevation were the most affected due to their low slope gradient, which impedes water runoff and increases water stagnation. In contrast, settlements above 15m elevation had steeper slopes, allowing faster water drainage and lower flood accumulation. Communities closer to major rivers and floodplains were more prone to severe flooding, especially during periods of heavy rainfall and river overflow. Odieke and Egorbiri, for example, are situated along low-lying riverbanks, making them highly susceptible to backflow flooding during extreme rainfall events. Poorly maintained or non-existent drainage systems or artificial canal in Abua/Odual and Ahoada West significantly contributed to flood risks, as many flood-prone communities rely on natural water pathways, which become clogged by debris, sediment buildup, and human activities, further worsening flood impacts. The soil composition in some flood-prone areas, particularly those with high clay content and poor permeability, further contributed to increased surface runoff and prolonged flood retention, while areas with sandy or loamy soils experienced lower flood durations due to better drainage capabilities.

The spatial distribution of flood vulnerability in the Lower Orashi Region highlights the urgent need for targeted flood risk management strategies. Improving drainage infrastructure through the construction of stormwater channels, embankments, and flood diversion structures would help reduce water retention in low-lying areas. Regular desilting and maintenance of natural drainage channels is necessary to enhance water flow efficiency. Land-use planning should be reviewed to restrict construction in high flood-risk zones (4–12m elevation) and consider the relocation of highly vulnerable communities to safer areas. Implementing flood-resilient urban planning with green spaces, permeable pavements, and retention basins could also help mitigate future risks.

GIS-based flood forecasting and monitoring should be integrated into early warning systems to provide real-time flood alerts for vulnerable communities. Strengthening community-driven flood preparedness programs can ensure timely evacuation and better disaster response coordination. Addressing these challenges requires a combination of structural and non-structural flood mitigation measures, including drainage improvements, land-use planning, and GIS-based monitoring systems. Integrating geospatial analysis with policy interventions, flood risk management efforts can be more precise, proactive, and community-focused, reducing long-term disaster impacts on vulnerable populations.

5.1.2 Socio-Economic and Demographic Characteristics of Respondents

Flood vulnerability is influenced not only by geophysical factors but also by socio-economic conditions, which determine how individuals and communities prepare for, respond to, and recover from floods. The demographic distribution of respondents (Table 4.2) indicates that flood impacts are experienced almost equally by men and women, with males accounting for 50.3% and females 49.7% of the total respondents. However, women in rural areas face greater flood-related challenges due to limited access to financial resources, caregiving responsibilities, and restricted mobility, which makes them more vulnerable to displacement, economic hardship, and post-flood recovery difficulties.

The age distribution analysis (Table 4.3) shows that young adults (20–30 years) are the most affected group (41.8%), followed by individuals aged 31–40 years (33.0%). This highlights the economic significance of young people in flood-prone areas, as they constitute the primary workforce engaged in farming, trading, and artisanal activities sectors that are highly vulnerable to flood-induced disruptions. The 41–50 age group (20.1%) also represents a considerable proportion of the affected population, while only 5.1% of respondents were above 50 years. The lower representation of older individuals may be due to migration to safer areas or a reduced ability to withstand the physical and economic pressures associated with recurrent flooding.

The high concentration of young people in flood-prone zones emphasises the need for targeted interventions that address youth vulnerability and enhance their adaptive capacity. Implementing youth-focused flood awareness campaigns, incorporating vocational training for alternative livelihoods, and promoting community-led disaster response initiatives can increase resilience and preparedness among economically active populations. Strengthening disaster preparedness programmes tailored for women, including financial support mechanisms, women-led community disaster networks, and improved access to emergency shelters, can also reduce gender-based vulnerabilities during flood events.

The findings underscore the importance of integrating socio-economic considerations into flood risk management policies, ensuring that interventions prioritise vulnerable groups and enhance community resilience through education, economic diversification, and proactive disaster planning.

5.1.3 Economic Impact of Flooding

The economic consequences of flooding in the Lower Orashi Region are severe and widespread, affecting agricultural productivity, business operations, and household financial stability. As presented in Table 4.4, 50.7% of respondents reported significant financial losses due to flooding, while 29.3% experienced moderate losses. The hardest-hit groups include farmers, traders, and small-scale business owners, whose livelihoods are highly dependent on stable environmental conditions. In contrast, 14.7% of respondents suffered slight losses, and only 5.3% reported no significant impact, likely due to their engagement in salaried employment or occupations less affected by weather conditions.

The disproportionate economic burden on farmers and traders is linked to flood-induced crop failures, loss of livestock, damaged marketplaces, and disrupted transportation networks. Many flooded farmlands suffer from soil degradation, erosion, and prolonged waterlogging, reducing agricultural output and leading to food shortages and price inflation in local markets. Similarly, traders and business owners face inventory losses, shop closures, and declining customer patronage, resulting in reduced income and financial instability. The cascading economic effects of flooding extend to daily wage earners, who experience job losses or reduced working hours, further exacerbating poverty levels in affected communities.

The financial resilience of households in the region is limited, with many respondents lacking savings, insurance coverage, or access to formal credit facilities to support post-flood recovery. Table 4.5 indicates that while 62.3% of respondents exhibited some level of resilience, 14.5% reported low or no resilience, highlighting critical gaps in disaster preparedness, financial assistance, and social protection policies. These findings underscore the urgent need for economic recovery strategies to mitigate flood-induced financial distress and promote long-term economic sustainability.

To address these challenges, financial support mechanisms and adaptive economic strategies should be prioritised. Expanding microfinance and credit facilities can provide low-interest loans and grants to help small business owners, farmers, and traders rebuild their enterprises after flood events. Establishing flood insurance schemes can mitigate economic shocks by providing compensation for flood-related losses, ensuring that affected households and businesses have access to recovery funds. Encouraging income diversification through vocational training, alternative farming methods, and climate-resilient business models can enhance household financial stability and reduce dependency on flood-prone activities.

In addition to economic interventions, strengthening community-based resilience strategies is essential to support vulnerable groups in flood-affected areas. Governments and disaster management agencies should integrate financial literacy programs, cash transfer schemes, and post-disaster livelihood support initiatives into broader flood risk management policies. Establishing community savings cooperatives and self-help groups can enable residents to pool financial resources and support one another during post-flood recovery periods. Investments in infrastructure improvements, such as flood-resistant marketplaces and storage facilities, can also enhance business continuity and reduce economic vulnerability in flood-prone areas.

These economic recovery strategies, coupled with enhanced disaster preparedness measures, will contribute to building long-term economic resilience in the Lower Orashi Region, ensuring that households and businesses can withstand and recover from flood-related disruptions more effectively.

5.2 Comparative Analysis with Existing Flood Risk Studies

The findings of this study are consistent with previous flood risk assessments conducted in Nigeria and other coastal flood-prone regions, reinforcing the understanding that low-elevation areas with poor drainage infrastructure face heightened flood risks. Research by Adelekan (2012) and Nkwunonwo et al. (2020) confirms that urban expansion, weak drainage systems, and rapid population growth in Nigeria's low-lying zones significantly contribute to flood susceptibility. Their studies highlight that unplanned settlements and poor enforcement of land-use regulations exacerbate flood impacts, findings that align with the high vulnerability of communities in Ahoada West and Abua/Odual LGAs, as identified in this study.

Similarly, Tehrany et al. (2014) demonstrated that GIS-based flood mapping improves the accuracy of flood risk analysis, allowing for more informed decision-making in disaster risk management. This study's application of Digital Elevation Models (DEM) and spatial analysis techniques further supports this argument, demonstrating that low-lying communities (4–12m elevation) exhibit the highest flood vulnerability, a pattern observed in similar GIS-based flood studies globally. When compared to reports from Nigeria's National Emergency Management Agency (NEMA), this study provides higher spatial resolution and a more localised assessment of flood risk, offering detailed insights into community-level vulnerabilities. While NEMA reports typically focus on broader flood risk assessments at the state or national level, this study integrates socio-economic data with GIS-based models, providing a comprehensive, location-specific approach to flood vulnerability assessment. The results reinforce the importance of incorporating demographic and economic variables into flood risk analysis, ensuring that flood mitigation strategies are both data-driven and tailored to the needs of affected communities.

5.3 Policy Implications for Disaster Risk Management

The findings of this study underscore the urgent need for targeted policy interventions to enhance flood disaster management in the Lower Orashi Region. The integration of structural flood mitigation, community-based disaster preparedness, socio-economic resilience strategies, and improved governmental response mechanisms is essential to reduce flood risks and support affected communities.

Expanding and maintaining drainage systems in high-risk zones is a critical measure for mitigating flood hazards. As shown in Table 4.1, communities situated at low elevations (4–12m above sea level) are particularly vulnerable due to poor drainage infrastructure and high water retention. Constructing embankments and levees can prevent river overflows, particularly in settlements adjacent to major water bodies. Additionally, regular desilting of rivers, canals, and drainage channels is necessary to enhance water flow and prevent blockages that exacerbate flooding.

Community-based disaster preparedness plays a significant role in enhancing local resilience. Findings in Table 4.6 indicate that community engagement is essential in flood risk management, yet participation in awareness programs remains low. Increasing public education on flood preparedness, evacuation protocols, and early warning systems can significantly improve disaster response. Strengthening GIS-based flood early warning systems through real-time monitoring and localised emergency broadcasts will enable timely evacuation and risk reduction strategies. Incorporating traditional knowledge and community-led disaster planning initiatives ensures that flood response measures are culturally appropriate and locally sustainable.

Enhancing socio-economic resilience is necessary to reduce the financial and livelihood-related vulnerabilities associated with flooding. As illustrated in Table 4.4, 50.7% of respondents suffered significant economic losses, highlighting the need for financial protection mechanisms. Implementing flood insurance schemes and providing financial aid for affected households can mitigate the economic impact of recurrent flooding. Supporting alternative livelihood opportunities will also reduce dependency on flood-prone activities such as farming and informal trading. Additionally, promoting climate adaptation training and sustainable land-use practices can help communities develop long-term resilience to environmental changes.

Improving governmental response and policy enforcement is necessary to address gaps in disaster relief and urban planning. As reported in Table 4.8, 44.8% of respondents rated government assistance as effective, while 11.6% reported minimal or no aid, indicating inconsistencies in disaster relief distribution. Stronger coordination between local, state, and federal agencies is required to ensure timely and equitable disaster relief interventions. Additionally, urban planning policies should be strictly enforced to prevent unregulated settlements in flood-prone areas. Implementing land-use zoning regulations and relocating highly vulnerable populations can significantly reduce future flood risks.

These policy recommendations highlight the need for a multi-dimensional approach to flood disaster management, integrating engineering solutions, community-driven strategies, financial resilience programs, and strengthened governance frameworks to ensure long-term flood risk reduction and sustainable development in the Lower Orashi Region.

VI. CONCLUSION

Flooding remains a major environmental and socio-economic challenge in the Lower Orashi Region, particularly in Abua/Odual and Ahoada West LGAs. This study utilised Geospatial Information Systems (GIS), socio-economic surveys, and hydrological analysis to assess flood vulnerability, identify high-risk areas, and propose mitigation strategies. The findings reveal those low-lying settlements (4–12m above sea level) face the highest flood risks, primarily due to poor drainage, proximity to river channels, and flat terrain. The GIS-based flood vulnerability mapping confirmed that inadequate flood control infrastructure significantly increases the risk of water retention and flood stagnation. Socio-economic assessments further highlight that younger populations (20–30 years) and economically disadvantaged groups, particularly farmers and traders, are the most affected, experiencing severe financial losses and livelihood disruptions.

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Additionally, governmental flood response efforts were found to be inconsistent, with a considerable proportion of respondents reporting inadequate or delayed assistance.

Recommendations

Addressing these challenges requires a multi-dimensional approach that integrates structural mitigation measures, community-based initiatives, and geospatial flood monitoring tools to enhance disaster preparedness and response efforts.

1. **Infrastructure Improvement**
   a. Expansion and maintenance of drainage systems, embankments, and flood diversion channels to reduce water stagnation in high-risk areas.
   b. Regular desilting of waterways to prevent blockages and improve water flow.
   c. Enforcement of flood-resilient urban planning policies to prevent construction in flood-prone areas.

2. **Community-Based Flood Mitigation Programs**
   a. Strengthening community awareness campaigns to improve local flood preparedness and emergency response capacity.
   b. Encouraging participatory flood risk management, where residents, local leaders, and government agencies collaborate on disaster response planning.
   c. Establishing local emergency response teams and early warning communication networks to facilitate timely evacuations.

3. **Use of Geospatial Tools for Continuous Flood Monitoring**
   a. Developing GIS-based flood prediction models to enhance early warning systems and improve disaster planning.
   b. Implementing remote sensing technology to track flood-prone areas over time and assess changes in vulnerability levels.
   c. Integrating hydrological and socio-economic data into a comprehensive flood risk management framework for better decision-making.

Contribution to Knowledge

This study advances the methodology of GIS-based flood risk assessment by integrating spatial analysis with socio-economic vulnerability indicators. The application of Digital Elevation Models (DEM) and GIS-based flood mapping provides a detailed and high-resolution assessment of flood-prone areas, allowing for more precise identification of risk levels and targeted intervention strategies. Furthermore, by incorporating community resilience assessments and hydrological analysis, the research contributes to a holistic understanding of flood vulnerability, ensuring that flood management approaches are data-driven, locally relevant, and sustainable.

The insights from this study serve as a valuable reference for policymakers, urban planners, and disaster risk management agencies, guiding the development of effective flood mitigation policies that align with both scientific evidence and community needs. By prioritising GIS-based monitoring, infrastructure development, and community-driven disaster preparedness strategies, flood vulnerability in the Lower Orashi Region can be significantly reduced, enhancing the resilience of at-risk populations and ensuring long-term environmental and economic sustainability.

REFERENCES

1. Adelekan, I. O. (2010). Vulnerability of poor urban coastal communities to climate change in Lagos, Nigeria. *Environment and Urbanization, 22*(2), 433–450. https://doi.org/10.1177/0956247810380141
2. Ajaero, C. K., & Mozie, A. T. (2017). The impact of flooding on the socio-economic livelihoods of people in Nigeria. *Natural Hazards, 88*(1), 1–15. https://doi.org/10.1007/s11069-017-2850-1
3. Altan, O., & Kemper, G. (2010). GIS applications in flood risk management. *Geospatial World, 7*(1), 55–67.
4. Associated Programme on Flood Management (APFM). (2006). *Integrated flood management concept paper.* Geneva: World Meteorological Organization.

5. Bahadur, A., Ibrahim, M., & Tanner, T. (2013). *Characterising resilience: Unpacking the concept for tackling climate change and development.* Institute of Development Studies.
6. Birkmann, J. (2006). *Measuring vulnerability to natural hazards.* United Nations University Press.
7. Blaikie, P., Cannon, T., Davis, I., & Wisner, B. (1994). *At risk: Natural hazards, people's vulnerability and disasters.* Routledge.
8. Cohen, S., Kettner, A., & Syvitski, J. (2017). Global environmental change and flood risk modeling. *Journal of Hydrology, 545*, 476–493. https://doi.org/10.1016/j.jhydrol.2016.12.004
9. Crichton, D. (1999). The risk triangle. In J. Ingleton (Ed.), *Natural disaster management* (pp. 102–103). Tudor Rose.
10. Cutter, S. L., Boruff, B. J., & Shirley, W. L. (2003). Social vulnerability to environmental hazards. *Social Science Quarterly, 84*(2), 242–261. https://doi.org/10.1111/1540-6237.8402002
11. Cutter, S. L., Emrich, C. T., Webb, J. J., & Morath, D. (2008). *Social vulnerability to climate variability hazards: A review of the literature.* Oak Ridge National Laboratory.
12. Department for International Development (DFID). (1999). *Sustainable livelihoods guidance sheets.* London, UK: DFID.
13. Folke, C. (2006). Resilience: The emergence of a perspective for social–ecological systems analyses. *Global Environmental Change, 16*(3), 253–267. https://doi.org/10.1016/j.gloenvcha.2006.04.002
14. Garschagen, M. (2013). Resilience and organizational institutionalism: From adaptive capacity to institutional transformation. *Journal of Environmental Planning and Management, 56*(3), 341–358. https://doi.org/10.1080/09640568.2012.681021
15. Global Water Partnership & World Meteorological Organization (GWP & WMO). (2015). *Integrated flood management tools series.* Geneva: WMO.
16. Hegger, D. L. T., Driessen, P. P. J., Dieperink, C., Wiering, M., Raadgever, G. T., & van Rijswick, H. F. M. W. (2013). Flood risk management strategies in the Netherlands. *Journal of Environmental Policy & Planning, 15*(2), 175–194. https://doi.org/10.1080/1523908X.2013.763713
17. Holling, C. S. (1973). Resilience and stability of ecological systems. *Annual Review of Ecology and Systematics, 4*(1), 1–23. https://doi.org/10.1146/annurev.es.04.110173.000245
18. Intergovernmental Panel on Climate Change (IPCC). (2014). *Climate change 2014: Impacts, adaptation, and vulnerability.* Cambridge University Press.
19. Jeb, D. N., & Aggarwal, S. P. (2008). Flood inundation hazard modeling of the River Kaduna using remote sensing and geographic information systems. *Journal of Applied Sciences Research, 4*(12), 1822–1833.
20. Jongman, B., Ward, P. J., & Aerts, J. C. (2015). Global exposure to river and coastal flooding: Long-term trends and changes. *Global Environmental Change, 31*, 67–82. https://doi.org/10.1016/j.gloenvcha.2015.01.002
21. Kienberger, S. (2014). Mapping vulnerability to natural hazards in developing countries: Challenges and opportunities. *Applied Geography, 51*, 52–62. https://doi.org/10.1016/j.apgeog.2014.03.013
22. Manyena, S. B., Fordham, M., & Collins, A. E. (2011). Disaster resilience: A bounce-back or bounce-forward ability? *Local Environment, 16*(5), 417–424. https://doi.org/10.1080/13549839.2011.583049
23. Matczak, P., Hegger, D. L. T., Jacobs, K., & Mees, H. L. P. (2017). The flood risk governance chain. *Environmental Science & Policy, 72*, 9–18. https://doi.org/10.1016/j.envsci.2017.02.013
24. Nkwunonwo, U. C., Whitworth, M., & Baily, B. (2016). A review of the current status of flood modeling for urban flood risk management in the developing world. *Scientific Research and Essays, 11*(8), 47–60.
25. Ogba, C. O., Ajayi, O., & Nwosu, E. (2016). Hydrology and flood risks in the Niger Delta. *Journal of Water Resources, 5*(2), 89–102.
26. Ologunorisa, T. E. (2004). An assessment of flood vulnerability zones in the Niger Delta, Nigeria. *International Journal of Environmental Studies, 61*(1), 31–38. https://doi.org/10.1080/0020723032000161455
27. Reed, M. S. (2008). Stakeholder participation for environmental management: A literature review. *Biological Conservation, 141*(10), 2417–2431. https://doi.org/10.1016/j.biocon.2008.07.014
28. Tehrany, M. S., Pradhan, B., & Jebur, M. N. (2014). Flood susceptibility mapping using GIS-based hybrid approaches. *Natural Hazards, 73*(2), 75–99. https://doi.org/10.1007/s11069-014-1089-3
29. United Nations Educational, Scientific and Cultural Organization (UNESCO). (2020). *The role of remote sensing in flood disaster management.* UNESCO.
30. Walker, B., Holling, C. S., Carpenter, S. R., & Kinzig, A. (2004). Resilience, adaptability, and transformability in social–ecological systems. *Ecology and Society, 9*(2), 5. https://doi.org/10.5751/ES-00650-090205
31. Wisner, B., Gaillard, J. C., & Kelman, I. (2004). *Handbook of hazards and disaster risk reduction.* Routledge.

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32. laikie, P., Cannon, T., Davis, I., & Wisner, B. (1994). *At Risk: Natural Hazards, People's Vulnerability, and Disasters.* Routledge.
33. Crichton, D. (1999). *The Risk Triangle.* Natural Disaster Management, 102(3).
34. Tehrany, M. S., Pradhan, B., & Jebur, M. N. (2014). Flood susceptibility mapping using a novel ensemble weight-of-evidence and support vector machine models in GIS. *Journal of Hydrology, 512*, 332–343.
35. Wisner, B., Blaikie, P., Cannon, T., & Davis, I. (2004). *Handbook of Hazards and Disaster Risk Reduction.* Routledge.

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