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Flooding Mitigation Infrastructure Analysis using GIS in Ilaje Coastal Region of Ondo State, Nigeria.

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Abstract

Flooding is an environmental hazard that needs appropriate control measures to stem the tide of occurrence. This paper examines: the characteristics of residents; causes and effects of flooding; and the flooding mitigation measures adopted by the people of Ilaje coastal communities of Ondo-State, Nigeria. The empirical research method was adopted to describe the causes and other variables associated with flooding in the study area. Primary data on socio-economic characteristics of respondents were captured using a structured questionnaire; while the Geographic Information System was used to analyze the Google Image of Ilaje Region on the vulnerability of communities to flooding. Twelve political Wards, were randomly selected for the administration of questionnaires in the study area. Ten percent (10%) sample size was adopted for questionnaire administration due to homogeneity characterizing the study population. Empirical analysis shows that, flooding is rampant between the months of November and March due to heavy rainfall and sea-surge. Raising of furniture, evacuation and construction of flood barriers were the adopted mitigation strategies. This paper canvasses regular channelization and dredging of water paths by appropriate local and state government agencies. In addition, a sustainable urban planning strategies is recommended for effective and sustainable mitigation measures.

Keywords: Flooding, Mitigation, Infrastructure, Ilaje, GIS

1.0 Introduction

FEMA (2016) define flood as a general and transient occurrence that ensue when two or more acres of typically dry land area or two or more properties are partially or completely submerged. Floods are currently regarded as the most frequent natural hazard inflicting enormous mortality in communities across the globe (Doocy et al., 2013). According to Hashizume (2013), floods are the most common natural disaster in the world, affecting over 2.8 billion people and causing over 200,000 fatalities in the last three decades.

Flooding is a natural occurrence that devastates large areas, negatively impacts day-to-day activities, and increases susceptibility to environmental, social, economic, and bodily harm (Chan, et al., 2022). Not only has it left many homeless, but it has also damaged property, disrupted commercial activities, and exposed the community to a wave of water illnesses like cholera, diarrhea, malaria, skin

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infections, and others (Olajuyigbe, Rotowa & Durojaye, 2012).

According to Rudari (2017), of all the natural hazards in the globe, floods have the most frequency and geographical dispersion. Due to the large number of fatalities, expensive damage to property, and loss of human life, it continues to be the second deadliest weather-related hazard and has negatively impacted many other societies in most parts of the world. Like in many impoverished countries, Nigeria is known for having more catastrophic flooding effects since many of its people are more vulnerable. For instance, the National Emergency Management Agency (NEMA) observed that Nigeria witnessed severe flooding from July to November 2012, resulting in over 2.1 million displaced people, 363 confirmed deaths, and losses estimated at N2.6 trillion (Ogunlesi, 2016). By the end of 2050, it is also expected that the amount of damage caused by floods worldwide would have doubled Chan et al., (2022). Also, Abbas et al., (2009) noted that , by 2030, the impact of flooding on people who live within 100 kilometers of the shore is expected to be significantly more serious. The likelihood of flooding was further enhanced by the mix of homes in built-up regions and the population's constant growth. Future population growth will have a greater impact on flooding (Walker & Burningham, 2011).

Flooding in developing nations is caused by a variety of factors, including unchecked rapid population expansion, poor preparedness, lack of political will, heavy precipitation, building on streams, sea level rise, soil moisture regime, and dam operations, particularly near borders. There are anthropogenic and natural causes of flooding (Abolade, Muili, & Ikotun, 2013). According to MacLeod et al. (2021), flooding is mostly caused by an increase in precipitation, which is a result of climate change. Moreover, Tramblay et al., (2021) associate flood occurrence more with the maximum soil moisture content than with the highest precipitation amount.

Aja & Olaore (2014) stated that in Nigeria, flooding is the most frequent natural disaster and this is due to increased precipitation due to climate change and that the majority of Nigeria's states are experiencing an increase in yearly floods throughout the rainy seasons. Flooding is Nigeria's most frequent environmental threat (Etuonovbe, 2011) with various effects ranging from erosive and structural damage to human and animal deaths, serious disruption of socioeconomic activities, agricultural land destruction, human relocation and pollution of water supplies among others

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(Adeniyi and Omole, 2015). Millions of people have been displaced from their homes due to flooding in several parts of Nigeria, which has also damaged businesses, contaminated water supplies, and raised the danger of disease (Etuonovbe, 2011). Floods also traumatize victims and their families for long period of time and the psychological impacts can be long lasting (Lamond, 2014).

Floods in Ilaje have a significant societal impact on both communities and individuals. One-on-one contact with the Ilaje people revealed that the immediate effects of floods include: loss of life, property damage, crop devastation, animal loss, and worsening health due to water-borne illnesses among others. Damage to public infrastructures affects a far greater proportion of the population than those whose homes or businesses are directly inundated by the flood.

It is therefore obvious that flood damage has high economic implications, and governments can distribute resources more wisely by knowing how successful mitigation techniques are (Merz, Kreibich, Schwarze & Thieken, 2010). In order to curb continuous damaging capacity of flooding, formidable mitigation measures are required. However, many studies have examined the efficacy of flood protection techniques, with varying degrees of success. Some contend that the effectiveness of these interventions may not be as great as initially thought (Pardoe, Penning-Rowsell & Tunstall, 2017). Therefore, more research is obviously needed to make sure that the most practical and efficient mitigation strategies are implemented, especially when new technologies are involved in such researches. This study therefore attempted the use of Geographic Information System (GIS) technology and structured questionnaires to evaluate the efficacy of flood prevention strategies by the people of Ilaje region of Ondo State.

Flooding is a common phenomenon all over the world. It is more rampant and distressing in the developing countries like Nigeria (Aderogba, Oredipe, Oderinde, & Afelumo, 2012). Flooding is normally caused by natural weather events as heavy rainfall and thunderstorms over a short period, prolonged rainfall or extensive rainfall. For instance, Aladelokun and Ajayi, (2014) stated that Floods normally occur on flat or low-lying terrain areas in the metropolis especially where little or no provision has been made for surface drainage or where existing drainage has been blocked with municipal waste, refuse and eroded soil sediments. Due to climate change and other human-caused factors, flooding has emerged as one of the most common disasters globally and is expected to become more frequent in the upcoming years

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(Mumuni, 2013) as many people have been forced from their homes and are now environmental refugees (Sarwar, 2005).

Olajuyigbe, Rotowa and Durojaye (2012) assessed flood hazard in Nigeria with specific focus on factors responsible for perennial flooding in Mile-12 Area of Lagos, Nigeria. The result shows that the perennial flooding problem in Mile-12 is as a result of consistent high rainfall and water releases from dam in the neighboring state of Ogun, Nigeria. Other causes of flood in the study area include blockage of drainage channels by refuse and other wastes, narrow river channels and construction along floodplains. In Surulere, Lagos, Okoye & Ojeh (2015) found critical causative elements that lead to flooding. They created a digital elevation map using GIS. They came to the conclusion that Surulere is vulnerable to floods due to elements including excessive rainfall and duration, urbanization, and soil impermeability. Changes in land use, such as urbanization, were identified by Adegboyega, Onuoha, Adesuji, Olajuyigbe, Olufemi, and Ibitoye (2018) as a cause of urban floods. According to Abolade, Muili, and Ikotun (2013), excessive precipitation is a natural cause. According to these writers, human factors include improper drainage, trash disposal in waterways, construction near waterways, and overflowing rivers and dams. These primary causes include encroachment, excessive rain, poor drainage systems, and canal blockages. Agbonkhese, Agbonkhese, Aka, Joe-Abaya, Ocholi, & Adekunle (2021) conclude that flooding is mostly caused by excessive or heavy precipitation; other contributing factors include anthropogenic activity and climate change. According to Komolafe, Adegboyega, and Akinluyi (2015), river storms and intense rainfall are the two natural causes. Anthropogenic causes include burst water pipelines, insufficient drainage systems, and dam overflow. The main causes of flooding in Nigeria and Ghana, according to Echendu (2022), are anthropogenic and exacerbate the consequences of heavy rainfall; however, the effects of these can be lessened by risk-management techniques and infrastructure planning. Nwigwe and Embergo (2014) evaluated the causes and consequences of floods in Nigeria in a study that was comparable. Their research revealed that the main causes of flooding in Nigeria's major cities and towns were the construction of illegal structures on or across drainage channels, land reclamation or encroachment, inadequate drainage channels, obstructions of canals and drains, collapsed dams, and topography. Olajuyigbe et al. (2012), identified high river

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levels, concentrated overland flow brought on by heavy rainfall, the incapacity of drainage systems, and the obstruction of rivers and drainage channels designed to assist surface runoffs as the main causes of flooding in Lagos.

The effects of floods on people and communities in Nigeria have been the subject of numerous studies, some of which have included demographic surveys to suggest ways to mitigate the effects. In the works of Saleem et al. (2013), the impact of flooding on agriculture (Punjab,s main source of income) was significant, exposing the community to food scarcity and other hazards such as property damage, contaminated water, and even fatalities. In Ajegunle, a suburb of Lagos state, Nigeria, Dalil, Mohammad, Yamman, Husaini, & Mohammed (2015) opined that following a flood, individuals, primarily children, die from watery illnesses such as diarrhea, cholera, dysentery, typhoid fever, and malaria; while Oyekale (2013) posited that the bulk of the homes in Lagos state were found to use wells as their primary source of water, but flooding contaminates the wells and can lead to illnesses, where children and older age groups were shown to be the most vulnerable groups.

Flooding Mitigation: Kapucu, Christopher & Fernando, (2013) posited that mitigation refers to a consistent course of action aimed at reducing or eliminating hazards to individuals or property. The authors further identified three common objectives of mitigation as: to decrease the risk to life and property; decrease a community's vulnerability to damage caused by natural disasters; and reducing the possibility of a future disaster. Da Silva et al. (2020) opined that there is an urgent need to deal with flood events in order to develop future flood management strategies to reduce the adverse consequences and cope with more complex types of floods. Series of practices to manage storm water and flood disasters have been practiced in many nations of the world, these include: Green Infrastructure (GI), Low-impact Development (LID) and Best Management Practices (BMP), USA; Sustainable Urban Drainage Systems (SUDS), United Kingdom; Water Sensitive Urban Design (WSUD), Australia; and Low-impact Urban Design and Development Programs (LIUDD), New Zealand among others (Fletcher et al., 2014). In China, the concept of the “sponge city” was adopted to increase a city's resilience to cope with natural disasters caused by rainfall-induced climate changes (Guan et al., 2021).

Green and Raygorodetsky (2010); Newsham and Thomas (2011) identified engineering, scientific and traditional approaches as global means of mitigating and responding to coastal

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flooding and areas prone to flood disasters. The traditional method in which the local populations build on their experiences and strength to develop climate change resilience and appropriate responses was singled out as the most sustainable approach. Huang, Li, and Xu, (2019) identified structural measures like floodwalls and levees as more effective than non-structural interventions such as floodplain zoning and public awareness initiatives. However, Filatova, Bokhove, Mynett, Kanning & Voortman, (2018) opined that it was more beneficial to combine structural and non-structural interventions like early warning systems, retention basins, and green roofs than to take them all alone.

From the ongoing, it is apposite to adopt one or more of the following steps to reduce the risk of flooding and reinforce the community's resilience to flooding and its after effects. For instance, structural measures such as building of embankments to rivers; detention basins (dams for flood control); and channelization of river courses are formidable measures to flooding control in the built environment. The non-structural approaches such as Land use planning control; House Raising, where applicable; Flood proofing; Building construction with resilient materials; Removal of buildings from the floodplains; Flood Mapping using GIS and Remote Sensing (RS); Education/awareness campaigns; raising community awareness of flooding issues; Flood forecasting and warning; meaningful and timely preparation of flood forecasts and Disaster Management Planning and emergency services response among others.

GIS and Flooding

The most popular approach to delineate and map flood-prone areas worldwide and in Nigeria is the use of Remote Sensing (RS) and Geographic Information Systems (GIS) techniques. Jeb & Aggarwal (2008) investigated flooding in Kaduna metropolis using GIS and revealed that locations near the River Kaduna are highly vulnerable to flooding. Also, Nkeki, Henah, & Ojeh (2013) analyzed flood risk along the Niger-Benue basin using Remote Sensing data to show locations that were susceptible to flooding in the study area. A spatial analysis of flood risk in the Aba metropolis was conducted by Njoku, Amangabara, and Duru (2013) using GIS methodologies and discovered that areas 35–39 meters and 43–48 meters above sea level are vulnerable to flooding because runoff from higher altitudes passes through areas of lower elevations. Dalil et al., (2015) mapped the flood-prone areas in Minna, Niger State, using the ArcView GIS package and revealed that human activities were primarily responsible for flooding in the city. To cap it all, Adewumi,

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Akomolafe, Ajibade, & Fabeku (2016) used GIS and RS techniques to identify flood-prone locations in Igbokoda town in Ondo State. Therefore, GIS and Satellite imageries were employed in this study to map out accurate location of communities prone to flooding disaster in the study area.

2.0: The Study Area:

2.1 Research Locale:

The study area is Ilaje Local Government Area (LGA) of Ondo State, Nigeria. In October 1st, 1996, Ilaje LGA was carved out of the the old Ilaje/Ese-Odo LGA. The Ilaje LGA occupied a total land area of 2,300 square kilometers. It is located within Latitude 60 00´ and 60 20´ North and Longitude 40 45´and 50 45´ East of the Greenwich Meridien. The bulk of Ondo State's coastline region is contained in the Ilaje LGA, with the town of Igbokoda serving as the administrative headquarter. The Atlantic Ocean forms its southern boundary, Ogun State borders it on the West, Delta State borders it on the East, and the Ese-Odo LGA of Ondo State borders it on the North (Ilaje Renaissance, 2013). Based on a growth rate of 3.18 (NPC 2006), the predicted population of Ilaje LGA is 397,442, up from the 290,615 figures from the 2006 census (NPC, 2006)

From a geomorphological standpoint, the Ilaje shoreline in Ondo State, Nigeria, is known as the Mahin Transgressive Mud Coast. The coast is the longest mud coast in Nigeria with approximately 180km. The shoreline is located inside the wider geographic area known as the Niger Delta and is adjacent to the Atlantic Ocean (Mafimisebi & Ogbonna, 2016). It lies between latitudes 5◦45′ and 6◦30′ north of the equator and longitudes 4◦30′ and 5◦07′ east of Greenwich. It stretches along the Nigerian coast for about 84 kilometers.

The Ilaje tribe is the largest tribe in Ondo State and fishing is the most common occupation. In addition to providing great places to fish, the seaside environment is also great for boating, swimming, sport fishing, picnics, boat regattas and diving among others. The Ilaje coast is laden with mud with an erosional shoreline, in contrast to the majority of Nigeria's coastline, which is depositional in character (Sexton and Murday, 1994). Because of the area's typically flat and low-lying geology, floods and coastline erosion are major risks, especially during high tides. The environment is made up of sediments that are quickly eroded and susceptible to washing by even little waves or tidal activity. The erosive processes are further aided by the Mahin Canyon's effect (Ibe, 1988). Awosika et al., (2001) reported a semi-diurnal tide with two inequalities along the shoreline and produces tidal currents that follow the tidal cycles.

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With an average annual rainfall of 2721mm and an average temperature of 27.8 0C, the Ilaje region has a tropical climate (Fasona, Omojola, & Soneye, 2011). The map of study area is as depicted in Figure 1.

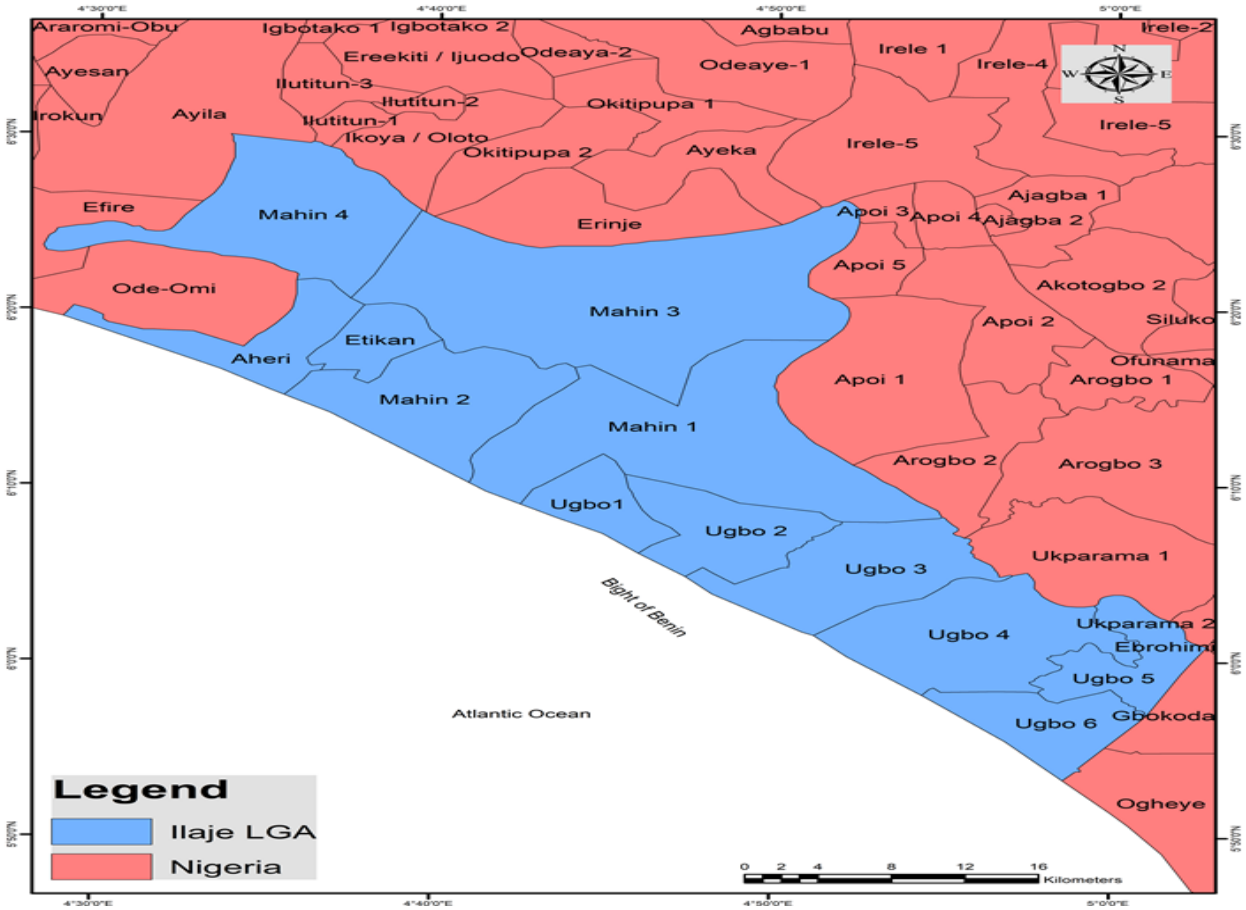


Figure 1: Map of Ilaje LGA
Source: Ilaje Local Government Office: Digitized in ArcGIS by the Author.

2.2: Methods

There are twelve (12) political Wards the study area; these Wards constitute the sampling frame for this study. One community from each of the twelve (12) political Wards were purposively selected for sampling purposes considering homogeneity and proximity of the communities to the sea shore. These communities include: Zionpepe, Agba-Etikan, Ugbo-Nla, Ipare, Igbokoda, Atijere, Eruna, Idi- Ogba, Ilowo-otumara, Obenla, Obepewoye, and Ubajakere. The target population for this study is the entire population of Ilaje LGA. The population was calculated using each community's estimated population from the 1991 population census up to 2023. Due to the rural nature of the communities, a 2.5% growth rate was adopted to project the population to 2023 giving a total

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estimated population of 105,642. The sampling process in the selected communities is as depicted in Table 1.

Table 1: Sampling in the Selected Communities in Ilaje LGA

S/N	Political Wards	Selected Communities	*NPC Figure (1991)	**Projected Population (2023)	0.2% Sample
1	Alheri	Zion pepe	4,465	9,841	20
2	Etikan	Agba-Etikan	3,185	6,960	14
3	Mahin I	Ugbo Nla	7,166	15,793	32
4	Mahin II	Ipare	2,070	4,562	9
5	Mahin III	Igbokoda	11,534	25,420	51
6	Mahin IV	Atijere	3,389	7,469	15
7	Ugbo I	Eruna	1,784	3,931	8
8	Ugbo II	Idi-Ogba	3,901	8,598	17
9	Ugbo III	Ilowo-otumara	1,396	3,077	6
10	Ugbo IV	Obenla	3,461	7,629	15
11	Ugbo VI	Obepewoye	3,660	8,067	16
12	Ugbo VII	Ubajakere	1,949	4,295	9
		Total	**47,960**	**105,642**	**212**

Source: *NPC (1991), **Author's Calculation, (2023).

Out of the total population of 105,642, a 0.2% sample size of 212 was adopted. The Research Schedule variant of questionnaire administration and the Interview Guide was used to collect primary data; while the Geographical Information system (GIS) ArcGIS 10.7.1, was used to collect and process spatial data. The IBM Statistical Package for Social Scientists (SPSS) version 22 and Microsoft Excel 2013 were used for data coding and processing of descriptive statistics, the result of which were presented in tables and charts. Additionally, photo documentation was used with well-written notes on each chosen point of interest along the planned path.

3.0: Discussion of Results

This section presents the data analysis and results of the study which include: socio-economic characteristics of respondents; factors responsible for flooding occurrence; periods of flooding; depth and main causes of flooding; impact of flooding and mitigation measure adopted by the people to control flooding among others.

3.1 Socio-Economic Characteristics of Respondents in Ilaje LGA

The socio-economic variables considered relevant to flooding mitigation were investigated in this paper; these are as shown in Table 2.

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Table 2: Socio-economic Characteristics of the Residents (N=212)

Variables	Classification	Frequency	Percentage
Gender	Male	154	72.6%
	Female	58	27.4%
Age group	18-25	10	4.7%
	26-35	79	37.3%
	36-45	92	43.4%
	46-55	24	11.3%
	56 and above	7	3.3%
Marital Status	Single	50	23.6%
	Married	110	52%
	Divorced	6	2.8%
	Widower	32	15.0%
	Separated	14	6.6%
Level of Educ.	None	40	18.9%
	Primary	90	42.5%
	Secondary	56	26.4%
	Tertiary	26	12.3%
Occupation	Public	27	12.7%
	Private Sector	40	24.8%
	Self Employed	116	54.7%
	Student	18	7.1%
	Retired	11	5.2%
Household Size	1-3	66	31.1%
	4-6	110	51.9%
	7-9	27	12.7%
	> 10	9	4.2%
Monthly Income	#30,000 - #60,000	115	54.2%
	#30,000 - #90,000	50	23.6%
	#90,000 - #120,000	28	13.2%
	> #120,000	19	9%
Tenure	Tenancy	118	55.7%
	Owner-occupied	94	44.3%

Source: Authors' Fieldwork, 2024

From Table 2, a substantial gender gap is obvious, with 72.6% male and 27.4% female representation. Traditional gender roles, livelihood patterns that put men at risk, and women's lower levels of awareness and education are the main causes of this imbalance. This scenario shows that men are at the forefront of flood extenuation in the study area.

On age distribution, 18-25 age group constitutes 4.7% of the total number of respondents; while 26-35, 36-45, 46-55 and 56 years and above age groups constitute 37.3%, 43.4%,11.3% and 3.3% respectively. From the on-going, it is obvious that majority of respondents who are in the prime of their careers, youthful and raising families constitute over 80% of the respondents.

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This shows that the appropriate respondents who are active and could contribute to flooding mitigation affecting their houses, jobs and safety in the study area, were involved in the study.

Marital status of respondents shows that singles constitute 23.6%; married, 52.0%; divorced, 2.8%; widowed, 15.0%; and separated, 6.6%. This analysis shows that singles might not have support system for flooding mitigation while married people may benefit from shared resources. However, due to altered household structures and possible financial instability, divorced and widowed people are more vulnerable to flooding; while individuals who are separated tend to exhibit family disintegration, which exacerbates vulnerability during floods.

On level of education, respondents with primary education constitute about 42.5% of the total number of respondents. Respondents with secondary and tertiary education constitute 26.4 and 12.3% respectively; while those without any formal education constitutes 18.9%. Different levels of vulnerability and resilience are highlighted by educational status. Educated individuals most likely have better access to knowledge and decision-making skills, which improves community resilience to flooding. From the on-going, it is obvious that about 61.4% (None + primary) of respondents may have difficulty recognizing and addressing flood risks, which may call for focused interventions.

Occupational distribution of respondents reveals that the majority (54.7%) are self-employed who likely engaged in small-scale businesses, farming or fishing activities. This group may have a vested interest in flood mitigation measures that protect their livelihoods and properties. The second-largest group (18.9%) is employed in the private sector, suggesting a significant number of wage earners who might prioritize measures that safeguard their ability to commute to work. However, government employees (12.7%) may advocate for public investment in flood control infrastructure and policies, as their salaries are funded by tax revenues. Students (7.1%) and retirees (5.2%) are smaller but still notable segments of the population that could be disproportionately impacted by flooding due to their generally limited financial resources and potential mobility challenges.

The household size data revealed a predominance of medium-sized households (4-6 members, 51.9%), Larger households may be more vulnerable during floods due to limited resources, overcrowding, or the presence of

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vulnerable members (e.g., elderly, young children). followed by smaller households (1-3 members, 33.1%), with larger households (7-9 members, 12.7%) and very large households (>10 members, 4.2%) being less common.

Income distribution analysis shows that 54.2% of respondents were in the #30,000–#60,000 income range. This suggests that while putting flood protection measures into place, cost can be an issue because these households do not have a lot of money to spare for such projects.
a sizeable percentage of the population falls into the lower to middle income level, as seen by the income distribution data, which showed that. Equally, financial restrictions may be the bane of significant percentage of respondents (23.6%) who earn between #60,000 and #90,000 and (13.2%) who earn between #90,000 and #120,000. This further suggests that even people with slightly higher salaries may have difficulty paying for flood prevention measures due to inflation and high cost of materials in the country presently. Only a meagre 9.0 % of households reported having earnings over #120,000. Indicating that a lower percentage of people fall into this upper income category.

3.2 Identification of flood prone areas in Ilaje

The areas susceptible to flooding in the study area are as shown in Figure 2. It is pertinent to note that the built-up area which occupies about 178.6 Sq Kms of land area with a corresponding 13.18% of the total land area are located along the coast; this is at the expense of Bare land which occupies about 30.0% of the total land area.

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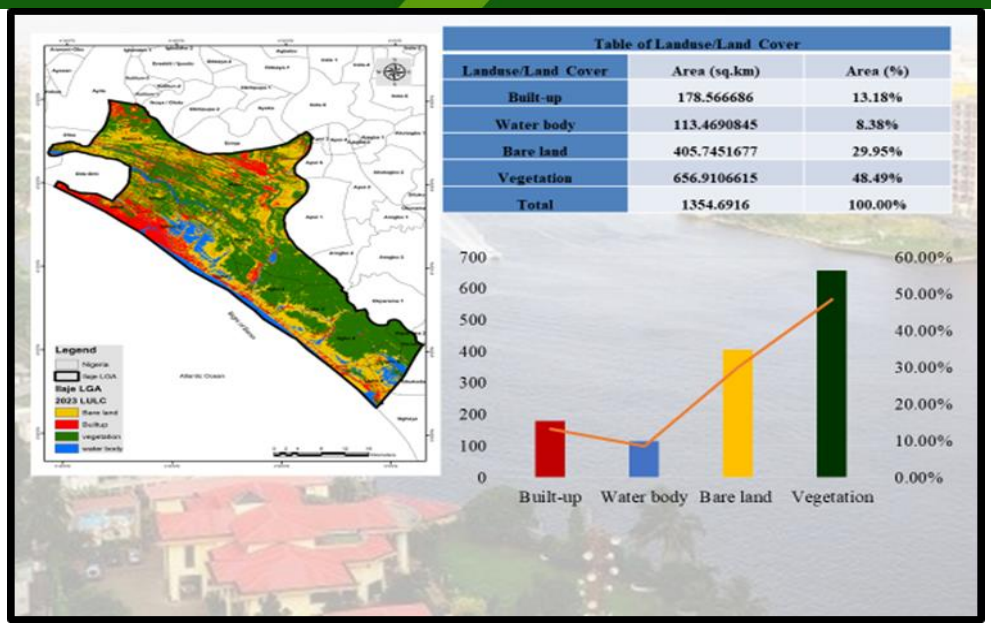


Figure 2: Landuse/Land cover map of the study area.
Source: The Author (2024)

This phenomenon shows that the people prefer to build very close to the ocean rather than building on the Bare land, which is understandable for the economic benefits derivable from fishing – the major occupation, in the study area.

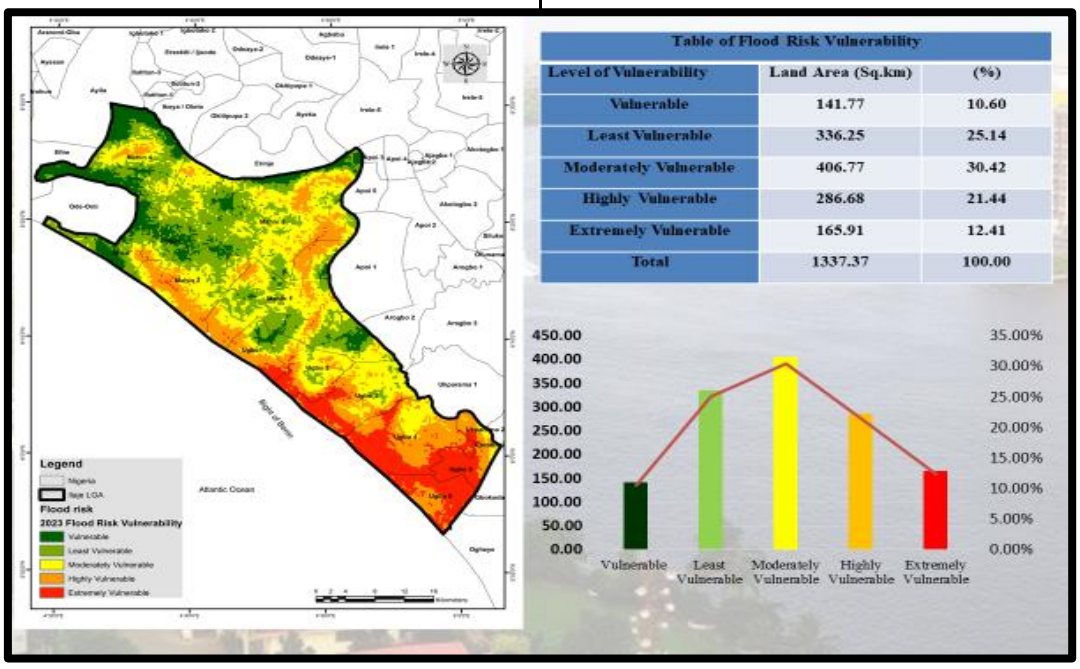


Figure 3: Flood Risk Vulnerability Map of the study area.
Source: The Author (2024)

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Figure 3 shows the analysis of flooding vulnerability in Ilaje. The analysis shows that five (5) levels of vulnerability were identified namely: vulnerable (10.6%); least vulnerable (25.1%); moderately vulnerable (30.42%); highly and extremely vulnerable (21.4 and 12.41% respectively). This phenomenon shows that about 33.81% of respondents agree that the study area is highly/extremely vulnerable to flooding covering a total land area of 446.63, which represents about 33.4% of the total land area.

3.2 Types of Buildings in the Study Area:

A considerable majority of respondents (42.5%) live in bungalows, which suggests that a substantial segment of the population may reside in low-rise buildings, which are more prone to flooding. Additionally, a high percentage of respondents live in face-to-face housing of bungalows (29.7%); this is followed by of respondents who live in face-to-face housing of multistorey structures (17.0%) and 12.3% of respondents who live in traditional housing types, which may also be more prone to floods depending on the building materials and methods utilized in the building construction. From the ongoing, it is evident that over 83.0% of respondents live in buildings that are susceptible to flooding.

3.3 Ownership of Buildings:

Information on building ownership (Table: 3.0) shows that more than half 55.7% of respondents live in rented homes, indicating that a sizeable section of the populace does not have the financial means or decision-making authority to independently adopt flood protection measures. Home owners, which constitute about 44.3% of respondents have a direct stake in preventing flood damage, they may have more control and incentive to invest in flood mitigation measures than renters, who frequently rely on landlords or property owners to make structural improvements or modifications to the homes they occupy.

Also, from Table 3, empirical analysis shows that respondents living in mud-buildings constitute about 30.2% while those living in plank-buildings constitute about 16.3% which make them more susceptible to the negative effects of flooding, such as structural damage, erosion, and collapse. Respondents living in brick-built buildings constitute about 47.2% of the total number of respondents. Obviously, brick buildings are comparatively more resilient and less vulnerable to flood damage. Therefore, majority of respondents (53.0%) live in buildings that are more vulnerable to flooding.

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Table 3: Building Characteristics in Ilaje LGA N = 215

Variable	Classification	Frequency	Percent
Building Type	Bungalow (Flat)	90	42.5
	Face to Face	63	29.7
	Storey	33	15.5
	Traditional	26	12.3
Tenure	Tenancy	118	55.7
	Owner-occupied	94	44.3
Building Material	Mud	64	30.2
	Bricks	100	47.2
	planks	34	16.3
	Others	14	6.6

Source: Authors' Fieldwork, 2024

3.4 Flooding Characteristics in Ilaje:

The period of flooding occurrence in the study area is crucial to the preparation to combating floods in the study area. Figure 4 shows the period of flooding occurrence in Ilaje area of Ondo State. From Figure 4, it is evident that about 52.8% of respondents indicated that flooding occurs "very often" , 37.7% reported 'often'; while 10.8% stated that flooding 'rarely occur', However, a lesser percentage, 4.2% claimed that flooding never occur in their area. This phenomenon shows that over 95.0% of respondents experience flooding in their areas. The implication is that flooding is a common occurrence in the study area.

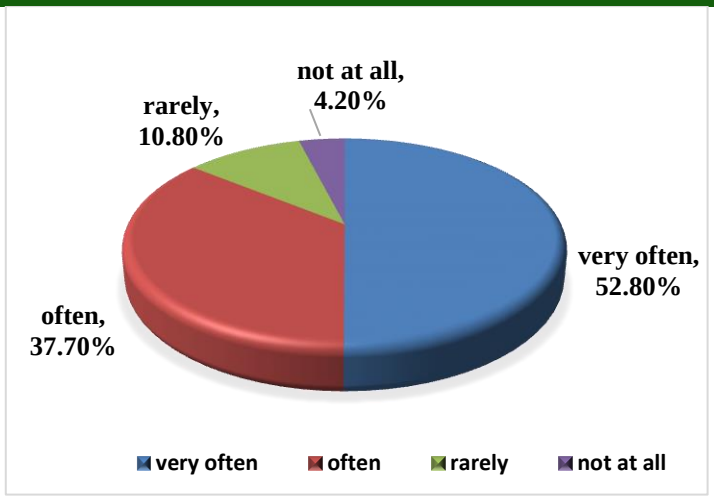


Figure 4: Occurrence of flooding in the Study area
Source: Author s' Fieldwork, 2024

Figure 5 shows the period of flood occurrence in the study area. Empirical analysis shows that 43.4% of respondents indicated that flooding occurs whenever there is intense and heavy rainfall between the month of March to October; while 36.3% indicated that flooding occurs in the study area between the month of November to March. However, which could occur anytime of the year due to the climatic situation at any period of time. About 36.3% of respondents signified that flooding occurs mostly during the raining season. However, 16.0% of respondents revealed that flooding occurs all the year round while a meagre 4.2% stated that flooding rarely occurs in the study area. From the on-going, it is evident that flooding is mostly associated with raining periods while there is less flooding during the dry seasons. The claim of flooding by some

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respondents throughout the year round could be as a result of Climate change in certain parts of the study area as those living in the upland regions may seldom or never experience flooding.

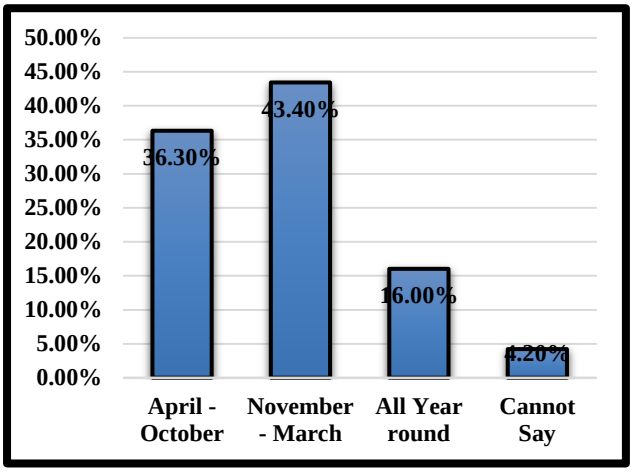


Figure 5: Period of Flood Occurrence
Source: Authors' Fieldwork, 2024

3.5 Depth of flooding in the Study Area

This paper investigated the depth of flood water in communities within the study area and found out differences in flood depths from locality to locality. Figure 6 reveals respondents' perception on the depth of flood waters during the peak periods. For instance, 16.0% of respondents experience flood depth of less than 30cm in their communities; 45.8% experience flood depth of between 30-90 cm; while 32.5% and 5.7% experience flood depths of 91-150cm and above 150cm respectively in their communities. From the on-going, it is obvious that respondents experience flood depths from shallow to moderate, severe and extreme situations respectively. The implication is that no matter the depth of flood water, flooding poses a great danger to infrastructure, property, and safety in all the communities in the study area.

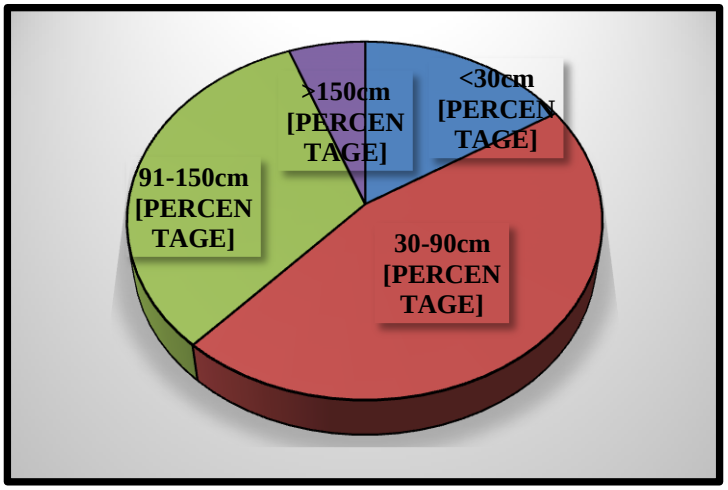


Figure 6: Depth of flood water in the study area
Source: Authors' Fieldwork, 2024

3.6 Flooding mitigation measures adopted by residents in the study area

Figure 7 shows different strategies adopted by respondents in coping with flooding in the study area. Majority of the residents (46.7%) adopted the Evacuation strategy i.e relocation from flood-prone areas to safer locations since water may take days before it subsides. Also, 42.9% of respondents adopted barrier construction such as sandbags, walls, or levees to prevent floodwaters from entering their properties; 31.6% adopted Raising Furniture and belongings above the anticipated flood level in order to minimize damage to personal property

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during floods. This strategy is common to most residents who live in moderate flood depth areas (see Figure 6).

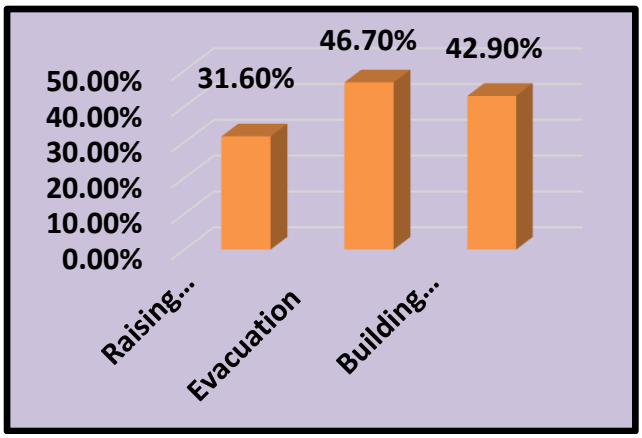


Figure 7: Flooding mitigation measures adopted by residents
Source: Authors' Fieldwork, 2024

3.7 Respondents' Suggested Flood Mitigation Strategies in the Study Area.

The respondents' suggested flood mitigation strategies to combat flooding in the study area are as depicted in Figure 8. From Figure 8, it is obvious that 45.8% chose channelization as the major strategy to be adopted to control and direct the flow of water in the study area; while 28.3%, 23.6% and 2.4% advocated for dredging of existing water channels, creation of more water paths and stoppage of waste pollution as their preferred mitigation strategies respectively. One-on-one interaction with the respondents revealed silting of the existing drainage channels, lack of adequate water paths and pollution by residents, which informed their choice of mitigation strategies respectively. From the on-going, it is very clear that the residents are well informed about flooding in the study area and the mitigation strategies they wish to adopt is out of their financial power, hence the adoption of less capital intensive strategies (Figure 7).

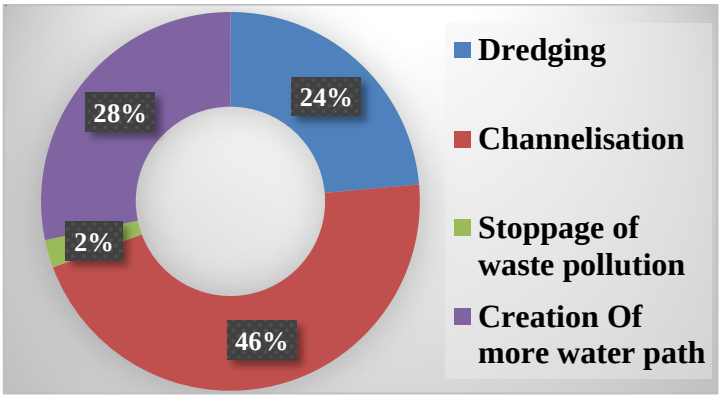


Figure 8: Suggested flood mitigation strategies by residents
Source: Author's Fieldwork, 2024

4.0 Conclusion and Recommendations

This paper underscores the critical need for comprehensive understanding of the peculiar flooding characteristics in Ilaje LGA of Ondo State, Nigeria. The socio-economic characteristics of the residents reveal vulnerabilities tied to gender disparities, educational levels, marital status, occupation and other economic conditions, which influence their capacity to adopt flood mitigation measures. Other flooding indicators in the study area such as type of building, ownership status of building, building type and building

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construction materials which makes flooding a frequent and severe issue were covered. Generally, the impacts of flooding in the study area are profound, causing significant loss of belongings, structural damage, crop loss, and income disruptions. These effects emphasize the urgency of implementing effective flood mitigation strategies to safeguard lives, properties, and livelihoods. The current flooding mitigation measures adopted by the people include evacuation, construction of flooding barriers, and raising of household furniture above flood level in the buildings during flooding. These adopted strategies demonstrate the people's resilience and also the need for more robust infrastructure and community support. For effective flooding mitigation in the study area, this paper recommends improved drainage systems, river dredging, and sustainable urban planning in order to reduce flood risks. Additionally, community education and people's involvement in flood management planning are vital to enhancing resilience and ensuring the adoption of effective sustainable mitigation measures.

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References:

Abbas, S.H., Srivastava, R.K., Tiwari, R.P. and Bala Ramudu, P. (2009), "GIS-based disaster management: A case study for Allahabad Sadar sub-district (India)", *Management of Environmental Quality*, Vol. 20 No. 1, pp. 33-51 https://doi.org/10.1108/14777830910922433

Abolade, O., Muili, A.B., & Ikotun, S. A. (2013). Impacts of flood disaster in Agege local government area Lagos, Nigeria. International *Journal of Development and Sustainability*, 2(4), 2354– 2367.

Aja, G. N., & Olaore, A. Y. (2014). The Impact of Flooding on the Social Determinants of Health in Nigeria: A Case for North-South Institutional Collaboration to Address Climate Issues." *Developing Country Studies* 4 (22): 6–12.

Aderogba, K., Oredipe, M, Oderinde, S., & Afelumo, T. (2012). Challenges of poor drainage systems and floods in Lagos Metropolis, Nigeria.

Aladelokun, A.O., and Ajayi, C.F. (2014) An Appraisal of the Soci-Economic Impacts of Urban Flood In Ado Ekiti Metropolis in Ekiti State. *International Journal of Asian Article Science* 4(10), 1027-1034.

JOURNAL OF THE NIGERIAN INSTITUTE OF TOWN PLANNERS
VOL30, NO 4. JULY, 2025
https://nitpjournals.ng/index.php/jnitp/



Adegboyega, S.A., Onuoha, O.C., Adesuji, K.A., Olajuyigbe, A.E., Olufemi, A.A., &Ibitoye, M.O. (2018). An integrated approach to modelling of flood hazards in the rapidly growing city of Osogbo, Osun State, Nigeria. *Space Science International* 4(1), 1–15.

Agbonkhese, O., Agbonkhese, E.G., Aka, E.O., Joe-Abaya, J., Ocholi, M., & Adekunle, A. (2014) Flood menace in Nigeria: Impacts, remedial and management strategies. *Civil and Environmental Research* 6(4), 32–40.

Adetunji, M. & Oyeleye, O. (2013). Evaluation of the causes and effects of flood in Apete, Ido local government area, Oyo State, Nigeria. *Civil and Environmental Research* 3(7), 19–26.

Doocy, S., Daniels, A., Murray, S., and Kirsch, T. D. (2013). The human impact of floods: A historical review of events 1980-2009 and systematic literature review.

Dalil, M., Mohammad, N.H., Yamman, U.M., Husaini, A., & Mohammed, S.L. (2015). An assessment of flood vulnerability on physical development along drainage channels in Minna, Niger State, Nigeria. African *Journal of Environmental Science and Technology* 9 (1), 38–46.

Da Silva L.B.L., Alencar M.H., & De Almeida A.T. (2020). Multidimensional flood risk management under climate changes: bibliometric analysis, trends and strategic guidelines for decision-making in urban dynamics. *Int. J. Disaster Risk Reduc.* 50

Echendu, A.J. (2022). Flooding, food security and the sustainable development goals in Nigeria: An assemblage and systems thinking approach. *Social Sciences* 11(2), 59.

Etuonovbe, A.K. (2011). Devastating Effect of Flooding in Nigeria. FIG Working Week 2011.

Fabiyi, O.O., & Oloukoi, J. (2013). Indigenous Knowledge System and local adaptation strategies to flooding in coastal rural communities of Nigeria. *Journal of Indigenous Social Development*, 1(2), 1-19,

Fletcher T.D., Shuster W., Hunt W.F., Ashley R., Butler D., Arthur S., Trowsdale S., Barraud S., Semadeni-Davies A., Bertrand-Krajewski J.-L., Mikkelsen P.S., Rivard G., Uhl M., Dagenais D., & Viklander M. (2014). SUDS, LID, BMPs, WSUD and more–The evolution and application of terminology surrounding urban drainage. *Urban Water J.* 12(7):525–542.

Guan X., Wang J.Y., & Xiao F.P. (2021). Sponge city strategy and application of pavement materials in sponge city. *J. Clean. Prod.* 303.

Green, D., and Raygorodetsky, G. (2010). Indigenous knowledge of a changing climate. *Climatic Change*, 100, 239-242.

JOURNAL OF THE NIGERIAN INSTITUTE OF TOWN PLANNERS
VOL30, NO 4. JULY, 2025
https://nitpjournals.ng/index.php/jnitp/



Huang, Y., Li, Y., & Xu, H. (2019). Comparative assessment of flood risk reduction measures in coastal regions of China. *Journal of Cleaner Production*, 223, 548-558.

Jeb, D., & 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.

Lamond J.E (2014). The role of flood memory in the impact of repeat flooding on mental health

June 2014 DOI: 10.2495/FRIAR140161, Conference: FRIAR 2014, Volume: 184

Kapucu, N., Christopher V.H., & Fernando I. R. (2013) Disaster Preparedness and Resilience for Rural Communities. *Risk, hazard and Crisis in public policy* 4(4) 2013

Komolafe, A.A., Adegboyega, S.A., and Akinluyi, F.O. (2015)., A review of flood risk analysis in Nigeria. *American Journal of Environmental Sciences* 11(3), 157–166.

MacLeod, D.A., Dankers, R., Graham, R., Guigma, K., Jenkins, L., Todd, M.C., Kiptum, A., Kilavi, M., Njogu, A., &Mwangi, E. (2021). Drivers and subseasonal predictability of heavy rainfall in equatorial East Africa and relationship with flood risk. *Journal of Hydrometeorology* 22(4), 887–903. doi: 10.1175/JHM-D-20-0211.1

Merz, B., Kreibich, H., Schwarze, R., & Thieken, A. (2010). Review article" assessment of economic flood damage". *Nature Hazards*, 56(3), 670-695.

Mumuni, A. (2013). Flooding and diarrheal disease incidence in urban poor communities in Accra, Ghana: investigating the effects of risk perception measures. Doctoral thesis, University of Ghana.

National Population Commission. (2006). *National Population Census.* Abuja: National Population Commission.

Nkeki, F.N., Henah, P.J., & Ojeh, V.N., (2013) Geospatial techniques for the assessment and analysis of flood risk along the Niger-Benue Basin in Nigeria. *Journal of Geographic Information System* 5(2), 123–135.

Newsham, A. J., & Thomas, D. S. G. (2011). Knowing, farming and climate change adaptation in North-Central Namibia. *Global Environmental Change*, 21, 761-770.

Nwigwe, C & Embargo, T. T. (2014). An assessment of causes and effect of flood in Nigeria. *Standard Scientific and Research Essay*, 2(7), 307-315

Okoye, C (2019). Perennial flooding and integrated flood risk management strategy in Nigeria. International Journal of Economics, Commerce and Management United Kingdom, 7(9): 364-375

JOURNAL OF THE NIGERIAN INSTITUTE OF TOWN PLANNERS
VOL30, NO 4. JULY, 2025
https://nitpjournals.ng/index.php/jnitp/



Olajuyigbe, A.E., Rotowa, O.O., & Durojaye, E. (2012). An Assessment of Flood Hazard in Nigeria. The Case of Mile 12, Lagos. *Mediterranean Journal of Social Sciences.* 3(2): 367-377.

Oyekale, A.S., 2013, Impact of flooding on the health of coastal fishing folks in Epe Division of Lagos State, Nigeria. *Journal of Human Ecology* , 44(2),183–188.

Pardoe, J., Penning-Rowsell, E., &Tunstall, S. M. (2017). How effective are flood mitigation measures: Evidence from a UK catchment? *Journal of Flood Risk Management*, 10(1), 35-45.

Rudari, R. (2017) "Flood Hazard and Risk Assessment," in "Words into Action Guidelines: *National Disaster Risk Assessment,"* U N, Geneva.

Sarwar, M. G. M. (2005) Impacts of sea level rise on the coastal zone of Bangladesh. Science, 328(5985), 1517-1520

Saleem, A., Muhammad, I., Babar, S., Ghazanfar, A. & Muhammad (2013). Impact of flood on livelihood and food security and food security of ruralCommunities: A case study of Southern Punjab, Pakistan. *Pakistan Journal of Agricultural Science*, 50(4), 751-758

Tramblay, Y., Villarini, G., El Khalki, E.M., Gründemann, G., & Hughes, D. (2021). Evaluation of the drivers responsible for flooding in Africa. *Water Resources Research* 57 (6). doi: 10.1029/2021WR029595

Walker, G., & Burningham, K. (2011). Flood risk, vulnerability and environmental justice: evidence and evaluation of inequality in a UK context. *Crit. Soc. Pol.*;31(2),216–240.