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FLOODING IN RESIDENTIAL AREA OF ASABA, NIGERIA (2012-2023)

By Saeed Kamaldeen Ojolowo¹ and Razaq Abolaji Olaitan

Abstract

Flooding remains a major environmental hazard in Nigerian cities, with severe impacts on housing and livelihoods. This study investigates the effects of recurrent flooding on residential housing stocks in Asaba, Delta State, Nigeria, between 2012 and 2023. Using systematic random sampling, 775 household heads were surveyed across ten residential estates comprising 3,700 housing units. Data was obtained using a structured questionnaire and field observation and analyzed using the descriptive statistics and weighted mean score. Findings show that flooding in Asaba is primarily caused by heavy rainfall (23–24%), poor drainage (22%), and blocked canals (19%). Weighted mean scores indicate high flooding severity across all estates, with Core Area, Infant Jesus, and Airport View Estates recording the highest levels (3.35). Impacts include property destruction (29%), structural defects (27%), housing collapse (23%), and market value depreciation (24%). Coping strategies adopted by residents include raising building foundations (24%), constructing small-scale drainage channels (19%), and proper waste disposal (21%). Despite these efforts, the effectiveness of flood control agencies is rated low (mean < 3.0). The study concludes that flooding poses a significant threat to housing sustainability in Asaba and recommends improved drainage infrastructure, stricter zoning laws, climate-resilient housing designs, and community-based early warning systems to reduce vulnerability and safeguard urban development.

KEY WORDS:

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1. INTRODUCTION

Flooding is one of the most significant natural hazards in both developed and developing countries. Floods are a major cause of disasters in many communities, and they have been associated with loss of livelihoods, morbidity, and fatalities (Ahmad & Ma 2020; Munawar 2020). In recent years, the world has experienced an escalation in the occurrence of flooding, which can be linked to global warming and increased urbanisation (Williams, Arguillas & Arguillas, 2020). Flooding can be a natural or man-made disaster; it is a global phenomenon with a detrimental impact on the built and the natural environment (Oginni, Famous, Akinrogbunde & Akinola, 2021). Flood occurs when there is an inundation of any area which is not normally covered with water, through a temporary rise in the level of a river, lake or sea, and when excess precipitation exceeds natural infiltration, evaporation, and possible transmission (Akosile, 2008). Also, Nwaogazie and Sam (2020) noted that flooding is a normal result of stream movement in a dynamic environment.

Housing is seen as a physical and social necessity of life which is strategic to human social, economic, psychological, environmental and health well-being (Ajayi, 2019). Housing is also seen as fundamental to national development and socio-cultural growth in any human society (Mogborukor, Boyitie & Okogwu, 2021). In this regard, housing is considered important to human sustenance. Housing is one major area of flooding incidence impact and the occurrence of flooding has continued to threaten housing stock value and structural conditions resulting in deterioration of residential housing conditions

and residential housing collapse (Ezeokoli, Okolie and Aniegbuna (2019). Udobi (2021) asserts that residential housing stock values are adversely affected by flooding and the impact of flooding on housing in addition to the loss of value has also resulted in the decrease of housing stocks and the decrease in the condition of existing housing stocks. Hence, flooding has negative implications for the housing development process.

Flooding impacts are classified into three types namely, social, ecological and economic losses (Bertilsson, Wiklund, de Moura Tebaldi., Rezende, Veról & Miguez, 2019). Flood events are accompanied by several devastating consequences that affect the vast majority of people. According to Buba, Obaguo, Ogah and Ajayi (2021), the most devastating floods in the history of the Nigeria occurred between July and October 2012, affecting 25 of the 36 states; Rhoda, Buku and Godwin (2017) stated that in August 2002, flooding occurrence resulted from rainfall which submerged several houses, resulting to the destruction of properties worth over 3.6 million of naira and rendering over 3,250 people homeless. In July 2012, over 300 people were rendered homeless (Rhoda, Buku & Godwin, 2017).

Floods have affected over 2.8 billion people worldwide and claimed over 200,000 lives over the previous 30 years (Olanrewaju, Chitakira, Olanrewaju, & Louw, 2019), account for 47% of all weather-related disasters worldwide (United Nations Office for the Coordination of Humanitarian Affairs, 2021). According to Cailin, Na Sun, Yihui, Baoyun, Yue, Xiaokai and Yukai (2023) in China, in 2021, China's flood disasters caused a total of

59.01 million people affected, 590 people died and disappeared, 152,000 houses collapsed, and direct economic losses of 245.89 billion yuan; In the UK, annual flood damage is estimated at £ 1.1 billion and, without additional adaptation measures, is expected to rise to £27 billion by 2080 and in 2021, severe floods occurred in Pakistan, resulting in 1162 deaths, 3554 injuries, more than 33 million people affected, and direct economic losses of more than USD 10 billion.

In 2022, Nigeria experienced the worst flooding in recent decades, with over 600 fatalities and 3.2 million people affected across 34 of the 36 states of the federation and the Federal Capital Territory (NBS, NEMA & UNDP, 2023). Also, Ofuoku, Abushe and Enughure (2023) noted that about 90% of Nigeria's 36 states were affected by the flood from July to October, 2012, resulting in 363 recorded deaths and damage of well over 618,000 houses. There is an increase in the incidence of flooding due to climate change and increased urban development. The flooding incidences of 2012 and 2022 are the most devastating flooding incidences in Nigeria. However, NBS, NEMA & UNDP (2023) noted that the 2022 floods have caused unprecedented disruption and destruction and proved to be more intense than the 2012 floods, which approximately 3 million families saw their houses damaged or destroyed.

In Nigeria, there are different initiatives and policy interventions at the national, state, local government and community levels to address the causal factors, challenges and impact of flooding on different segments of human life, however, these have not reduced the incidence of flooding. Some of the issues of concern is the

inability to adequately address flooding including the level of resilience, vulnerability to flooding due to socio-economic characteristics of the people, poor implementation of policy interventions, inconsistency of flooding initiatives, and disregard for urban planning regulations among others. Flooding disaster is a major challenge to Asaba's physical development and economic growth. Many studies have been conducted to unravel the impact of flooding on the health (Amadi & Chibuzor, 2022; Itaa, Kale, Itaa & Itaa, 2023); on economy (Nwankwagu & Nkwede, 2016; Ikechukwu, 2015); on agriculture (Olunwa & Lawal, 2021); on public

infrastructure (Abraham, Umoh, Otu & Ita, 2023), however, there are few studies on the impact of flooding on residential housing stock. Therefore, this study investigates the impact of perennial flooding on residential housing stock in Asaba, Delta State, Nigeria.

2. MATERIALS AND METHOD

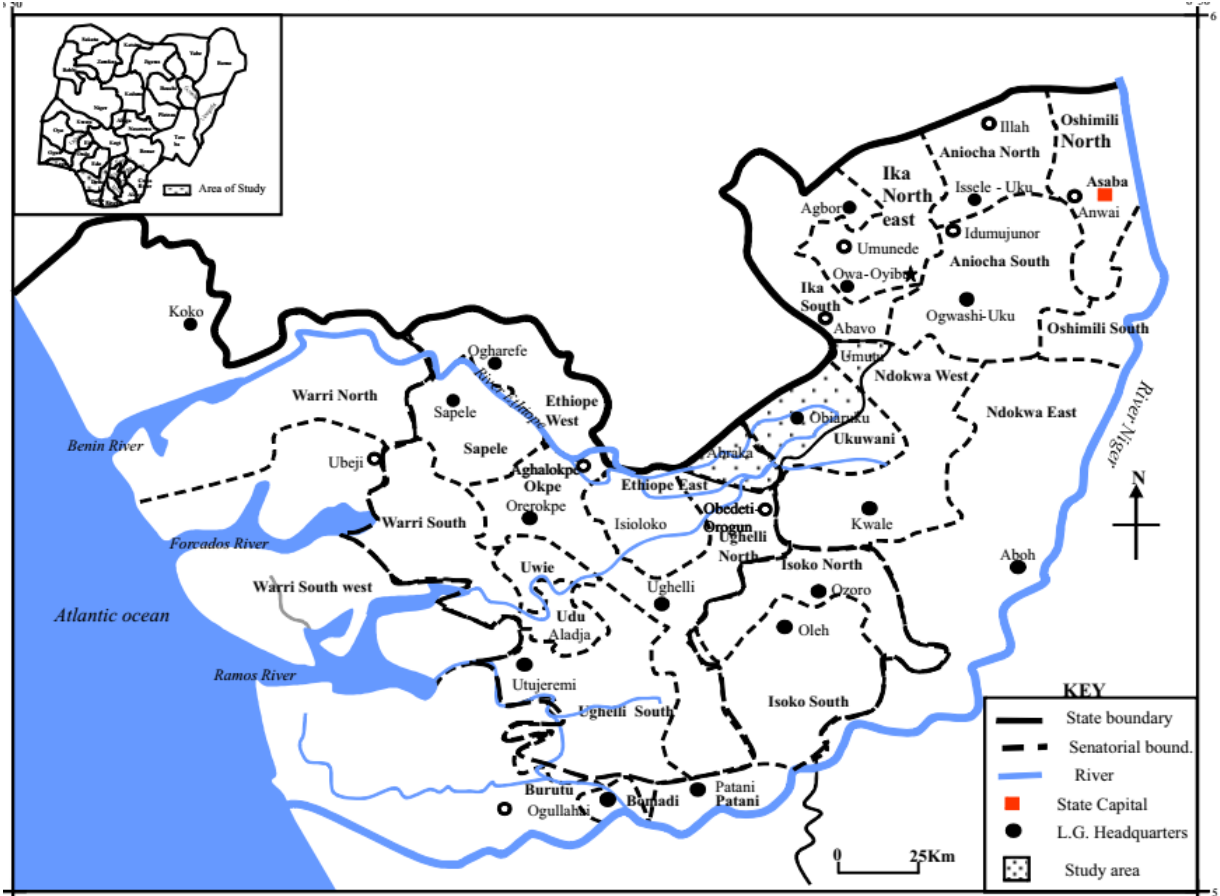
2.1. The Study Area

Asaba falls approximately between Latitude $6^{\circ} 40' - 6^{\circ} 15'$ and Longitude $6^{\circ} 40' E - 6^{\circ} 45' E$, and is bound on the east and northeast by the River Niger and on the west by the rolling slopes of the Asaba plateau. In addition to being the administrative headquarters of Delta State, it is also the headquarters of Oshimili South Local Government Area. Asaba is situated in

the tropics and therefore experiences a fluctuating climate, ranging from the humid tropical in the south to the sub-humid in the northeast. The lessening of humidity towards the north is accompanied by an increasingly marked dry season. Mean annual temperatures range from about $22^{\circ}C$ to $34^{\circ}C$, while rainfall is between 1,501mm and 1850mm; mean evapotranspiration is 1117mm (Akpoborie, Nfor, Etobro & Odagwe, 2011). Rainfall is heaviest in July. Temperature increases from the south to the north. In Warri, located in the south for example, the average daily temperature is $30^{\circ}C$, while the temperature in Asaba in the north eastern area is $44^{\circ}C$ (<https://www.nigerdeltabudget.org/overview-of-delta/>). Asaba is made up of different residential layouts, owned by private individuals and the government, these layouts are largely residential (Izegbue, 2017).

Figure 1: Asaba Town within State Context

Source: Adapted from Ndakara and Boyitie, 2019



2.1.1. Population and sampling

Selecting the research sample size depended on several elements including investigation duration, funding contingencies, and manpower constraints for acquiring information. The study sample size for each of the residential housing estates was determined by utilising

simplified Taro Yamane formulae (1967) as presented in Table 1. The study used systematic random sampling approach which is a probability sampling technique in choosing respondents in Asaba, Delta State. This involves deciding the nth entity from chronologically itemised population constituents (Aremu, 2004). The total housing units for each estate were divided by the sample size, which gave the nth number, using the nominal numbering of each residential housing estate, housing units were selected, and from each of the selected housing units, the study survey instrument (questionnaire) was administered to the household heads.

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

Where:

n = Study sample size

N = Study Population

e = precision of sampling error @10%

1 = Constant

Table 1: Residential Housing Estates in Asaba, Delta State

	Housing Estate	Location	Type	Housing Units	Housing Estate Flooding Status	Sample Size
1.	Core Area Housing Estate	Central Asaba	Mixed-use	450	Moderate risk during heavy rains	82
2.	Asaba GRA (Government Reserved Area)	GRA Phase I and II, Asaba	High-end Residential	300	Low risk due to good drainage	75
3.	Okpanam Housing Estate	Okpanam Road, Asaba	Residential	600	Low-risk, well-elevated area	86
4.	Infant Jesus Housing Estate	Infant Jesus	Residential	500	Moderate risk during the rainy season	83
5.	DLA (Direct Labour Agency) Estate	Asaba	Residential	400	Moderate-risk, poor drainage	80
6.	Airport View Estate	Near Asaba Airport	Residential	350	Low risk, near airport drainage	78
7.	MCC (Missionary Church of Christ) Estate	Asaba	Residential	250	Moderate risk varies by section	71
8.	Fidelity Estate	Asaba	Residential	200	Low risk, good infrastructure	67
9.	Junior Staff Quarters	Asaba	Residential	300	Low-risk, inadequate drainage	75
10.	DBS Housing Estate	Asaba	Residential	350	Moderate risk, improved drainage	78
	Total			3700	Total	775

Source: Research Field Survey & Estates Brochure, 2024

2.1.2. Data collection

The data collection instrument was structured questionnaire. The study instrument was adapted from previous studies on flooding impact and modified to suit this study's aim and objectives. The questionnaire contained structured questions using a five-point Likert-scale format of strongly disagree (1), disagree (2), moderately agree (3), agree (4) and strongly agree (5). The questionnaire was divided into three sections, section one focused on the socio-economic characteristics of residents of the selected residential housing estate, section two focused on the occurrence of flooding in the selected residential housing estate and section three focused on ascertaining the impact of flooding on residential housing stocks in the selected residential housing estates.

2.2. Data and Analysis

The data were analysed and presented using descriptive statistics with frequency table, bar chart, pie chart and weighted mean score. Data were collated using Statistical Package for Social Sciences (IBM SPSS Statistics 23).

3. RESULTS

3.1. Socio-Economic Characteristics of Respondents in Flood Prone Areas

This section presents data on the socio-economic characteristics of sampled residents across ten selected flood-prone residential estates in Asaba, Delta State. Issues covered include the gender of respondents, age of respondents, educational status of residents, length of residency in the residential estate, and household size.

3.1.1 Gender of the Respondents

As presented in Table 2, selected residential housing estates in Asaba, indicate the ample, consist of both genders across the study locations with more male residents than the female respondents. Male respondents in Okpanam Housing Estate are 50 (58.14%), this represents the highest number of male respondents while the lowest male respondent population is 35 (52.24%) Fidelity Estate. The gender composition suggests that men may be more actively involved in flood management within households across the selected residential estates household.

Table 2: Respondents' Gender

Housing Estate	Male (%)	Female (%)	Total
Core Area Housing Estate	45 (54.88%)	37 (45.12%)	82
Asaba GRA	40 (53.33%)	35 (46.67%)	75
Okpanam Housing Estate	50 (58.14%)	36 (41.86%)	86
Infant Jesus Housing Estate	47 (56.63%)	36 (43.37%)	83
DLA Estate	42 (52.50%)	38 (47.50%)	80
Airport View Estate	43 (55.13%)	35 (44.87%)	78
MCC Estate	39 (54.93%)	32 (45.07%)	71
Fidelity Estate	35 (52.24%)	32 (47.76%)	67
Junior Staff Quarters	41 (54.67%)	34 (45.33%)	75
DBS Housing Estate	44 (56.41%)	34 (43.59%)	78

Source: Field Survey, 2024

3.1.2. Age of the Respondents

Table 3 shows the respondent age cohorts with majority of the residents across the residential housing estates are between 18 and 50 years old. In this cohort, the 31-40 age group have the highest representation across the selected residential housing with Asaba GRA having 29.33% and Infant Jesus Housing Estate at 26.51%. This age distribution implies a predominantly young and middle-aged demographic structure of the areas. This suggests a working population faced with economic impacts due to flooding occurrence in their different estates. Respondents in the age cohort of 60 years above comprise a smaller proportion of the total sample with Core Area Housing Estate having the lowest representation (9.76%). The dominance of the younger population based on the prevailing rural-urban migration trend in Nigeria indicates that most of the younger would likely migrate resulting in high older residency, this makes it imperative for the adoption of resilience strategies as the older residents may face greater health risks and limited adaptive capacity in flood-prone environments.

Table 3: Respondents' Age

Housing Estate	18-30 years	31-40 years	41-50 years	51-60 years	61 years above	Total
Core Area Housing Estate	18 (21.95%)	23 (28.05%)	21 (25.61%)	12 (14.63%)	8 (9.76%)	82
Asaba GRA	15 (20.00%)	22 (29.33%)	20 (26.67%)	12 (16.00%)	6 (8.00%)	75
Okpanam Housing Estate	19 (22.09%)	25 (29.07%)	21 (24.42%)	13 (15.12%)	8 (9.30%)	86
Infant Jesus Housing Estate	20 (24.10%)	22 (26.51%)	21 (25.30%)	12 (14.46%)	8 (9.64%)	83
DLA Estate	16 (20.00%)	24 (30.00%)	19 (23.75%)	12 (15.00%)	9 (11.25%)	80
Airport View Estate	17 (21.79%)	23 (29.49%)	19 (24.36%)	12 (15.38%)	7 (8.97%)	78
MCC Estate	15 (21.13%)	21 (29.58%)	18 (25.35%)	10 (14.08%)	7 (9.86%)	71
Fidelity Estate	14 (20.90%)	19 (28.36%)	18 (26.87%)	10 (14.93%)	6 (8.96%)	67
Junior Staff Quarters	16 (21.33%)	22 (29.33%)	19 (25.33%)	11 (14.67%)	7 (9.33%)	75
DBS Housing Estate	18 (23.08%)	22 (28.21%)	19 (24.36%)	12 (15.38%)	7 (8.97%)	78

Source: Field Survey, 2024

3.1.3. Educational Status of the Respondents

Table 2 shows the number of flood-affected structures in five Lokoja localities between 2010 and 2019. Flooding affected a total of 9,663 structures. The Kabawa-Adankolo Axis in Lokoja has the most affected structures with 3,681 (38.09%) properties. This is followed by SarkinNoma neighbourhood with 2,183 (22.59%) structures affected. Gadumo reported 1,764 (18.26%) damaged structures, indicating significant damage, whereas the Ganaja area had 1,448 (14.98%) affected structures. These data indicate the broad nature of flooding in several neighbourhoods. In contrast, the Phase 1-Old Poly Qtrs Axis has the fewest affected structures with 587 (6.07%) of structures. This lower percentage may indicate improved flood management measures or geographic advantages that lessen risk. Example of damage caused by flood in Lokoja during the study period is shown in Plate 1.

Table 4: Respondents' Educational Status

Housing Estate	No formal education	Primary education	Secondary education	Tertiary education	Total
Core Area Housing Estate	5 (6.10%)	16 (19.51%)	31 (37.80%)	30 (36.59%)	82
Asaba GRA	4 (5.33%)	14 (18.67%)	28 (37.33%)	29 (38.67%)	75
Okpanam Housing Estate	6 (6.98%)	18 (20.93%)	33 (38.37%)	29 (33.72%)	86
Infant Jesus Housing Estate	5 (6.02%)	15 (18.07%)	32 (38.55%)	31 (37.35%)	83
DLA Estate	4 (5.00%)	17 (21.25%)	31 (38.75%)	28 (35.00%)	80
Airport View Estate	5 (6.41%)	16 (20.51%)	30 (38.46%)	27 (34.62%)	78
MCC Estate	4 (5.63%)	14 (19.72%)	27 (38.03%)	26 (36.62%)	71
Fidelity Estate	3 (4.48%)	14 (20.90%)	26 (38.81%)	24 (35.82%)	67
Junior Staff Quarters	4 (5.33%)	15 (20.00%)	28 (37.33%)	28 (37.33%)	75
DBS Housing Estate	4 (5.13%)	15(19.23%)	29 (37.18%)	30 (38.46%)	78

Source: Field Survey, 2024

3.1.4. Occupation of the Respondents

The occupational distribution of residents in the chosen housing estate is primarily in the public and private sectors, according to data on sampled residents' jobs in Table 5. About 26–29% of people living in all estates work for the government. The public sector employs 26.83% of people in Core Area Housing Estate, 26.67% in Asaba GRA, 29.07% in Okpanam Housing Estate, 28.92% in Infant Jesus Housing Estate, 28.75% in DLA Estate, 28.21% in Airport View Estate, 28.17% in MCC Estate, 26.87% in Fidelity Estate, 28.00% in Junior Staff Quarters, and 29.49% in DBS Housing Estate. The location of the sampled residential estate in Asaba, the state administrative capacity, may be the reason for the preponderance of public sector employment. Employment in the private sector and self-employment rank second and third, respectively. Among the 10 residential housing estates chosen for the study, 66 sampled respondents reported being unemployed. Given that the study's unemployment rate was low, it may be concluded that the sampled inhabitants' high employment status allows them to make investments in efficient flood prevention strategies.

Housing Estate	Public sector employed	Private sector employed	Artisan	Self-employed	Retired	Unemployed	Total
Core Area Housing Estate	22 (26.83%)	17 (20.73%)	10 (12.20%)	17 (20.73%)	8 (9.76%)	8 (9.76%)	82
Asaba GRA	20 (26.67%)	16 (21.33%)	10 (13.33%)	14 (18.67%)	8 (10.67%)	7 (9.33%)	75
Okpanam Housing Estate	25 (29.07%)	18 (20.93%)	11 (12.79%)	18 (20.93%)	7 (8.14%)	7 (8.14%)	86

Infant Jesus Housing Estate	24 (28.92%)	16 (19.28%)	11 (13.25%)	18 (21.69%)	7 (8.43%)	7 (8.43%)	83
DLA Estate	23 (28.75%)	17 (21.25%)	10 (12.50%)	17 (21.25%)	6 (7.50%)	7 (8.75%)	80
Airport View Estate	22 (28.21%)	16 (20.51%)	10 (12.82%)	17 (21.79%)	6 (7.69%)	7 (8.97%)	78
MCC Estate	20 (28.17%)	15 (21.13%)	9 (12.68%)	15 (21.13%)	6 (8.45%)	6 (8.45%)	71
Fidelity Estate	18 (26.87%)	14 (20.90%)	9 (13.43%)	15 (22.39%)	6 (8.96%)	5 (7.46%)	67
Junior Staff Quarters	21 (28.00%)	16 (21.33%)	10 (13.33%)	16 (21.33%)	6 (8.00%)	6 (8.00%)	75
DBS Housing Estate	23 (29.49%)	16 (20.51%)	11 (14.10%)	16 (20.51%)	6 (7.69%)	6 (7.69%)	78

Source: Field Survey, 2024

3.1.5. Length of Stay in the Neighbourhood

The respondent's duration was sampled across the ten study locations of Core Area Housing Estate, Asaba GRA, Okpanam Housing Estate, Infant Jesus Housing Estate, DLA Estate, Airport View Estate, MCC Estate, Fidelity Estate, Junior Staff Quarters and DBS Housing Estate as presented in Table 6 which revealed that a majority of residents have lived in their estates between 6–10 years. From the responses of sampled residents, Core Area Housing Estate has a total of 31.71% of respondents in this category, while Asaba GRA, Okpanam Housing Estate, Infant Jesus Housing Estate, DLA Estate, Airport View Estate, MCC Estate, Fidelity Estate, Junior Staff Quarters and DBS Housing Estate respondents' percentage who have lived for 6–10 years are 24 (32.00%), 27 (31.40%), 25 (30.12%), 26 (32.50%), 25 (32.05%), 22 (30.99%), 21 (31.34%), 24 (32.00%), and 24 (30.77%) respectively.

It is expected that the longer residency in flood-prone areas implies that sampled residents would have a high familiarity with flood issues and impacts and also expected to understand different developed coping mechanisms within their communities. Also, sampled residents with less than 5 years of estate residency are about 24–26% across the sampled residential estates, this indicates some section of the community residents may be less prepared for flooding challenges in the estate. More importantly, the high percentage of residents who stayed in the estates for less than 5 years implies there is demand for housing within flood-prone areas.

Housing Estate	Less than 5 years	6-10 years	11-15 years	16-20 years	21 years above	Total
Core Area Housing Estate	20 (24.39%)	26 (31.71%)	17 (20.73%)	10 (12.20%)	9 (10.98%)	82
Asaba GRA	19 (25.33%)	24 (32.00%)	16 (21.33%)	9 (12.00%)	7 (9.33%)	75
Okpanam Housing Estate	21 (24.42%)	27 (31.40%)	19 (22.09%)	11 (12.79%)	8 (9.30%)	86
Infant Jesus Housing Estate	22 (26.51%)	25 (30.12%)	18 (21.69%)	10 (12.05%)	8 (9.64%)	83
DLA Estate	20 (25.00%)	26 (32.50%)	17 (21.25%)	10 (12.50%)	7 (8.75%)	80
Airport View Estate	20 (25.64%)	25 (32.05%)	17 (21.79%)	10 (12.82%)	6 (7.69%)	78
MCC Estate	18 (25.35%)	22 (30.99%)	16 (22.54%)	9 (12.68%)	6 (8.45%)	71
Fidelity Estate	16 (23.88%)	21 (31.34%)	15 (22.39%)	9 (13.43%)	6 (8.96%)	67
Junior Staff Quarters	19 (25.33%)	24 (32.00%)	16 (21.33%)	10 (13.33%)	6 (8.00%)	75
DBS Housing Estate	20 (25.64%)	24 (30.77%)	17 (21.79%)	10 (12.82%)	7 (8.97%)	78

Source: Field Survey, 2024

3.1.6. Respondent's Household Size

A cursory look at Table 7 reveals that most households have four to six individuals, with estates like DLA Estate accounting for 35% of these households and MCC Estate for 35.21%. With an average of almost 24% across estates, large households—defined as those with seven to nine members—are common. Adegboyega et al. (2018) emphasise the significance of community-centered flood mitigation strategies to support large households, and research indicates that larger households in flood-prone areas, particularly in Nigeria, are more likely to experience severe impacts, including economic strain and potential displacement, due to the increased resource demands (Mucherera & Mavhura, 2020).

Table 7: Respondents Household Size

Housing Estate	1-3 persons	4-6 persons	7-9 persons	9 persons above	Total
Core Area Housing Estate	22 (26.83%)	28 (34.15%)	20 (24.39%)	12 (14.63%)	82
Asaba GRA	20 (26.67%)	26 (34.67%)	18 (24.00%)	11 (14.67%)	75
Okpanam Housing Estate	24 (27.91%)	29 (33.72%)	20 (23.26%)	13 (15.12%)	86
Infant Jesus Housing Estate	22 (26.51%)	28 (33.73%)	20 (24.10%)	13 (15.66%)	83
DLA Estate	21 (26.25%)	28 (35.00%)	19 (23.75%)	12 (15.00%)	80
Airport View Estate	20 (25.64%)	27 (34.62%)	19 (24.36%)	12 (15.38%)	78
MCC Estate	19 (26.76%)	25 (35.21%)	17 (23.94%)	10 (14.08%)	71
Fidelity Estate	18 (26.87%)	23 (34.33%)	17 (25.37%)	9 (13.43%)	67
Junior Staff Quarters	20 (26.67%)	26 (34.67%)	18 (24.00%)	11 (14.67%)	75
DBS Housing Estate	21 (26.92%)	27 (34.62%)	19 (24.36%)	11 (14.10%)	78

Source: Field Survey, 2024

3.2. Flood-Prone Residential Areas and Frequency of Flooding in Asaba Town

This section focuses on this study objectives two and three to identify and map the locations of residential areas prone to flooding and also examine the frequency of flooding between the years 2012 to 2023.

3.2.1. Flooding Prone Residential Areas

Flood areas and flood flash points in Asaba are depicted in Figures 8 and figure 9. Flood flash points are indicated in red in Figure 8, and they are located along major road networks and densely populated residential zones; these are low-lying areas, and field observation reveals that the majority of these areas have inadequate drainage infrastructure. Figure 9 features the topography and land use patterns surrounding Asaba.

Different colour codes were used to indicate the types of areas that experienced flooding in Asaba town: residential areas with higher development density and impermeable surfaces that contribute to water runoff and flooding are indicated by the colour codes pink and purple; areas with higher elevation and less developed land cover, as well as more natural land cover, are indicated by the colour codes green and brown; and the flood flash points within these areas suggest that urbanisation and limited drainage may be aggravating flood risks.

Figures 8 and 9 identify specific flood-prone points within Asaba and study locations urban areas, allowing for the prioritisation of areas for infrastructure improvement, such as drainage enhancements, or for the implementation of flood mitigation measures. It is evident that Asaba town is close to important water bodies, especially the Niger River to the east, which means that areas near these water bodies may experience seasonal flooding due to river overflow, especially during heavy rains or when river levels rise.

3.2.2. Nature of Flooding Experienced

Core Area Housing Estate, Asaba GRA, Okpanam Housing Estate, Infant Jesus Housing Estate, DLA Estate, Airport View Estate, MCC Estate, Fidelity Estate, Junior Staff Quarters, and DBS Housing Estate in Asaba, Delta State, all have weighted mean scores that range from very low to very high flooding severity, as shown in Table 10 below. There is a high level of flooding in the Core Area Housing Estate, Infant Jesus Housing Estate, and Airport View Estate, as shown by their weighted means, which vary from 3.28 to 3.35. Furthermore, the weighted mean for the chosen residential estate is higher than 3.0, indicating that residents of all the Asaba estates under consideration endure a high degree of flooding.

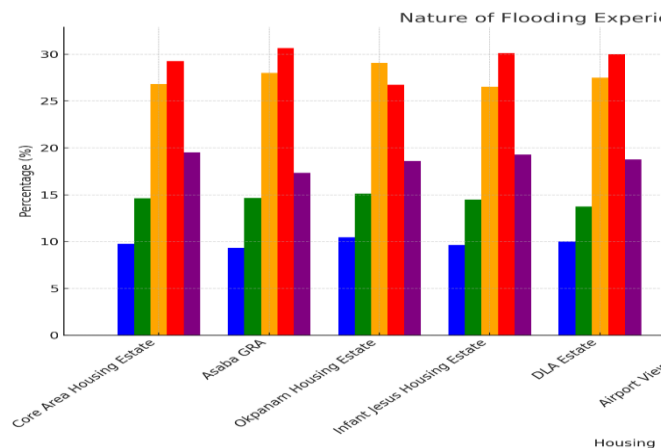


Figure 4: Graph showing the Flooding Experience

Source: Field Survey, 2024

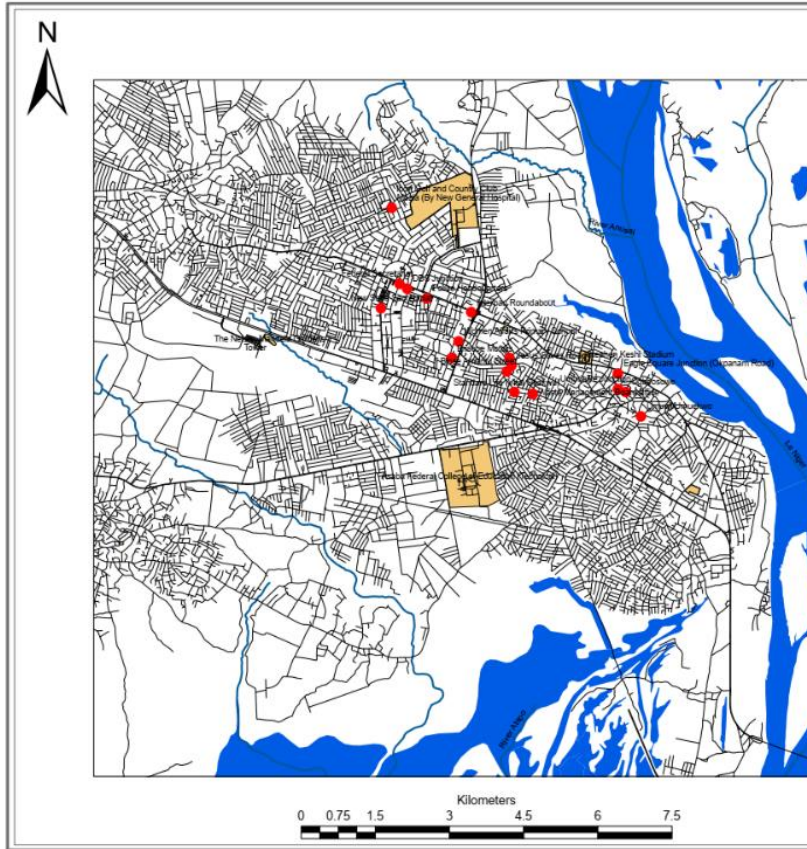


Figure 2: Flooding Area, Asaba, Delta State
Source: Field Survey, 2024

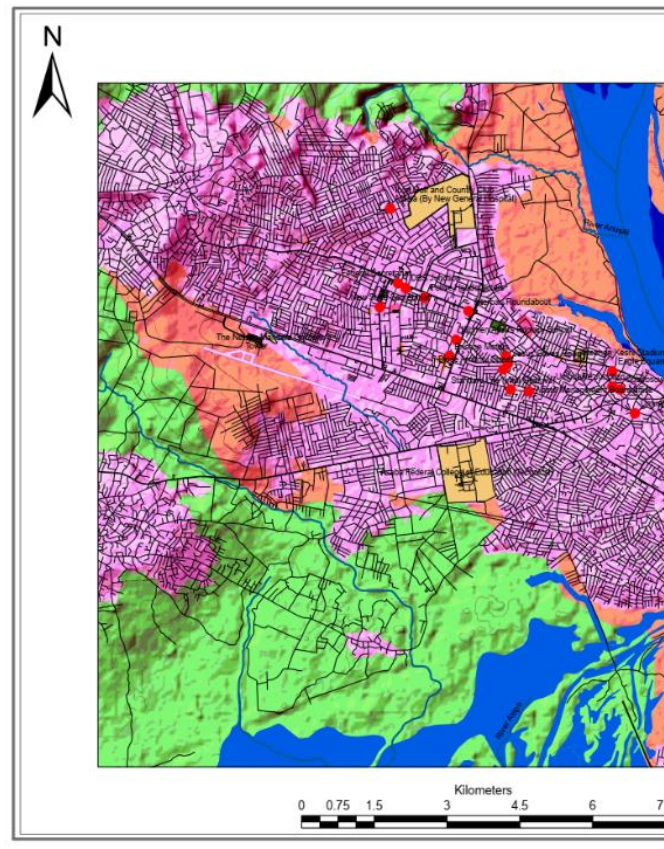


Figure 3: Flood-Flash Points, Asaba, Delta State
Source: Field Survey, 2024

Table 11: Household and Neighbourhood
Vulnerability to Flooding

H o u s i n g E s t a t e	V e r y l o w	L o w	M o d e r a t e	H i g h	V e r y h i g h	T o t a l	W e i g h t e d M e a n
C o r e A r e a	9 (1 0. 9 8 %)	1 2 (1 4. 6 3 %)	20 (2 4. 4. 39 %)	2 3 (2 8. 0 5 %)	1 8 (2 1. 9 5 %)	8 2 36	3.
A s a b a G	8 (1 0. 6 7	1 (1 4. 6 7	18 (2 4. 00 %)	2 2 (2 9. 3 3	1 (2 1. 3 3	7 5 36	3.

Region	Population	Population	Population	Population	Population	Population	Population
Region A	10.1%	10.2%	21.4%	2.3%	2.0%	8.6%	3.36%
Region B	9.1%	2.1%	20.4%	3.2%	1.9%	8.3%	3.36%
Region C	8.1%	1.1%	17.4%	2.0%	1.6%	7.1%	3.37%
Region D	7.1%	1.0%	17.5%	1.9%	1.4%	6.7%	3.34%
Region E	8.1%	1.1%	19.2%	2.1%	1.7%	7.5%	3.3%

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Source: Field Survey, 2024

3.2.4. Drivers of Neighbourhood Vulnerability to Flooding

It was established that there is a high level of vulnerability to flooding across the selected residential estates in Asaba, Delta State. The causes of this high level of vulnerability to flooding is presented in Table 12. It is revealed that the key drivers of flood vulnerability across Core Area Housing Estate, Asaba GRA, Okpanam Housing Estate, Infant Jesus Housing Estate, DLA Estate, Airport View Estate, MCC Estate, Fidelity Estate, Junior Staff Quarters and DBS Housing Estate are high poverty levels, lack of early warning systems, and population growth among others.

In Core Area Housing Estate, 21.95% of respondents cite poverty as a vulnerability driver, closely followed by Okpanam Housing Estate (22.09%). Similarly, the lack of a flood early warning system is acknowledged by 18-19% of residents across the selected ten residential housing estates. High poverty levels as a driver of flood vulnerability align with studies by Béné et al. (2012) that suggest economically disadvantaged households are less able to implement protective measures against floods. The lack of an early warning system further exacerbates vulnerability, a common issue noted in flood-prone regions, where emergency response infrastructure remains underdeveloped (Olunwa & Lawal, 2021).

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Estate, Airport View Estate, MCC Estate, Fidelity Estate, Junior Staff Quarters and DBS Housing Estate are high poverty levels, lack of early warning systems, and population growth among others.

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Table 12: Drivers of Neighbourhood Vulnerability to Flooding

Housing Estate	High level of poverty (%)	Low levels of education (%)	Lack of knowledge on flooding (%)	Lack of flood early warning system (%)	Increasing population (%)	Size of household (%)	Total
Core Area Housing Estate	18 (21.95%)	14 (17.07%)	12 (14.63%)	15 (18.29%)	13 (15.85%)	10 (12.20%)	82
Asaba GRA	16 (21.33%)	13 (17.33%)	11 (14.67%)	14 (18.67%)	12 (16.00%)	9 (12.00%)	75
Okpanam Housing Estate	19 (22.09%)	15 (17.44%)	13 (15.12%)	16 (18.60%)	14 (16.28%)	9 (10.47%)	86
Infant Jesus Housing Estate	18 (21.69%)	14 (16.87%)	12 (14.46%)	15 (18.07%)	13 (15.66%)	11 (13.25%)	83
DLA Estate	17 (21.25%)	14 (17.50%)	12 (15.00%)	15 (18.75%)	12 (15.00%)	10 (12.50%)	80
Airport View Estate	16 (20.51%)	14 (17.95%)	12 (15.38%)	15 (19.23%)	13 (16.67%)	8 (10.26%)	78
MCC Estate	15 (21.13%)	13 (18.31%)	11 (15.49%)	14 (19.72%)	12 (16.90%)	6 (8.45%)	71
Fidelity Estate	14 (20.90%)	12 (17.91%)	11 (16.42%)	13 (19.40%)	10 (14.93%)	7 (10.45%)	67
Junior Staff Quarters	16 (21.33%)	13 (17.33%)	11 (14.67%)	14 (18.67%)	12 (16.00%)	9 (12.00%)	75
DBS Housing Estate	17 (21.79%)	14 (17.95%)	12 (15.38%)	15 (19.23%)	13 (16.67%)	7 (8.97%)	78

Source: Field Survey, 2024

3.2.5. Neighbourhood Flooding Risk Level

Table 13 shows the perceived flooding risk levels across selected residential housing estates in Asaba, with weighted means above 3.0. Airport View Estate has the highest weighted mean of 3.40, this suggests residents perceive high flood risk. Also, Core Area and DLA Estates other residential estate has a weighted means above 3.35. This indicates that residents in these residential housing estates acknowledge their households and neighbourhoods have high exposure to flooding. Asaba's urban structure and climate also contribute to persistent flood risks, as noted in studies on Delta State's flood-prone regions, where rapid urbanisation intensifies flooding impacts (Komolafe *et al.*, 2015).

Table 13: Neighbourhood Flood Risk Level

Housing Estate	Very low	Low	Moderate	High	Very high	Total	Weighted Mean
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Core Area Housing Estate	8 (9.76%)	12 (14.63%)	21 (25.61%)	25 (30.49%)	16 (19.51%)	82
Asaba GRA	7 (9.33%)	11 (14.67%)	20 (26.67%)	23 (30.67%)	14 (18.67%)	75
Okpanam Housing Estate	9 (10.47%)	13 (15.12%)	24 (27.91%)	23 (26.74%)	17 (19.77%)	86
Infant Jesus Housing Estate	8 (9.64%)	12 (14.46%)	22 (26.51%)	24 (28.92%)	17 (20.48%)	83
DLA Estate	8 (10.00%)	11 (13.75%)	22 (27.50%)	23 (28.75%)	16 (20.00%)	80
Airport View Estate	7 (8.97%)	11 (14.10%)	20 (25.64%)	23 (29.49%)	17 (21.79%)	78
MCC Estate	7 (9.86%)	11 (15.49%)	19 (26.76%)	21 (29.58%)	13 (18.31%)	71
Fidelity Estate	6 (8.96%)	10 (14.93%)	18 (26.87%)	21 (31.34%)	12 (17.91%)	67
Junior Staff Quarters	7 (9.33%)	11 (14.67%)	20 (26.67%)	22 (29.33%)	15 (20.00%)	75
DBS Housing Estate	8 (10.26%)	12 (15.38%)	21 (26.92%)	23 (29.49%)	14 (17.95%)	78

Source: Field Survey, 2024

3.2.6. Household and Neighbourhood Flooding Resilience Level

Based on the responses of sampled residents across Core Area Housing Estate, Asaba GRA, Okpanam Housing Estate, Infant Jesus Housing Estate, DLA Estate, Airport View Estate, MCC Estate, Fidelity Estate, Junior Staff Quarters and DBS Housing Estate. Table 14 presents the resilience levels of households and neighbourhoods, all sampled residential estates have weighted means above 3. The residential housing estates of Airport View and MCC Estates have the highest weighted mean (3.37), this suggests that these housing estates have very strong coping capacities to flooding and their varied level of resilience to flooding across the residential housing estates. This moderate resilience reflects the findings of Adedeji (2022), who observed that urban areas in Nigeria, including Delta State, display varied resilience based on socioeconomic resources and the extent of community engagement.

Table 3.11: Household and Neighbourhood Flooding Resilience Level

Housing Estate	Very low	Low	Moderate	High	Very high	Total	Weighted Mean
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O kp a n a m H o u s in g Es ta te	1 0 (1 1. 6 3)	1 2 (1 3. 9 5)	2 3 (2 6. 7 4)	1 9 (2 2. 0 9)	8 3. 6 33	Ju ni or St af f Q u ar te rs	8 (1 0. 6 7)	1 1 (1 4. 6 7)	2 1 (2 8. 0 3)	1 6 (2 2. 1 3)
D L A Es ta te	9 (1 1. 2 5)	1 1 (1 3. 7 5)	2 3 (2 8. 7 5)	1 6 (2 0. 0)	8 3. 0 32	D B S H o u s in g Es ta te	9 (1 1. 5 4)	1 2 (1 5. 3 8)	20 (2 5. 64)	2 5 (2 8. 2 1)
Ai rp or t Vi	8 (1 0. 2 6)	1 1 (1 5. 64)	2 2 (2 8. 2)	1 7 (2 1. 7)	7 3. 8 37					

Source: Field Survey, 2024

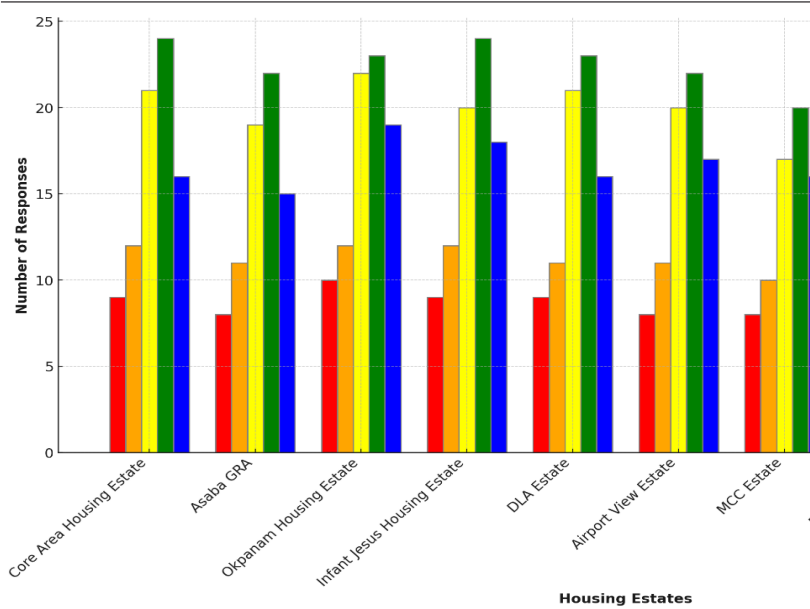


Figure 5: Graph showing the Household and Neighbourhood Flooding Resilience Level

Source: Field Survey, 2024

3.2.7. Causes of Flooding in Sampled Neighbourhoods

The causes of flooding in Core Area Housing Estate, Asaba GRA, Okpanam Housing Estate, Infant Jesus Housing Estate, DLA Estate, Airport View Estate, MCC Estate, Fidelity Estate, Junior Staff Quarters, and DBS Housing Estate varied, as shown in Table 15. These included excessive rainfall, inadequate drainage systems, river overflow, and canal blockage. In Okpanam Housing Estate, heavy rainfall is the leading cause of flooding, accounting for 24.42% of all causes, while in Infant Jesus Housing Estate, it accounts for 24.10%.

Due to a flawed and insufficient drainage system, stormwater does not sufficiently flow out of the residential estates and adjacent development, exposing Asaba's drainage infrastructure issues. The difficulties with drainage infrastructure are consistent with research showing that clogged drainage systems in metropolitan areas frequently increase the danger of flooding in Nigeria (Ojo, 2011).

Table 15: Causes of Flooding in Sampled Neighbourhood

Housing Estate	Topography	Heavy rainfall	Poor drainage system	Blockage of canal system	Overflow of the river	Climate change impact	Total
Core Area Housing Estate	15 (18.29%)	20 (24.39%)	18 (21.95%)	16 (19.51%)	8 (9.76%)	5 (6.10%)	82
Asaba GRA	14 (18.67%)	18 (24.00%)	17 (22.67%)	15 (20.00%)	7 (9.33%)	4 (5.33%)	75
Okpanam Housing Estate	16 (18.60%)	21 (24.42%)	19 (22.09%)	17 (19.77%)	9 (10.47%)	4 (4.65%)	86
Infant Jesus Housing Estate	15 (18.07%)	20 (24.10%)	18 (21.69%)	16 (19.28%)	8 (9.64%)	6 (7.23%)	83
DLA Estate	14 (17.50%)	19 (23.75%)	17 (21.25%)	15 (18.75%)	9 (11.25%)	6 (7.50%)	80
Airport View Estate	15 (19.23%)	18 (23.08%)	17 (21.79%)	14 (17.95%)	8 (10.26%)	6 (7.69%)	78

MCC Estate	13 (18.31%)	17 (23.94%)	16 (22.54%)	14 (19.72%)	7 (9.86%)
Fidelity Estate	12 (17.91%)	16 (23.88%)	15 (22.39%)	14 (20.90%)	6 (8.96%)
Junior Staff Quarters	14 (18.67%)	18 (24.00%)	17 (22.67%)	15 (20.00%)	8 (10.67%)
DBS Housing	15 (19.23%)	19 (24.36%)	18 (23.08%)	16 (20.51%)	7 (8.97%)

Source: Field Survey, 2024

3.3. Impact of Flooding on Residential Housing Stocks

This section presents the results of the analysis that explain objective four. The focus is to ascertain the impact of flooding on residential housing stocks in Asaba, Delta State. Issues discussed in this section include the general impact of flooding, flooding impact on housing stocks, flooding occurrence and control measures across the selected residential housing estates in Asaba, Delta State.

3.3.1 Overall Impacts of Flooding

According to responses from a sample of residents in Core Area Housing Estate, Asaba GRA, Okpanam Housing Estate, Infant Jesus Housing Estate, DLA Estate, Airport View Estate, MCC Estate, Fidelity Estate, Junior Staff Quarters, and DBS Housing Estate, Table 16 lists the general effects of flooding. The main effects are property damage and interruption of business operations. Places 1-4 highlight these effects. Property destruction had an impact on 29.27% of respondents in Core Area Housing Estate.

On the other hand, between 24 and 25 percent of all respondents in the ten Asaba residential housing estates that were chosen mentioned business problems. The socioeconomic effects of floods are emphasised by these effects, which cause households to bear heavy financial costs as a result of lost income and property destruction. According to Borga et al. (2014), who examined the financial effects of floods on city dwellers, this result is consistent. Business interruption and property damage further highlight the necessity of improved flood risk management and resilience (IPCC, 2017).

Table 16: Flooding General Impacts

Housing Estate	Destruction of properties	Causes traffic congestion	De
Core Area Housing Estate	24 (29.27%)	18 (21.95%)	De

Asaba GRA	22 (29.33%)	16 (21.33%)	18 (24.00%)
Okpanam Housing Estate	26 (30.23%)	19 (22.09%)	20 (23.26%)
Infant Jesus Housing Estate	24 (28.92%)	18 (21.69%)	20 (24.10%)
DLA Estate	23 (28.75%)	18 (22.50%)	19 (23.75%)
Airport View Estate	22 (28.21%)	17 (21.79%)	19 (24.36%)
MCC Estate	20 (28.17%)	15 (21.13%)	18 (25.35%)
Fidelity Estate	19 (28.36%)	15 (22.39%)	16 (23.88%)
Junior Staff Quarters	22 (29.33%)	16 (21.33%)	18 (24.00%)
DBS Housing Estate	23 (29.49%)	17 (21.79%)	19 (24.36%)

Source: Field Survey, 2024



3.3.2. Impacts of Flooding on Housing Stock in Sampled Neighbourhoods

Sequel to the assessment of the general impact of flooding, the impact of flooding on housing was examined as presented. Table 17 shows that flooding has directly affected housing stocks in terms of market value reduction, structural defects, and even housing unit collapses. A total of 26.83% of respondents in Core Area Housing Estate claimed they have experienced housing structural defects due to flooding. In Airport View Estate a total of 30.77% of respondents noted a reduction in housing stock. The impact of flooding indicates severe damage and potential long-term impact on property values and housing provision in Asaba. These impacts align with Ayedun et al. (2018), authors noted that properties in flood-prone areas often suffer significant depreciation and structural degradation, which results in a reduction in existing housing stocks in the study area

Table 17: Flooding Impacts on Neighbourhood Housing Stocks

Housing Estate	Reduction of housing stocks market value	Collapse of housing units	Housing structural defects	Reduction in housing stocks	Total
Core Area Housing Estate	20 (24.39%)	18 (21.95%)	22 (26.83%)	22 (26.83%)	82
Asaba GRA	18 (24.00%)	17 (22.67%)	19 (25.33%)	21 (28.00%)	75
Okpanam Housing Estate	21 (24.42%)	20 (23.26%)	22 (25.58%)	23 (26.74%)	86
Infant Jesus Housing Estate	20 (24.10%)	19 (22.89%)	21 (25.30%)	23 (27.71%)	83
DLA Estate	19 (23.75%)	18 (22.50%)	20 (25.00%)	23 (28.75%)	80
Airport View Estate	18 (23.08%)	17 (21.79%)	19 (24.36%)	24 (30.77%)	78
MCC Estate	17 (23.94%)	16 (22.54%)	18 (25.35%)	20 (28.17%)	71
Fidelity Estate	16 (23.88%)	15 (22.39%)	17 (25.37%)	19 (28.36%)	67
Junior Staff Quarters	18 (24.00%)	17 (22.67%)	19 (25.33%)	21 (28.00%)	75
DBS Housing Estate	19 (24.36%)	18 (23.08%)	20 (25.64%)	21 (26.92%)	78

Source: Field Survey, 2024

3.3.3. Flood Reduction and Control Measures

The Core Area Housing Estate, Asaba GRA, Okpanam Housing Estate, Infant Jesus Housing Estate, DLA Estate, Airport View Estate, MCC Estate, Fidelity Estate, Junior Staff Quarters, and DBS Housing Estate have been found to have a high degree of flooding, and the chosen residential estates in Asaba, Delta State, have a high level of vulnerability to flooding. In this context, the research area's sampled residents' flood mitigation and control measures were analysed. Raising building foundations provides for roughly 23–24% reduction and control measures, while creating small-scale drainage accounts for roughly 18–19%. These are just a few of the control measures homeowners have chosen, as shown in Table 18.

According to the respondents, the three most commonly used flooding reduction and control strategies in the study are building small-scale drainage channel construction (18.71%), proper waste disposal (20.65%) and raising building foundations (24.0% of all measures implemented based on adoption by 186 sampled residents out of the 775 total sampled residents). These results imply that the sampled tenants of the ten residential dwelling units view drainage infrastructure, waste management, and structural adjustments as crucial reduction and control strategies. This self-initiated mitigation approach is consistent with research by Adedeji (2022), who found that because of a lack of government assistance, people in flood-prone areas frequently turn to self-adaptation techniques.

Table 18: Flooding Occurrence Reduction and Control Measures

Housing Estate	Reduction of housing stocks market value	Collapse of housing units	Housing structural defects	Reduction in housing stocks	Total
Core Area Housing Estate	20 (24.39%)	18 (21.95%)	22 (26.83%)	22 (26.83%)	82
Asaba GRA	18 (24.00%)	17 (22.67%)	19 (25.33%)	21 (28.00%)	75
Okpanam Housing Estate	21 (24.42%)	20 (23.26%)	22 (25.58%)	23 (26.74%)	86
Infant Jesus Housing Estate	20 (24.10%)	19 (22.89%)	21 (25.30%)	23 (27.71%)	83
DLA Estate	19 (23.75%)	18 (22.50%)	20 (25.00%)	23 (28.75%)	80
Airport View Estate	18 (23.08%)	17 (21.79%)	19 (24.36%)	24 (30.77%)	78
MCC Estate	17 (23.94%)	16 (22.54%)	18 (25.35%)	20 (28.17%)	71
Fidelity Estate	16 (23.88%)	15 (22.39%)	17 (25.37%)	19 (28.36%)	67
Junior Staff Quarters	18 (24.00%)	17 (22.67%)	19 (25.33%)	21 (28.00%)	75
DBS Housing Estate	19 (24.36%)	18 (23.08%)	20 (25.64%)	21 (26.92%)	78

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Source: Field Survey, 2024

3.3.4. Household and Neighbourhood Flood Coping Strategies

Residents use a variety of tactics, as shown in Table 19, to mitigate the effects of flooding, such as temporary displacement, community coordination, raising valuables, and building adaptations such flood-resistant structures. Because there are few official flood management initiatives in Nigerian urban flood-prone areas, these coping mechanisms mirror the adaptation techniques frequently used there (Adegboyega et al., 2018). Igwe & Wordu (2016) pointed out that temporary removal and the elevation of goods are quick and practical solutions to flood disasters, accentuating the need for readiness in high-risk regions.

Table 19: Household and Neighbourhood Flood Coping Strategy

Housing Estate	Temporary Relocation During Severe Flooding	Community Coordination for Flood Response	Elevating/Securing Valuable Items
Core Area			
Housing Estate	17 (20.73%)	16 (19.51%)	18 (21.9)
Asaba GRA	16 (21.33%)	14 (18.67%)	16 (21.3)
Okpanam			
Housing Estate	19 (22.09%)	17 (19.77%)	18 (20.9)
Infant Jesus			
Housing Estate	17 (20.48%)	16 (19.28%)	18 (21.6)
DLA Estate	17 (21.25%)	16 (20.00%)	18 (22.5)
Airport View			
Estate	16 (20.51%)	15 (19.23%)	17 (21.7)
MCC Estate	15 (21.13%)	14 (19.72%)	15 (21.1)
Fidelity	14 (20.90%)	13 (19.40%)	15 (22.3)
Estate	16 (21.33%)	15 (20.00%)	16 (21.3)
Junior Staff			
Quarters	17 (21.79%)	16 (20.51%)	18 (23.0)
DBS Housing			
Estate			

Source: Field Survey, 2024

3.3.5. Perception of Residents on Effectiveness of Flood Control and Management Agencies

Residents' perceptions of the efficacy of Asaba's flood control and management agencies are generally ineffective, as shown in Table 20. The weighted mean of residents' perceptions of the efficacy of flood control and management in the Asaba residential housing estates that were chosen is less than 3.0 points. This suggests that the problems of floods and their effects have not been

adequately addressed by various government agencies and community development organisations in Core Area Housing Estate, Asaba GRA, Okpanam Housing Estate, Infant Jesus Housing Estate, DLA Estate, Airport View Estate, MCC Estate, Fidelity Estate, Junior Staff Quarters, and DBS Housing Estate.

A statistical analysis was carried out to determine if there is variation in the level of residents’ perception of the effectiveness of flood control and management agencies and policies across the selected housing estates in Asaba, Delta State. The analysis was carried out using the Chi-Square Test for Independence to determine if there are statistically significant differences in the perception of effectiveness across the different housing estates. The test aimed to determine if there were significant differences in perception across various housing estates. The statistical test result indicates:

estates. The statistical test result indicates:
Chi-Square Statistic (χ^2): 1.124
p-value: 1.0
Degrees of Freedom (df): 36

With a p-value of $1.0 \geq \alpha 0.05$, the null hypothesis is not rejected, this indicates that there is no statistically significant association between the type of housing estate and residents’ perceptions of flood control and management effectiveness. Consequently, the distribution of responses regarding effectiveness perception is similar across the housing estates. Table 21 provides the expected frequencies for each perception level in each housing estate, assuming there is no association between housing estate type and perception. The close alignment of observed and expected values supports the conclusion of independence

Table 20: Flood Control and Management Agencies and Policies Effectiveness Perception

Housing Estate	Very ineffective	Ineffective	Moderately effective	Effective
Core Area Housing Estate	22 (26.83%)	22 (26.83%)	14 (17.07%)	12 (14.63%)
Asaba GRA	20 (26.67%)	19 (25.33%)	13 (17.33%)	11 (14.67%)
Okpanam Housing Estate	23 (26.74%)	22 (25.58%)	14 (16.28%)	13 (15.12%)
Infant Jesus Housing Estate	21 (25.30%)	22 (26.51%)	14 (16.87%)	12 (14.46%)
DLA Estate	22 (27.50%)	21 (26.25%)	14 (17.50%)	11 (13.75%)
Airport View Estate	21 (26.92%)	20 (25.64%)	13 (16.67%)	12 (15.38%)
MCC Estate	19 (26.76%)	18 (25.35%)	13 (18.31%)	11 (15.49%)
Fidelity Estate	17 (25.37%)	18 (26.87%)	12 (17.91%)	10 (14.93%)
Junior Staff Quarters	19 (25.33%)	19 (25.33%)	13 (17.33%)	11 (14.67%)
DBS Housing	21 (26.92%)	20 (25.64%)	14 (17.95%)	12 (15.38%)

Source: Field Survey, 2024

Table 21: Expected Frequencies Table

Housing Estate	Very Ineffective	Ineffective	Moderately Effective	Effective	Highly Effective
Core Area Housing Estate	21.69	21.27	14.18	12.17	12.70
Asaba GRA	19.84	19.45	12.97	11.13	11.61
Okpanam Housing Estate	22.75	22.30	14.87	12.76	13.32
Infant Jesus Housing	21.95	21.53	14.35	12.32	12.85

DLA Estate	21.16	20.75	13.83	11.87
Airport View Estate	20.63	20.23	13.49	11.57
MCC Estate	18.78	18.41	12.28	10.54
Fidelity Estate	17.72	17.38	11.58	9.94
Junior Staff Quarters	19.84	19.45	12.97	11.13
DBS Housing Estate	20.63	20.23	13.49	11.57

Source: Field Survey, 2024

3.3.6. Flood Reduction, Control, and Mitigation

The different flood management techniques that the residents of the ten Asaba residential housing estates that were chosen are shown in Table 22. Flood early warning systems, urban development regulation, flood-resilient building rules, community sensitisation, and structural elevation are some of the solutions. These answers represent modifications made at the individual and communal levels to lessen the effects of flooding. The most recommended approach, with a response rate of roughly 21%, is structural elevation. In comparison to structural solutions, elevating buildings can assist minimise water penetration during floods and is frequently a more cost-effective choice. Due to resource constraints in flood-prone metropolitan regions frequently use reactive, cost-effective measures, which is reflected in this score.

Table 22: Neighbourhood Flooding Management, Flood Reduction, Control, and Mitigation Strategies

Housing Estate	Structural Elevation	Early Warning Systems	Flood-Resilient Building Rules	Community Sensitisation	Urban Development Regulation
Core Area Housing Estate	12 (15.00%)	8 (10.00%)	10 (12.50%)	7 (8.75%)	13 (16.25%)
Asaba GRA	12 (15.38%)	7 (8.95%)	9 (11.44%)	6 (7.69%)	11 (14.13%)
Okpanam Housing Estate	10 (12.50%)	6 (7.50%)	8 (10.00%)	5 (6.25%)	9 (11.25%)
Infant Jesus Housing Estate	10 (12.50%)	6 (7.50%)	8 (10.00%)	5 (6.25%)	9 (11.25%)
DLA Estate	12 (15.00%)	8 (10.00%)	10 (12.50%)	7 (8.75%)	13 (16.25%)
Airport View Estate	12 (15.38%)	7 (8.95%)	9 (11.44%)	6 (7.69%)	11 (14.13%)
MCC Estate	10 (12.50%)	6 (7.50%)	8 (10.00%)	5 (6.25%)	9 (11.25%)
Fidelity Estate	10 (12.50%)	6 (7.50%)	8 (10.00%)	5 (6.25%)	9 (11.25%)
Junior Staff Quarters	13 (16.25%)	7 (8.75%)	9 (11.25%)	6 (7.50%)	11 (13.75%)
DBS Housing	11 (13.75%)	7 (8.75%)	9 (11.25%)	6 (7.50%)	10 (12.50%)

As ab a G R A O kp an a m H ou si ng Es ta te In fa nt Je su s H ou si ng Es ta te DL A Es ta te Ai rp or t Vi e w Es ta te M C C Es ta te Fi de lit y Es ta te Ju ni or St af f Q	16 (2 1. 33 %)	14 (18 .67 %)	19 (25 .33 %)	13 (17 .33 %)	13 (17. 33 %)	7 5
	19 (2 2. 09 %)	17 (19 .77 %)	23 (26 .74 %)	14 (16 .28 %)	13 (15. 12 %)	8 6
	18 (2 1. 69 %)	16 (19 .28 %)	22 (26 .51 %)	14 (16 .87 %)	13 (15. 66 %)	8 3
	17 (2 1. 25 %)	15 (18 .75 %)	21 (26 .25 %)	14 (17 .50 %)	13 (16. 25 %)	8 0
	16 (2 0. 51 %)	15 (19 .23 %)	21 (26 .92 %)	13 (16 .67 %)	13 (16. 67 %)	7 8
	15 (2 1. 13 %)	14 (19 .72 %)	19 (26 .76 %)	12 (16 .90 %)	11 (15. 49 %)	7 1
	14 (2 0. 90 %)	13 (19 .40 %)	17 (25 .37 %)	12 (17 .91 %)	11 (16. 42 %)	6 7
	16 (2 1. 33 %)	14 (18 .67 %)	20 (26. 67 %)	13 (17 .33 %)	12 (16. 00 %)	7 5

ua rt er s D BS H ou si ng Es ta te	17 (2 1. 79 %)	15 (19 .23 %)	21 (26 .92 %)	13 (16 .67 %)	12 (15. 38 %)	7 8
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Source: Field Survey, 2024

4. DISCUSSIONS

Flood-prone areas in Asaba experience flooding of moderate to high impact. Weighted mean scores on flooding severity range from moderate to high, indicating a threat to housing provision. Contributing factors, such as blocked drainage, high rainfall, and insufficient urban planning, further escalate the flooding risk in these neighbourhoods. These conditions highlight a systemic issue in Asaba, where rapid urbanization and inadequate drainage exacerbate natural flood risks, as indicated by previous studies on Delta State's flooding challenges (Ikusemaran, 2017). Similarly, Olunwa and Lawal (2021) note that in Nigeria, urban flooding has intensified with climate change, highlighting how inadequate flood control exacerbates losses in housing stock and infrastructure across the country.

Flooding has profound impacts on residential housing stocks in Asaba, resulting in significant property damage, reduction in market value, and structural defects reported across estates. Studies within Nigeria emphasize that flood-prone properties face substantial depreciation, as they are considered less desirable due to perceived and actual risks (Ezeokoli et al., 2019). The recurring loss of housing stock value in Asaba points to a broader implication for housing policy, as insufficient regulatory frameworks and ineffective disaster response mechanisms contribute to sustained market devaluation. These findings align with Abraham et al. (2023), who argue that inadequate regulatory frameworks and delayed flood response measures contribute to persistent housing market declines in flood-prone areas. The reduction in available housing stock worsens housing shortages and reduces urban resilience, underscoring the importance of targeted flood management interventions.

There is a significant gap between minimum water levels and the various land uses and also minimum water levels and population of persons affected by

Source: Field Survey, 2024

4. DISCUSSIONS

Flood-prone areas in Asaba experience flooding of moderate to high impact. Weighted mean scores on flooding severity range from moderate to high, indicating a threat to housing provision. Contributing factors, such as blocked drainage, high rainfall, and insufficient urban planning, further escalate the flooding risks in these neighbourhoods. These conditions highlight a systemic issue in Asaba, where rapid urbanization and inadequate drainage exacerbate natural flood risks, as indicated by previous studies on Delta State's flooding challenges (Ikusemaran, 2017). Similalry, Olunwa and Lawal (2021) note that in Nigeria, urban flooding has intensified with climate change, highlighting how inadequate flood control exacerbates losses in housing stock and infrastructure across the country.

Flooding has profound impacts on residential housing stocks in Asaba resulting in significant property damage, reduction in market value, and structural defects reported across estates. Studies within Nigeria emphasize that flood-prone properties face substantial depreciation, as they are considered less desirable due to perceived and actual risks (Ezeokoli et al., 2019). The recurring loss of housing stock value in Asaba points to a broader implication for housing policy, as insufficient regulatory frameworks and ineffective disaster response mechanisms contribute to sustained market devaluation. These findings align with Abraham et al. (2023), who argue that inadequate regulatory frameworks and delayed flood response measures contribute to persistent housing market declines in flood-prone areas. This reduction in available housing stocks worsens housing shortages and reduces urban resilience, underscoring the importance of targeted flood management interventions.

between minimum water levels and the various land uses and also minimum water levels and population of persons affected by

flood in the study area. This is in line with the argument of Agenzia, (2012) and Kayode et al. (2017) where both land uses and population of communities are threaten by flood reoccurrence.

5. CONCLUSION

In conclusion, the current housing stock and housing provisions in Asaba, Delta State and Nigeria, are challenged by flooding. Asaba's housing stocks are impacted by floods, which have an effect on the residential estate's physical layout, the socioeconomic status of its occupants, and the value of its individual units. It was determined that a multifaceted strategy, encompassing enhanced infrastructure, community awareness, policy reform, and climate-resilient urban development, is necessary to address these problems. Reducing Asaba's susceptibility to flooding requires sustainable interventions supported by community involvement and governmental backing. This will secure the current housing stocks and make it possible to provide additional dwelling units. The results and suggestions of the study emphasise the necessity of robust solutions that will consider both short-term requirements and long-term flood risks and effects throughout the study region.

To address the flooding phenomenon across selected residential estates in Asaba, recommendations are proffered based on the study findings. These recommendations are to improve flood resilience, reduce impact on housing stocks, and enhance community well-being:

- Enhance Drainage Systems and Regular Maintenance: As noted in this study, poor drainage systems are primary contributors to flooding due to blockages and inadequate capacity to contain runoff during heavy rainfall. It is recommended that existing drainage systems should be improved, and more drainage systems be constructed;
- Regular maintenance and clearing of drainage to remove blockage;
- Strict zoning laws and restrictions on construction in high-risk areas and flood plains in Asaba;
- Mandating elevated building structures in flood zones to mitigate flood damage and enhance resilience;
- Establishing community awareness and training programmes to focus on emergency planning, property protection, and the establishment of neighbourhood watch teams to report drainage issues or early flood signs;
- The development of early warning and emergency response systems;
- Investing on climate-adaptive infrastructure, such as permeable pavements, green spaces, and flood-absorbent landscaping among others.

6. CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest regarding the publication of this manuscript.

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Notes
