

# Flood Risk Zones, Housing Development and Response of Residential Property Owners in Calabar Metropolis, Nigeria

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**Abstract** - The study examined flood risk zones as ecological constraint to housing development and the response of residential property owners in the Calabar metropolis, Nigeria. Multi-research design was used to map flood risk zones. The continuous data types include satellite imageries, digital elevation model, distance to river and administrative boundary data made up secondary data. Primary data include questionnaires administered to 400 respondents based on the Taro Yamane sample size formula and multi criteria analysis was adopted to select flood prone zones. Findings revealed that places such as MCC road, Old Odukpani Road, Good luck Jonathan Bypass, IBB way, Murtala Mohammed way, Marian and Ndidem Iso Road are located at the very low risk zones. Furthermore, areas located within the Low-risk zone include: Atu street, Ediba Road, Palm street, Summit hills road, Uwanse road, Orok-orok streets, Mary Slessor avenue, 4th avenue and Barracks road. More so, streets such as: Eyo-Ita, Court road, Ekorinim, New Airport road, Atimbo, Bedwell street and Diamond road are located within the Moderate risk zone. Lastly, areas like Jebes road, Edem Ekpo street, Afokang street and Hawkins road fall under the low-risk zones, while no street was classified as very high-risk zone. However flash floods do a lot of damage to properties of urban residents yet many find it difficult to relocate due to cost implication. 69.5% of respondents experience severe flooding 3 to 4 times a year while 10.5% and 20% experience the disaster twice and once respectively in a year. Majority of the respondents depend on government preventive measures. Mixed layouts varying from walled, unwallled to kindred has not help matters. Indication that Calabar is urbanizing rapidly with weak planning agency leading to irrationality of developers in land acquisition.

**Keywords:** Flooding, Ecological constraint, Housing Development, Land Availability, property owners.

## I. INTRODUCTION

Ecological factors are vital when considering land space for housing development projects. In fact, the suitability of a land space for any project depends on the physical component of the land which can pose a major challenge to the accessibility of land for housing development (Festus & Amos, 2015). The physical condition or ecological feature of a location where housing is located can affect the daily lives, security health and wellbeing of people (UN- Habitat, 2012). The complexity of anthropogenic activities without adequate attention to the ecological structure of most cities of developed and developing nations has undoubtedly contributed to reoccurrence of disaster and consequently poses threat to environmental sustainability in most of these nations (Oludare, Bashir & Olusegun, 2012). Many researchers have failed to examine the impact of ecological configuration as a constraint to land accessibility for housing development (Smersh, Smith and Schwartz 2016). One of the ecological constraints is flooding which is as a result of natural (e.g. extreme precipitation) and anthropogenic activities within the urban sector, such as encroachment of development to flood prone areas (Olajoke, Akeem & Stephen, 2013). Water will always find its way if not well channelized (Oyebande1990). Its choice route often poses problems to man by tampering with his physical environment. This has created a lot of social and economic cost on the environment and the citizenry. Few among these social and economic impacts on the environment are: infrastructure failure, building collapse and unavailability of land.

In urban areas especially within the coastal area such as Calabar, Lagos, Port Harcourt, Warri, etc., flooding has posed a major concern to the occupants of properties (Ajibola, Izunwanne & Ogungbemi, 2012). The access roads to some of these properties during rainy season are usually in their worse states and they deteriorate year after year. Owing to the lack of availability of land space and the high cost of lands in the study area, developers utilize whatever land they find available no matter the condition of the land or location. It is

not new to find lands located around flood prone areas in the metropolis being developed for residential housing. For instance, Ekeya district has massive density of housing infrastructures located around flood prone areas (Nku-Ekpang, Okpiliya, Okon, Njoku, Itu, Erhabor, & Okeniyi, 2017). Likewise, Anantigha and Ekpo Abasi areas are major flood prone areas as well as Satellite Town area, Atimbo, Edim Otop and Tinapa areas which are also regions with housing development located around flood and gully erosion problems.

These flood prone areas pose lots of risk to housing development, lives and properties. The interplay of these factors is not far-fetched in the City of Calabar. Accessibility to land for housing has been a major challenge due to the complication from constraint of flooding. Hence, this study assessed the impact of flooding as an ecological constraint of housing development in Calabar Metropolis, Cross River State, Nigeria. Specifically the study maps flood vulnerability as an ecological constraint to housing development in Calabar Metropolis and also examine the perception of residential property owners towards identified ecological constraint.

### Nexus between Land Availability and Physical Constraint

Housing is a fundamental social condition that determines not only the quality of life and well-being of a people but also the quality of a place. Housing development relies on natural resources (Land) for construction with often detrimental effects to the environment such as site clearance, deforestation, encroachment, and waste disposal. A sustainable housing development is very essential particularly in developing countries because it addresses the challenges to health, water, sanitation, national security, and climate change. However, land availability can be a major obstacle to housing development where it is not available or accessible, or even suitable. The delivery system of housing in many countries is a combination of many integrated components which include building materials, Infrastructure, policies, building regulations, finance, and more importantly land suitability (Atati, 2014) or availability.

Land availability refers to the solid part of the surface of the earth ready for immediate use. The use of such land for housing development depends on several factors which have attracted multiple discussions, subjecting multiple hypotheses into in-depth research. Most of this literature has been monocentric and polycentric models focusing on rent gradient, population density, spatial mismatch and Job/housing balance. Smersh, Smith, and Schwartz (2016) noted that most of these researches failed to examine the factors that determine the specific location of housing development among the number of the potentially suitable sites available. Monocentric models presupposed the existence of a point in geographic space to

which access is scarce, hence valuable with associated consequences (Hamilton, 2016). While polycentric models presupposed multiscale and multifaceted construct points with a similar degree of Importance.

There are many constraints to accessing land for housing development but less focus has been given to ecological or physical constraints. According to Poulton (2011), Land, as a resource is available everywhere but attached to it, are physical constraints that determined its accessibility and utility. Similarly, Bahadur (2011) noted that Land use efficiency boosts sustainability while inefficiency leads to depletion and hence poor economic returns with a loss of ecosystem services. Land use denotes the use into which a piece of land is put. This depends on the accessibility and eventual use of the land determined by building materials, Infrastructure, policies, building regulation, finance, daily lives security, health, well-being and Land suitability. These are summarized in the figure below.

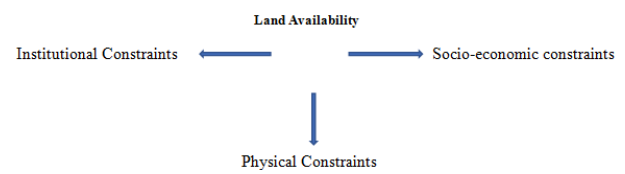


Figure 1: Nexus between Land Availability and Physical Constraint

The Physical constraints are embedded in land suitability issues such as wetlands, gullies, floods, and terrain characteristics. Accessing land for development without adequate attention to physical constraints has often contributed to the reoccurrence of disaster and threat to environmental sustainability. The way people understand and perceive physical constraints is a necessary step for designing studies that will generate reliable and valid data as well as implement policies that are ecologically and politically sustainable.

### Site Description

Calabar Metropolis is located in the southern part of Cross River State and comprises Calabar Municipality and the Calabar South Local Government Areas. It lies between longitudes 8018' East to 8024' East and latitudes 4054' North to 5010' North of the equator (Figure 2). Calabar exhibits a humid tropical climate with a double maxima rainfall pattern of approximately 3063mm (Edet, Okereke, Teme & Esu, 1998). The study area has a short dry season usually occurring between November and March, and a relatively longer wet season from April to October. The dry season is dominated by North East trade wind, while the South-East trade wind dominates the wet season. The rains are usually of long duration and with very high intensity. The unique characteristics of high humidity, high rainfall and temperature

have culminated into a highly unique complex and diverse flora and fauna. The vegetation of Calabar is evergreen tropical vegetation with tall trees and creeping ferns. The floristic richness is due to the high rate of speciation. The vegetation is very rich in both timber and non-timber species. In addition, the study area is bounded by two rivers. These are the Great Kwa River and Calabar River on whose bank is the Metropolis. The Calabar River has minor streams and tributaries.

Earth Explorer platform. The sample size of the study was determined using the Taro Yamane sample size formula. Based on the population estimation of Calabar Municipality as 546,706 according to the NPC (1991 and 2017). The number of questionnaires administered following the Taro Yamane (1967) sampling formula was;

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

Where;

n = Sample Size

N = Sampled population

e = Level of precision or confidence level at 0.05 significance

$$n = 546,706 \{ 1 + 546,706(0.05)^2 \}$$

**Method of data analysis for identification of flood risk zones**

To generate a flood risk map for Calabar metropolis, the area selection of effective parameters is vital. Although it is difficult to choose factors unanimously to be applied in flood risk assessments, some important variables have a definitive role in flood risk mapping as mentioned by Samanta, Koloa, Pal and Palsamanta (2016). Different geospatial data sets, such as elevation, slope and distance to river were considered as dependent parameters. Elevation plays a vital role on the spread of flooding. Slope is another independent parameter which can accelerate the soil erosion and surface runoff as well as vertical percolation. Figure 3 shows the multi-criteria research design adopted in identifying the flood prone zones in Calabar metropolis. The multi-criteria step for flood risk zone identification is effectively illustrated in Figure 3.

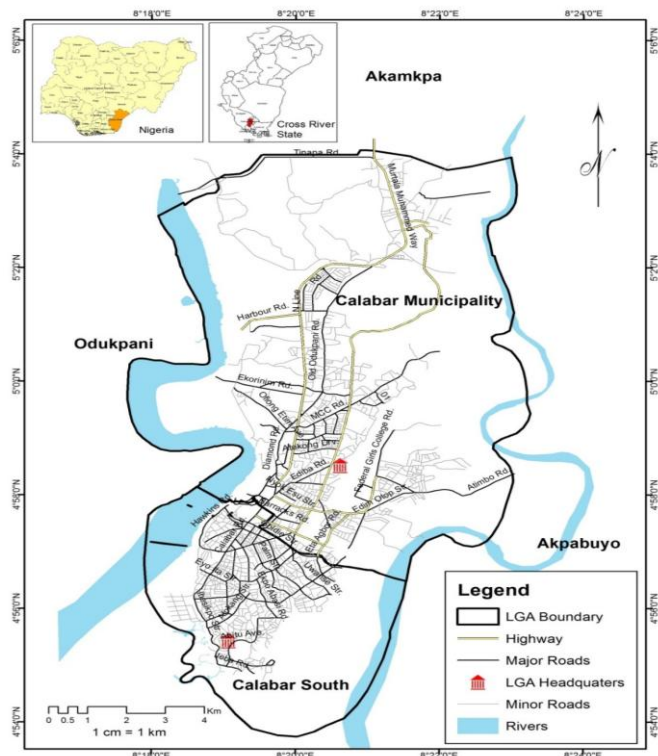


Figure 2: Map of Calabar metropolis

Source: GIS Unit, Department of Geography and Environmental Science, University of Calabar (2021)

**II. MATERIALS AND METHODS**

The study adopts a multi-research design to identify ecological constraint zones in Calabar. Field type of data in which geographic phenomena that have values everywhere in the study area was employed (Otto & Rolf, 2009). The continuous data adopted include: the digital elevation model of the terrain, slope of terrain, rainfall data, and satellite imagery of Calabar metropolis. Also secondary data for the flood zone identification process involved raster datasets such as satellite imagery, which were continuous field datasets adopted. The satellite imagery was acquired from the United States Geological Surveys (USGS) Google Earth platform. Likewise, a 1-arc second resolution Shuttle Radar Topography Mission Advanced Space-borne Thermal Emission and Reflection Radiometer DEM of the area was sourced from the

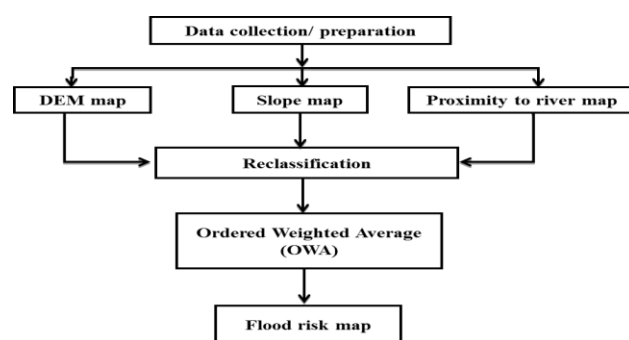


Figure 3: Multi-criteria research design for flood risk zones

Source: Author's field work, 2021

The DEM measured in meters was initially classified into 9 classes (0-14, 15-28, 29-42, 43-56, 57-70, 71-84, 85-98, 99-112 and >113). This was further reclassified into 9 categories (9-1) as shown on Table 1. Also, the slope in degree was categorized into 9 groups thus; 0-10, 11-21, 22-32, 33-43, 44-54, 55-65, 66-78, 77-87 and >88. The slope data was again reclassified to allow for raster analysis into 9 rates (9-1) as

tabulated on Table 2. Further, floodplains and the areas in the vicinity of Rivers are the most affected areas during floods (Fernandez & Lutz, 2010). Proximity analysis in ArcGIS was used to produce distance from river data sets. A total of 5 different distance classes were generated with a specific interval of distance in kilometers, such as; <1, 1-2, 2-3, 3-4 and 4-5. This classification was also reclassified as 5-1 as portrayed on Table 3.

Different rates for all the classes under each parameter and weights for the parameters were assigned simultaneously to take a final decision on suitable rates and weights, which produced better results. After preparation of all parameters and their individual class, user defined rate on a scale of 9 to 1 were assigned for slope and proximity to Rivers and 6-1 for DEM depending on their significance or influence on flood risk (Samanta, Koloa, Pal & Palsamanta, 2016). The highest rate refers to extreme vulnerability to flood risk and rate of 1 refers to almost no risk zones. For example, the probability of flood occurrences and intensity are high close to the river (Fernandez& Lutz, 2010), so the rank of 9 was assigned to the areas which are located less than 200m from the Calabar and Great Kwa Rivers.

More so, to execute the weighted overlay analysis, a total weight (W) of 100 was assigned amongst all 3 parameters. As depicted on Table 4, a weight of 40 was assigned to the distance from river because the most affected areas during floods are those near the river, as a consequence of bank overflow. Slope of the land plays an important role in determining surface runoff velocity and rate of vertical percolation and a weighted value of 20 was assigned to this parameter. Altitude has an important impact on the spread of flooding and has a key role in the control of the direction of overflow movement and also in the depth of the flood. A weight value of 40 was assigned to this parameter. The weighted overlay overlays several rasters, in this scenario, the DEM, slope and multiple rings buffer of proximity to Rivers, using a common measurement scale and weights each according to its importance.

**Table 1: Reclassification of the DEM**

S/N	DEM Class (m)	Reclass (Rates)	Rating Index	Weight
1	>113	9	Low risk	40
2	99-112	8		
3	85-98	7		
4	71-84	6		
5	57-70	5		
6	43-56	4		
7	29-42	3	Medium risk	
8	15-28	2	High risk	
9	<= 14	1		

Source: Author's field work 2021

**Table 2: Reclassification of the slope**

S/N	Slope Class (°)	Reclass (Rates)	Rating Index	Weight
1	>= 88	9	Low risk	20
2	77-87	8		
3	66-76	7		
4	55-65	6		
5	44-54	5		
6	33-43	4		
7	22-32	3	Medium risk	
8	11-21	2	High risk	
9	<=10	1		

Source: Author's field work 2021

**Table 3: Buffer distance and reclassification of river buffer**

S/N	Distance to River (km)	Reclass (Rates)	Rating Index	Weight
1	3-3.5	6	Low risk	40
2	2.5-3	5		
3	2-2.5	4		
4	1.5-2	3	Medium risk	
5	1-1.5	2	High risk	
6	0.5-1	1		

Source: Author's field work 2021

**Table 4: Buffer distance and reclassification of river buffer**

S/N	Distance to River (km)	Reclass (Rates)	Rating Index	Weight
1	3-3.5	6	Low risk	40
2	2.5-3	5		
3	2-2.5	4		
4	1.5-2	3	Medium risk	
5	1-1.5	2	High risk	
6	0.5-1	1		

Source: Author's field work 2021

### III. RESULT AND DISCUSSION

#### Flood vulnerability and ecological constraint

Figures 4 to 8 shows the map output of the reclassification process carried out for the flood risk zone multi-criteria analysis. The final results of the multi-criteria analysis are displayed in Figure 8. The result divided the metropolis into five (5) zones which are: (i) Very high risk zone (ii) High risk zone (iii) Moderate zone (iv) Low risk zone (v) Very low risk zone.

Furthermore, in other to assess the spatial implication of the flood risk zones to development, the street map of Calabar metropolis was overlaid on the flood risk map. The resultant flood risk map with the metropolis street map overlay, displayed in figure 8, showed that places such as MCC road, Old Odukpani Road, Good luck Jonathan Bypass, IBB way, Murtala Mohammed way, Marian and Ndidem Iso road are

located at the very low risk zone. Furthermore, areas located within the Low-risk zone include: Atu Street, Ediba road, Palm street, Summit hills road, Uwanse road, Orok –orok street, Mary Slessor avenue, 4th Avenue and Barracks Road. More so, streets such as: Eyo-Ita, Court road, Ekorinim, New Airport road, Atimbo, Bedwell street and Diamond road are located within the Moderate risk zone. Lastly, areas like Jebes road, Edebom street, Afokang street, Abitu street, Ibesikpo street and Hawkins road fall under the high-risk zone, while no street was classified as very high-risk zone. However section of 8 Miles via highway where development hinders water from finding its course experience intense flash floods during heavy downpour.

Although residents living within the flood-risk zones are aware of the danger of flooding and how vulnerable they are to the phenomenon, they still find these ecological constraint zones a better option than any other available options, due to their financial constraint to acquire a decent house in the low-risk flood zones or very low risk flood zones. However, the onset of extreme flooding event has made many residents leaving in the flood prone zone to move out to find alternative options to their predicament. Hence, flood prone zones are ecological constraint to housing in Calabar metropolis.

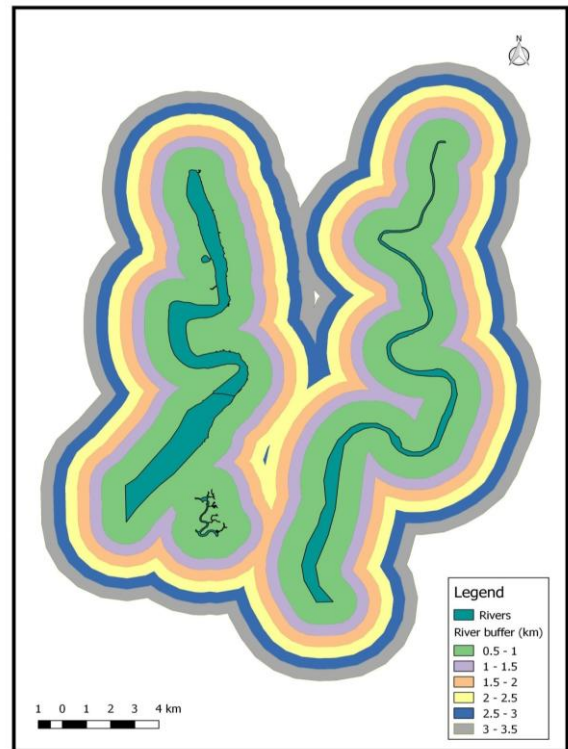


Figure 5: River buffer classification of Calabar metropolis

Source: Author’s field work 2021

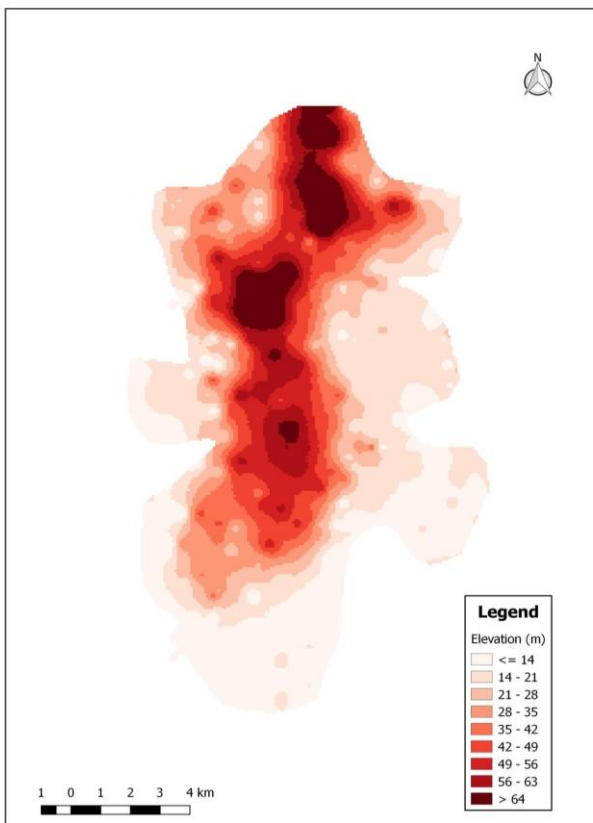


Figure 4: DEM classification of Calabar metropolis

Source: Author’s field work 2021

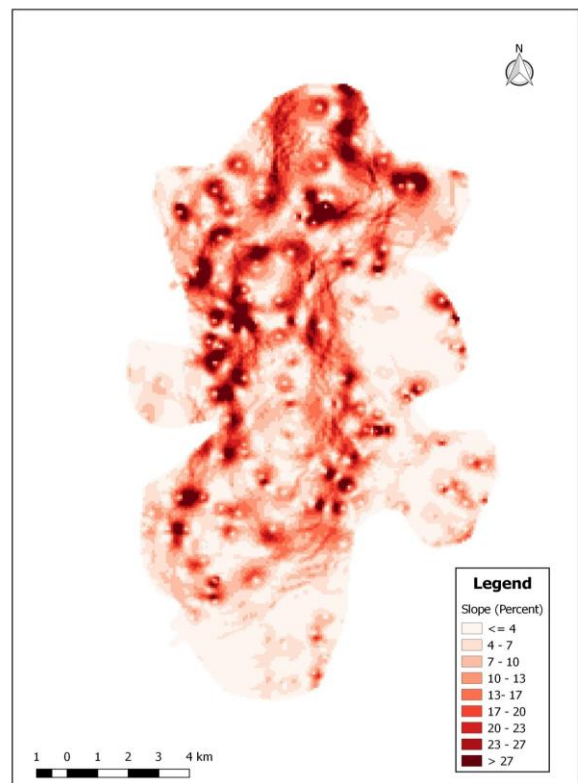


Figure 6: Slope classification of Calabar metropolis

Source: Author’s field work 2021

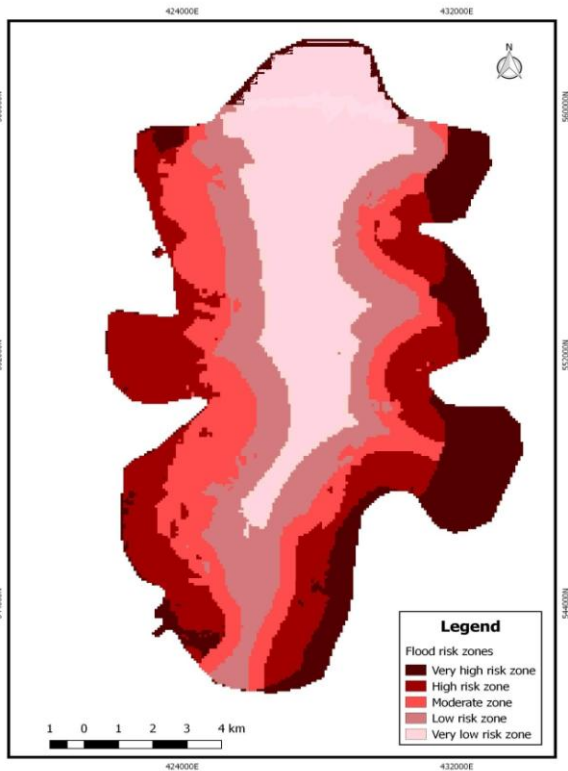


Figure 7: Flood risk zones of Calabar metropolis

Source: Author's field work 2021

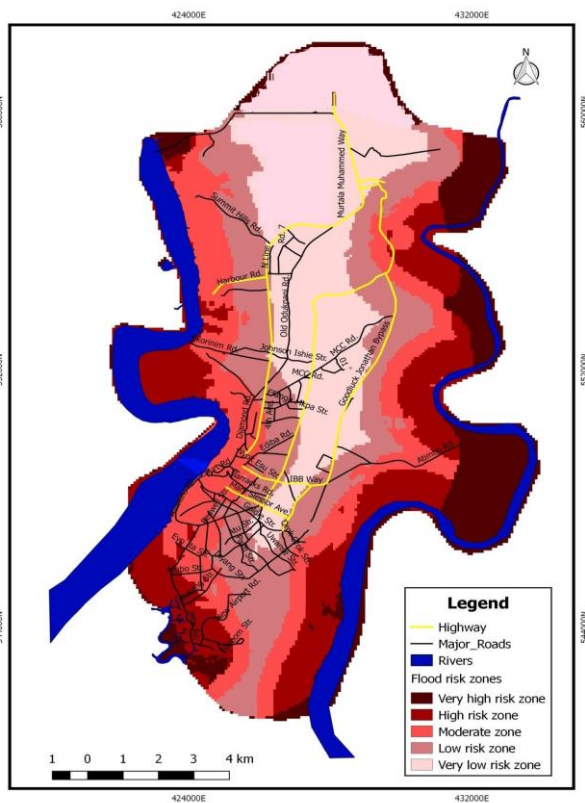


Figure 8: Flood risk zone of Calabar metropolis with street map overlay

Source: Author's field work 2021

### Perception of property owners to ecological constraints

Result shows that 65 percent of the respondents sampled were aware that the area was ecologically constraint before they sited their houses, while 35 percent of the sampled population feigned ignorance. 55 per cent fear the risk of losing their houses but 10.5 had the intention of personal protection while 42.5 percent seek prevention measures from the government. Majority of the respondents therefore hope on government for prevention measures. Although 55.5 percent prefer engineering measures but the cost of its execution push many to opt for indogenous measures. Figure 9 revealed that 68 percent of respondents sampled used indogenous measure to tackle the menace, while 26.5 percent partner with government agencies to tackle the menace, whereas only 5.5 percent engaged the government on dialogue through the community leaders on way to check the spade of such ecological constraint.

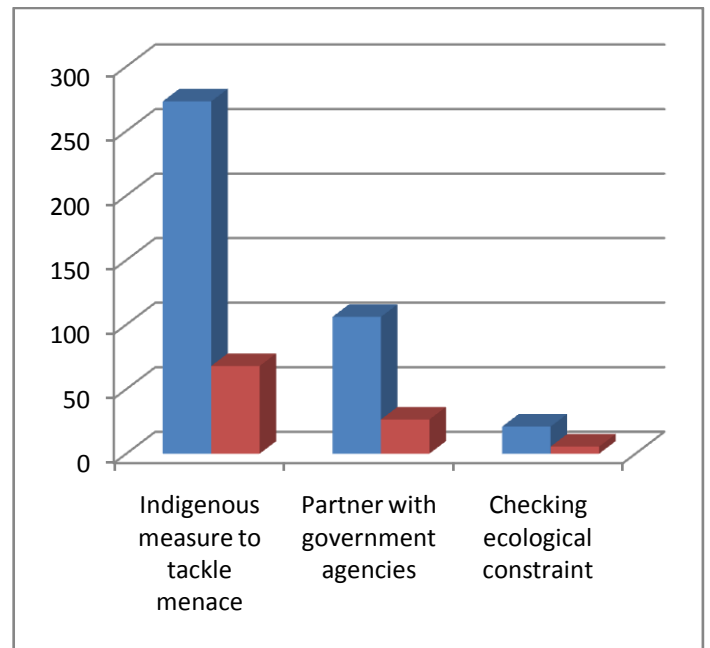


Figure 9: Ecological constraint measures by property owners

Source: Author's fieldwork, 2021

In order to understand the status of building in ecologically constraint zones, it was relevant to know why developers build in ecologically constraint zones. From the data displayed in figure 10, it was discovered that 20 per cent build in ecological constraint zone due to land affordability; 11 per cent think it's as a result of government intervention; 22 per cent as a result of managing the situation, while 19 per cent due to devastation before government intervention. Also, 28 per cent attribute to family inheritance while 47 per cent to other reasons (see Figure 12).

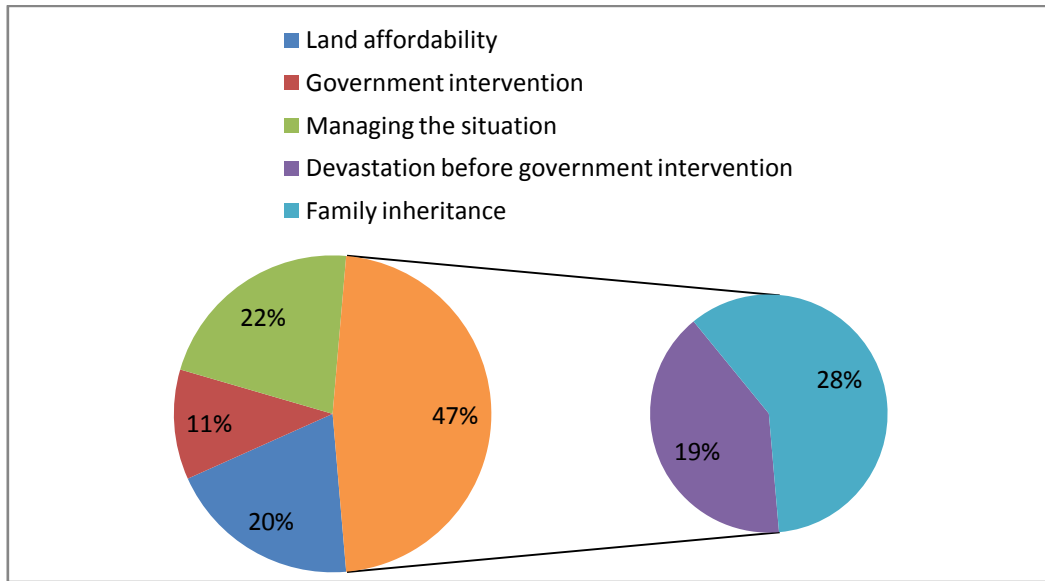


Figure 10: Reasons for building in ecological constraint area?

Source: Author’s fieldwork, 2021

Furthermore, figure 11 shows the distribution of flooding experience per annum. Based on the result, 20 per cent of the respondents agree it occurs once, 10.5 per cent said twice, 42.5 per cent said thrice and lastly 27.0 per cent of respondents said above four times.

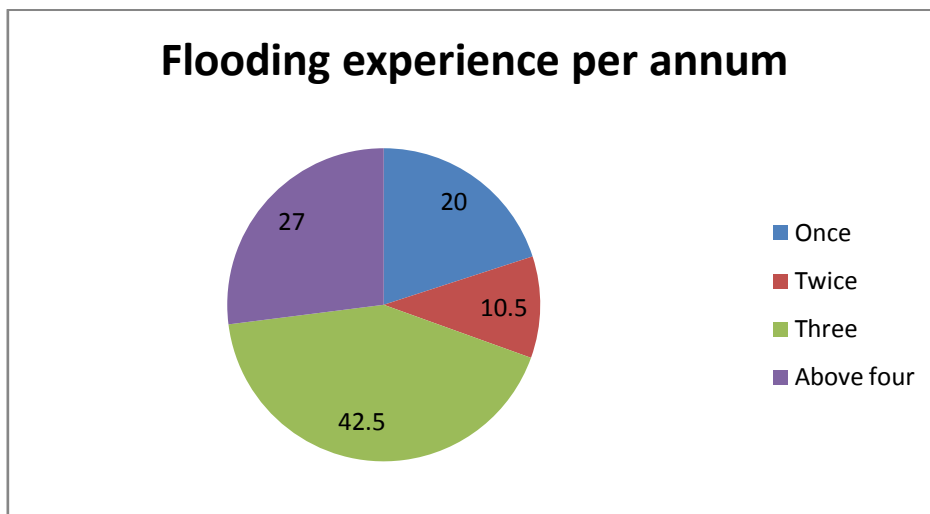


Figure 11: Flooding experience per annum

Source: Author’s fieldwork, 2021

#### IV. CONCLUSION AND RECOMMENDATION

This study examined flooding as an ecological constraint to housing development in Calabar Metropolis, Cross River State, Nigeria. From the result of this study, it is established that flooding has impacted so much on environmental and socio-economic livelihood of residents in the area and therefore, requires urgent government intervention to check the effects within the study area. However, it is noted that developers do not randomly choose to acquire properties at

flood prone zone. Various reasons are adduced for building locations but most of them cannot be disassociated from inadequate land space and high cost of land. Man is obviously a risk taker as most of the decisions taken on land ignore the ecological structure of the study area and therefore created more problems for himself. People build without proper channelization forgetting that water will always find its course and when it does, social and economic cost on the environment and citizenry ensue. As a follow up to the study, it was thus recommended that:

- i. Government should make efforts to educate developers on the implication of developing in flood prone zones so as to avoid the threats and challenges such action pose on the environment, lives and properties.
- ii. Government should execute their laws efficiently and strictly as well as put up severe penalties for developers who default on the building regulation of the city.
- iii. Furthermore, the government should adopt the use of buffer zones so as to the dissuade the developers from developing in flood prone zones. With the adoption of buffer zones, developers become relegated to the available lands apportioned by the government for development.

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**Citation of this Article:**

Ogar, Timothy Okey, Etim, Emmanuel Asuquo, Ayuk Simon Obietta,, “Flood Risk Zones, Housing Development and Response of Residential Property Owners in Calabar Metropolis, Nigeria” Published in *International Research Journal of Innovations in Engineering and Technology - IRJIET*, Volume 6, Issue 9, pp 9-17, September 2022. Article DOI <https://doi.org/10.47001/IRJIET/2022.609002>

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