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SUSTAINABLE ENVIRONMENTAL PLANNING IN UYO CAPITAL CITY: ADDRESSING FLOOD VULNERABILITY THROUGH URBANIZATION AND LAND USE MANAGEMENT

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ABSTRACT

Urban flooding has become a major environmental challenge in rapidly urbanizing cities, particularly in developing countries where urban growth often exceeds environmental planning and infrastructure development. This study examined the role of sustainable environmental planning in addressing flood vulnerability in Uyo Capital City, Akwa Ibom State, Nigeria, through effective urbanization control and land use management. The study specifically assessed the effects of rapid urbanization, poor land use practices, wetland encroachment, blocked drainage systems, and inadequate environmental governance on flood vulnerability, while also evaluating sustainable planning strategies for reducing urban flood risks and enhancing environmental sustainability. A descriptive survey and spatial analytical research design were adopted. Data were obtained through Geographic Information System (GIS) analysis, remote sensing techniques, Digital Elevation Models (DEM), rainfall records, field observations, questionnaires, community surveys, and secondary sources including academic journals, government reports, and environmental publications. A purposive sampling technique was used in selecting flood-prone communities, while a sample size of 382 respondents was determined using the Bill Godden formula. Data were analyzed using qualitative content analysis, descriptive statistics, and spatial analytical techniques. Findings revealed that rapid urban expansion, conversion of wetlands into built-up areas, increased impervious surfaces, poor waste disposal practices, drainage blockage, and weak implementation of land use regulations significantly contributed to flood vulnerability in Uyo Capital City. The study further established that sustainable environmental planning strategies such as green infrastructure development, sustainable drainage systems, flood-sensitive land use planning, urban afforestation, climate adaptation measures, and stronger environmental governance can significantly reduce flood risks and improve urban resilience. The study contributes to knowledge by integrating sustainable environmental planning, urbanization management, and land use regulation within the context of flood vulnerability reduction and sustainable urban development in rapidly growing cities.
Keywords: Environmental sustainability, Flood vulnerability, Land use management, Sustainable environmental planning, Urban flooding, Urbanization.

1.0 INTRODUCTION

Urbanization is a global phenomenon characterized by the rapid growth and expansion of cities due to population increase, industrialization, economic transformation, and infrastructural development. Although urbanization contributes to economic growth and modernization, uncontrolled urban expansion often leads to environmental problems such as flooding, pollution, deforestation, ecosystem degradation, and climate vulnerability (United Nations, 2019). In many developing countries, rapid urban growth has exceeded environmental planning and infrastructure provision, thereby increasing environmental risks and urban vulnerability. Globally, urban flooding has become more frequent due to climate change, increased rainfall intensity, poor drainage infrastructure, and unsustainable land use practices. The Intergovernmental Panel on Climate Change (IPCC, 2021) noted that climate-induced extreme weather events have intensified flood occurrences in many urban regions worldwide. The impacts are more severe in developing countries where weak environmental governance, inadequate planning systems, and rapid population growth increase exposure to environmental hazards. Douglas *et al*. (2008) observed that uncontrolled urbanization, inadequate drainage systems, and poor environmental planning significantly increase flood vulnerability, especially among low-income urban populations. Similarly, Jha *et al*. (2012) revealed that ineffective land use planning, weak environmental governance, and urban expansion into wetlands and floodplains contribute greatly to urban flood disasters and environmental degradation.

In Nigeria, urban flooding remains a major environmental challenge affecting cities such as Lagos, Port Harcourt, Benin, and Uyo. Aderogba (2012) identified rapid urbanization, poor physical planning, inadequate drainage systems, indiscriminate waste disposal, and uncontrolled development as major causes of recurrent flooding. Adelekan (2016) further noted that rapid urban population growth and unplanned urbanization overstretch drainage infrastructure, encourage settlement in flood-prone areas, and worsen flooding through blocked drainage channels and poor waste management. Urbanization also alters natural hydrological systems by increasing impervious surfaces such as roads, buildings, and pavements. Miller and Hutchins (2017) observed that these changes increase surface runoff, reduce groundwater infiltration, and intensify flash flooding in urban areas. In response to these challenges, sustainable environmental planning has emerged as an important strategy for managing urban growth and reducing environmental risks.

Sustainable planning integrates environmental protection measures into urban development and land use management to ensure long-term ecological sustainability (WCED, 1987). It promotes effective land use regulation, green infrastructure development, climate adaptation, and ecological management. Gill *et al*. (2007) revealed that urban forests, parks, green roofs, and permeable surfaces help reduce flooding by increasing rainwater infiltration and minimizing surface runoff. Fletcher et al. (2015) also demonstrated that sustainable drainage technologies such as bioswales, retention ponds, and permeable pavements effectively reduce stormwater runoff and urban flood risks. Similarly, Newman and Jennings (2008) observed that cities with strong environmental planning policies, efficient land use management, and green infrastructure experience lower environmental risks and greater urban resilience. However, poor implementation of sustainable urban planning policies remains a challenge in Nigeria. Echendu (2020) affirmed that weak governance structures, corruption, and inadequate policy implementation contribute to flooding, pollution, and environmental degradation in many Nigerian cities.

Uyo Capital City, the administrative headquarters of Akwa Ibom State, has experienced rapid urban growth over the past two decades due to rural-urban migration, infrastructural expansion, and economic development. This growth has led to the conversion of wetlands, floodplains, and vegetated areas into residential and commercial infrastructures, obstructing natural water flow and increasing flood occurrences. Akpan and Umoh (2019) found that rapid urban expansion, wetland conversion, blocked drainage systems, and poor land use planning significantly increase flood vulnerability in Uyo. Furthermore, Ruggerio (2021) emphasized that sustainable environmental planning promotes efficient resource utilization, environmental conservation, and long-term ecological resilience through the integration of sustainability principles into urban development policies. Despite increasing attention to urban flooding and environmental sustainability in Nigeria, flood vulnerability remains a major challenge in Uyo Capital City due to rapid urbanization, poor drainage systems, indiscriminate waste disposal, and weak land use management practices. Consequently, there is a growing need for sustainable environmental planning approaches capable of reducing flood risks while promoting urban resilience and ecological sustainability. This article therefore examines the role of sustainable environmental planning in addressing flood vulnerability in Uyo Capital City through urbanization management and land use planning, while proposing sustainable strategies for enhancing environmental sustainability in the study area.

2.0 MATERIALS AND METHODS

2.1 Study Area

Uyo Local Government Area is located in the central part of Akwa Ibom State and lies within latitude $5^{0}02^{I}$ N and Longitude $7^{0}56^{I}$ E. It is bounded in the north by Ikono, Ibiono Ibom and Itu Local Government Areas, in the south by Ibesikpo Asutan, Nsit Ibom, and Etinan Local Government Areas, in the East by Uruan Local Government Area and in the west by Abak Local Government Area. It covers a total landmass of about 155.856 square kilometres. The limit of the capital city however exceeds some of the boundaries of Uyo Local Government Area, and covers approximately 314.65 square kilometres and is made up of four clans namely, Oku (14 villages), Etoi (23 villages), Offot (23 villages), and Ikono Clan (19 villages). Uyo lies in the humid tropics characterized by two distinct seasons: dry and wet seasons. The dry season starts from November to March while the wet season lasts from April to October. The dry season is influenced by the North-Eastern Trade Winds known as the tropical Continental (cT) which originates from the Sahara Desert. The wet season is influenced by the movement of the rain-bearing Tropical Maritime Air mass (mT) which comes from the Atlantic Ocean. During the rainy season, a period of intense sunshine may be recorded in August (Udosen, 2008).

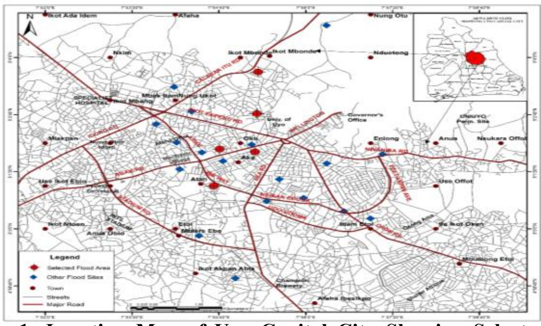


Figure 1: Location Map of Uyo Capital City Showing Selected Flash Flood Prone Areas
Source: GIS Laboratory, Department of Geography, University of Uyo

The temperature of Uyo is constantly high with a mean monthly value of approximately 27^{0}C. Relative Humidity is at a constant high value of between 70% and 90% all year round. The city is affected by the hot and humid maritime air mass as a result of its proximity to Guinea coast. Consequently, rainfall is expected during every month of the year although a well – marked longer dry season occurs from mid – December to late February/early March or early August followed by a short dry season of about 2 – 4 weeks called AUGUST BREAK. During the rainy season, southerly winds bring moisture to all parts of the state. Mean monthly rainfall computed for eighteen (18) years (2007 - 2025). Any month with an average rainfall of at least 102 mm denotes a wet month. (Figure 2)

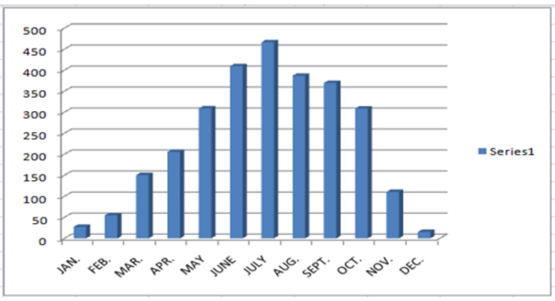


Figure 2: Mean Monthly Rainfall (mm) Pattern in Uyo (2007 – 2025)
Source: Agro-Meteorological Station, University of Uyo, Uyo.

2.2 Sample Collection

Samples for this study were collected from selected flood-prone communities and urban areas within Uyo. The study focused on locations characterized by rapid urbanization, poor drainage conditions, wetland encroachment, uncontrolled physical development, and recurrent flood incidents. Data for the study were obtained from both primary and secondary sources, including satellite imagery and Geographic Information System (GIS) spatial data, field observations of drainage systems and land use patterns, community surveys and interviews, government reports and environmental records, as well as relevant academic journals and related literature. A purposive sampling technique was adopted in selecting the flood-prone communities included in the study. The selected communities were chosen based on the frequency and severity of flooding, level of urban expansion, and environmental vulnerability within the study area. Primary data were collected through direct field observations and the administration of structured questionnaires to residents and stakeholders within the affected communities. The population for the study was derived from the 1991 National Population Census figures, which were projected to 2019, giving an estimated population of 57,649 persons within the selected flood-prone communities. The sample size for the questionnaire survey was determined using the Bill Godden (2004) formula for infinite populations as presented in Equation 1:

$$SS = \frac{Z^2 \times (P) \times (1-P)}{C^2} \qquad \text{Equation 1}$$

Where, SS = sample size

Z = Z – Value[A] (e.g., 1.95 for a 95 percent confidence level),

P = percentage of population picking a choice, expressed as decimal), C = confidence interval, expressed as decimal (e.g., 0.05 = +/- percentage parts)

$$SS = \frac{3.8416 \times 0.5 \times (1-0.5)}{0.0025} \quad SS = 384.16$$

To obtain the adjusted sample size for the finite population, the Bill Godden correction formula was applied as shown in Equation 2:

$$\text{New SS} = \frac{SS}{(1+(\frac{SS-1}{Pop}))} \qquad \text{Equation 2}$$

Where: Pop = Population (57,649). Substituting the values into the equation:

$$\text{New SS} = \frac{384.16}{\left(1+\left(\frac{384.16-1}{57,649}\right)\right)} \quad \text{New SS} = 382$$

Therefore, a total sample size of 382 respondents was adopted for the study and proportionately distributed among the selected flood-prone communities.

2.3 Sample Identification

The samples identified for this study consisted of selected flood-prone communities, urban land use features, and environmental components within Uyo Capital City. The identification process focused on areas and variables directly associated with urbanization and flood vulnerability. The identified samples included:

Flood-Prone Communities: Residential areas within Uyo Capital City frequently affected by flooding due to poor drainage systems, wetland encroachment, and uncontrolled urban development.

Land Use Features: Built-up areas, roads, drainage channels, wetlands, floodplains, commercial zones, and residential layouts affected by rapid urban expansion.

Environmental Variables: Drainage conditions, waste disposal sites, vegetation cover, impervious surfaces, and blocked waterways contributing to flood occurrence.

Population Samples: Residents, community leaders, urban planners, environmental officials, and stakeholders with knowledge of flooding and urban development in the study area.

Spatial and Geographical Data: Satellite imagery, GIS maps, remote sensing data, and GPS coordinates used to identify urban growth patterns and flood-vulnerable locations.

The sample identification was guided by the level of flood occurrence, degree of urbanization, land use changes, and environmental vulnerability within different parts of Uyo Capital City.

To know the number of questionnaires to be administered at each flash flood location, Bourley (1998) proportional allocation formula was used to determine the sample size for each flash flood location as given in Equation 3:

$$Nh = \frac{n * XNh}{N} \qquad \text{Equation 3}$$

Where:

Nh = Number of units of questionnaire in each flash flood location

n =the total sample size

XNh = population size of the flash flood location

N = the total population of the study area

The proportional allocation technique ensured equitable distribution of questionnaires across the selected flood-prone communities based on their projected population sizes (Table 1)

Table 1: Sample Size for Socio-Economic Survey

S/N	Flash Flood Locations	Population (1991)	Projected Population (2019)	Sample size
1.	Afaha Oku	4127	10,582	70
2.	Afaha Offot	1989	5100	33
3.	Aka Offot	3362	8620	57
4.	Atan Offot	3387	8684	58
5.	Effiat Offot	4179	10,715	71
6.	Ikot Okubo	2213	5674	38
7.	Itiam Etoi	3227	8274	55
	Totals	22,484	57,649	382

Source: Extracted from National Population Census Figures (1991).

2.4 Sample Presentation

Data and findings were presented using Tables, GIS maps, charts and graphs, photographs from field observations, Descriptive narratives and thematic discussions. Spatial maps were specifically used to illustrate flood-prone communities, drainage conditions, and land use changes within Uyo Capital City.

2.5 Experimental Design

The study adopted a descriptive survey and spatial analytical design to examine the relationship between urbanization, land use management, and flood vulnerability in Uyo Capital City. The design integrated Geographic Information System (GIS), remote sensing techniques, field observations, and qualitative assessments to evaluate how rapid urban growth influences flood occurrence and environmental sustainability.

2.6 Data Collection

Primary and secondary data were collected for the study. Primary data included field observations, questionnaires, interviews, and GPS coordinates. Secondary data included rainfall records, Digital Elevation Models (DEM), satellite imagery, government reports, and published literature. Rainfall data covering 1977–2024 were obtained from the Agro-Meteorological Station, University of Uyo. DEM data obtained from the United States Geological Survey (USGS) were used to generate topographic maps and digital surface models (dsm) for flood vulnerability analysis.

2.7 Data Analysis

The collected data were analyzed using both qualitative and spatial analytical techniques. GIS and remote sensing tools were used to map flood-prone areas, identify land use changes, and assess urban expansion patterns. Qualitative content analysis was used to interpret information obtained from interviews, surveys, and literature sources. Spatial analysis helped determine the relationship between: Urban expansion, Wetland encroachment, Drainage blockage, Impervious surface development and Flood vulnerability Descriptive statistical methods such as percentages, charts, and thematic interpretation were also used to explain findings.

3.1 Socio-Economic Characteristics of Respondents

The study involved a well-distributed sample of respondents based on sex, age, marital status, educational level, length of residence, and household size. Males constituted 57.2% (214) of respondents, while females accounted for 42.8% (160). Most respondents were within the economically active age group, with 41–50 years representing the largest proportion (39.6%), followed by 31–40 years (29.9%), 50 years and above (16%), and 21–30 years (15%). In terms of marital status, the majority of respondents were married (75.4%), while 19.3% were single, 4% widowed, and 1.3% divorced. Educational attainment among respondents was relatively high, with 52.9% possessing HND/B.Sc/B.Tech qualifications, 18.7% holding O'Level certificates, 18.5% OND/NCE, 5.6% postgraduate qualifications, and 4% First School Leaving Certificates. Most respondents had lived in the study area for over 10 years (79.1%), while 15.8% had resided there for 5–10 years and only 5.1% for less than 5 years. Household sizes were predominantly moderate to large, with 69% having 5–9 members, 24.3% having 1–4 members, and 6.7% having more than 10 members (Table 2).

Table 2: Distribution of Household Capacities of Respondents

Variables	Frequency (n)	Perce %)
Distribution of Respondents by Sex	214	57.2
Male		
Female	160	42.8
Distribution of Respondents by Age		
21 – 30	56	15.0
31 – 40	110	29.9
41 – 50	148	39.6
50 and above	60	16.0
Total	374	100
Marital Status		
Single	72	19.3
Married	282	75.4
Divorced	5	1.3
Widowed	15	4.0
Total	374	100
Distribution of Respondents by Educational Status	15	4.0
FSLC		
O'LEVEL	70	18.7
OND/NCE	69	18.5
HND/B.SC/B.TECH or Equivalent	198	52.9
M.Sc/M.A/PhD or equivalent	22	5.6
TOTAL	374	100
How long have you lived here?	19	5.1
0 – 5 years	59	15.8
5 – 10 years	296	79.1
Above 10 years	374	100
Total		
Household Size	91	24.3
1 – 4	258	69.0
5 – 9	25	6.7
10 and above	374	100
Total		

Source: Researcher's Field Survey (2025).

3.2 Inter-Annual Variability and Rainfall Trends

Table 3 shows the analysis of rainfall data obtained from the Agro-Meteorological Station, University of Uyo, covering the period 1977–2024, revealed significant temporal variations in rainfall distribution within Uyo Capital City. The mean annual rainfall for the 48-year period was 2576.5 mm. The highest annual rainfall value of 5083.3 mm was recorded in 2024, while the lowest annual rainfall value of 1612.7 mm occurred in 1983. High rainfall values exceeding 3000 mm were observed in years such as 1977, 1978, 1979, 2005, 2006, 2012, 2014, 2019, and 2024. The study also showed that extreme rainfall events ranging from 78 mm to 180 mm occur mostly during the peak rainy months of June to September. Mean monthly rainfall analysis indicated a gradual increase in rainfall intensity and frequency, peaking in July. No month within the study period recorded zero rainfall, confirming the humid tropical climatic condition of Uyo (Figure 3)

Table 3: Annual Rainfall Distribution 1977 – 2024

Year	Annual Total Rainfall(mm)	Departure from Mean
1977	3831.0	1254.5
1978	3361.7	784.5
1979	3722.4	1145.9
1980	2812.3	235.8
1981	2369.4	−207.1
1982	2524.9	−51.6
1983	1612.7	−963.8
1984	1875.9	−700.6
1985	2130.1	−446.4
1986	1762.9	−813.6
1987	2283.0	−293.5
1988	2120.0	−456.5
1989	2537.6	−38.9
1990	2119.0	−457.5
1991	2129.6	−446.9
1992	2365.6	−210.9
1993	2181.4	−395.1
1994	2628.9	52,4
1995	2318.5	−258
1996	1931.2	−645.3
1997	1859.7	−716.8
1998	2501.6	−74.9
1999	2069.1	−507.4
2000	1874.1	−702.4
2001	2502.4	−74.1
2002	1779.6	−796.9
2003	2175.6	−400.9
2004	2176.6	−399.9
2005	3033.3	456.8
2006	3324.6	748.1
2007	2406.7	−169.8
2008	2787.4	210.9
2009	2008.1	−568.4
2010	2824.6	248.1
2011	2803.9	227.4
2012	3827.5	1251
2013	2819.4	243.9
2014	3203.1	626.6
2015	2521.3	−55.2
2016	2826.1	249.6
2017	2484.4	−92.1
2018	2991.1	414.6
2019	3172.4	595.9
2020	2901.2	324.7
2021	2062.7	−513.8
2022	2446.5	−130
2023	2588..7	12.2
2024	5083.3	2508.8
Mean	2576.5	

Source: Agro-Meteorological Station, University of Uyo, Uyo (2025)

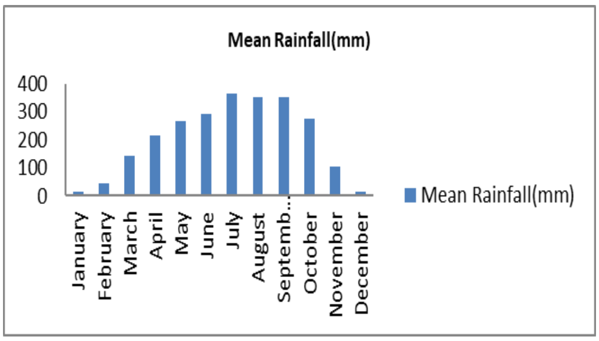
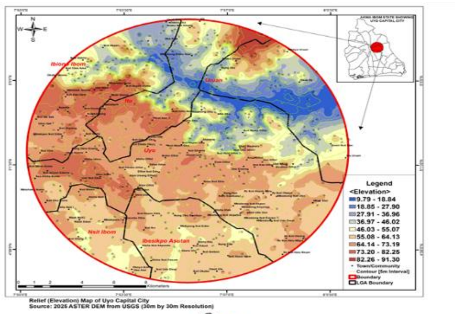


Figure 3: Mean Monthly Rainfall (mm) Pattern in Uyo (1977 – 2006)
Source: Extracted from Rainfall Records in Uyo; in Udosen (2017)

3.3 Identification of Flood-Prone Areas Using Topographic Analysis

Topographic analysis generated from the Digital Elevation Model (DEM) showed that the study area ranges between 48 m and 89 m above sea level. Low-lying areas such as Effiat Offot, Atan Offot, Urua Ekpa, Udo Eduok, and IBB Avenue were identified as highly vulnerable to flooding. IBB Avenue was found to be particularly flood-prone due to its extensive runoff catchment area and low elevation of about 53 m above sea level. Similarly, flash flood occurrences were observed around Abak Road/Nkemba Street, Port Harcourt Street, and Udoette Street following heavy rainfall events. The terrain analysis further showed that flooding in higher elevation areas is associated with blocked drainage systems, poor drainage infrastructure, and unregulated urban development (Figure 4)



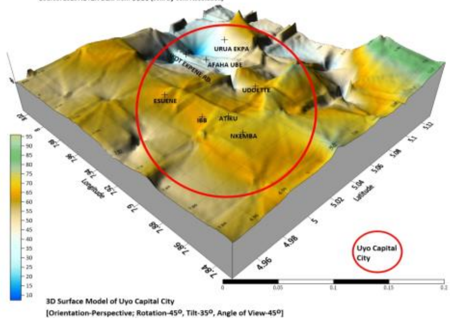


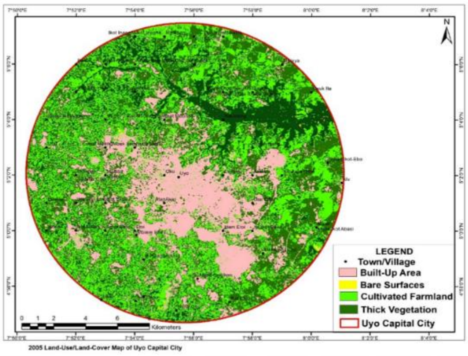
Figure 4: Relief (Elevation) Map of Uyo Capital City
Figure 5: Digital Surface Model (DSM) of Uyo Capital City
Source: 2025 ASTER DEM OF UYO FROM USGS
Source: 2025 ASTER DEM OF UYO
(30m by 30m Resolution)

3.4 3D Surface Model of the Study Area

The Digital Surface Model (DSM) revealed significant relief variability within Uyo Capital City. Areas around Abak Road, Nkemba, Esuene, IBB Avenue, and Atiku recorded unique relief patterns that make them highly susceptible to flooding. Similarly, low terrain areas such as Afaha Ube, Tabernacle Road, Udoette, and Urua Ekpa were identified as highly vulnerable to flood incidents due to poor drainage and low elevation characteristics. (Figure 5)

3.5 Land Use Change and Flood Vulnerability

The study revealed that rapid urbanization has significantly altered land use and land cover patterns in Uyo Capital City. Forests, wetlands, and cultivated farmlands have progressively been converted into built-up areas, transportation infrastructure, and commercial facilities. In 2005, thick vegetation covered 23.5% of the study area, cultivated farmlands accounted for 27.1%, bare surfaces 17.8%, and built-up areas 31.7%. By 2015, thick vegetation had reduced to 12.5% while built-up areas increased to 42.8%. (Figure 6). In 2015 (ten years after), thick vegetation and cultivated farmlands reduce to 12.5% and 26.5% respectively. Similarly, bare surfaces and built-up areas increase to 18.4% and 42.8% respectively (Figure 7). Figure 8 gives the summary of Land-Use Classification in 2025. Here, thick vegetation reduces to 7.3%, likewise cultivated farmland to 10.9% while bare surfaces and built-up area increase to 21.8% and 60.1% respectively.



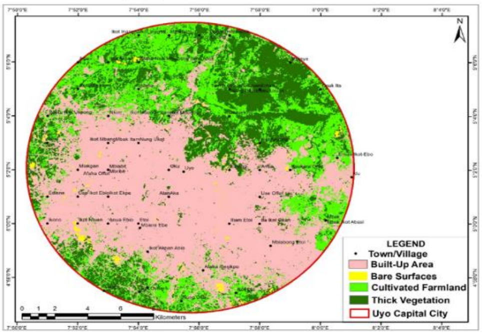


Figure 6: 2005 Land-Use/Landcover Classes
Figure 7: 2015 Land-Use/Landcover Classes.
Source: Classified Satellite Image of Uyo Capital City (2005) Classified Satellite Image of Uyo Capital City (2015)

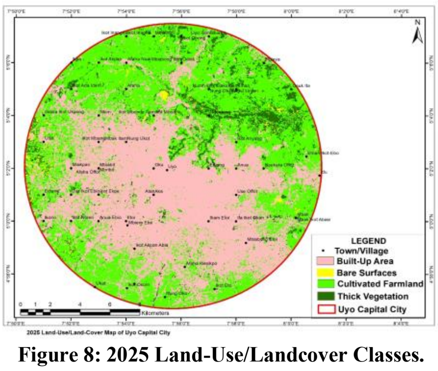


Figure 8: 2025 Land-Use/Landcover Classes.
Source: Classified Satellite Image of Uyo Capital City (2025)

3.5.2 Summary of Land-use Changes and Urbanization trends

As shown in Table 4, in 2005, thick vegetation covers 23.5% of the whole Uyo Capital City, cultivated farmlands covers 27.1% while bare surfaces and built-up area cover 17.8% and 31.7% respectively. In 2015 (ten years after), thick vegetation and cultivated farmlands reduce to 12.5% and 26.5% respectively. Similarly, bare surfaces and built-up areas increase to 18.4% and 42.8% respectively. In 2025, thick vegetation reduces to 7.3%, likewise cultivated farmland to 10.9% while bare surfaces and built-up area increase to 21.8% and 60.1% respectively. The increase in built-up areas within Uyo Capital City at the expense of thick vegetation and farmlands is due to the high level of urbanization in the capital city. The findings further showed that increased impervious surfaces such as roads and buildings have reduced infiltration capacity and increased stormwater runoff. Encroachment into wetlands and natural drainage corridors has also intensified urban flooding.The study additionally identified improper waste disposal, blocked drainage channels, weak enforcement of land use regulations, and poor implementation of Environmental Impact Assessments as major contributors to flood vulnerability in ¸ ıpital City.

Table 4: Inventory of Land Use/Land Cover Status

S/N	Land use/land cover Classes	Coverage extent in hectares for 2005 (%)	Coverage extent in hectares for 2015 (%)	Coverage extent in hectares for 2025 (%)
1.	Thick vegetation	7874.2 (23.5%)	4204.1(12.5%)	2448.0(7.3%)
2.	Cultivated farmland	9082.3 (27.1%)	8806.2(26.2%)	3652.5(10.9%)
3.	Bare surfaces	5985.8 (17.8%)	6187.8(18.4%)	7303.4(21.8%)
4.	Built up areas	10632.5 (31.7%)	14376.8(42.8 %)	20171.0(60.1 %)
	Totals	**33574.8**(100.0 %)	**33574.8**(100%)	**33574.9**(100%)

Source: Extracted from Satellite Imageries (2005, 2015 and 2025) of Uyo Capital City

4.0 DISCUSSION

The socio-economic characteristics of respondents indicate that most residents are long-term inhabitants of the study area and are therefore familiar with flooding patterns and environmental changes within Uyo Capital City. The relatively high educational status of respondents also suggests that the information obtained from the field survey is reliable and informed. The rainfall analysis confirms that Uyo experiences high annual rainfall with considerable temporal variability. The increasing intensity and frequency of rainfall events, especially during peak rainy months, contribute significantly to flash flooding in the city. This finding agrees with the report of the Intergovernmental Panel on Climate Change (IPCC, 2021), which noted that climate-induced extreme rainfall events are increasing globally.

The topographic and Digital Elevation Model analyses revealed that low-lying terrains such as IBB Avenue, Urua Ekpa, Effiat Offot, and Atan Offot are naturally susceptible to flooding. However, flooding in relatively higher terrain areas further demonstrates the influence of anthropogenic factors such as blocked drainage systems, unregulated urban development, and poor drainage infrastructure.

The findings on land use change indicate that rapid urbanization has significantly transformed the natural landscape of Uyo Capital City. The continuous reduction in vegetation and cultivated farmlands, alongside the rapid increase in built-up areas, confirms the intensity of urban expansion within the city. These changes have increased impervious surfaces, reduced groundwater infiltration, and intensified stormwater runoff. The findings support Douglas *et al*. (2008), Jha *et al*. (2012), and Adelekan (2016), who observed that uncontrolled urbanization, wetland encroachment, and poor environmental planning significantly increase flood vulnerability in urban areas. Similarly, the results agree with Miller and Hutchins (2017), who reported that urbanization alters natural hydrological systems by increasing surface runoff and reducing infiltration. The study also aligns with Akpan and Umoh (2019), whose research in Uyo Metropolis identified wetland conversion and poor land use planning as major causes of urban flooding.

The findings further demonstrate that poor waste disposal practices, weak enforcement of environmental regulations, and inadequate drainage systems significantly worsen flood conditions in the study area. Sustainable environmental planning strategies such as green infrastructure development, sustainable drainage systems, urban afforestation, wetland conservation, and effective land use management were identified as critical measures for reducing flood risks and enhancing urban resilience. The study therefore establishes that flood vulnerability in Uyo Capital City is largely driven by rapid urbanization and unsustainable land use practices. Consequently, sustainable environmental planning remains essential for promoting environmental sustainability, effective flood management, and resilient urban development in the study area.

5.0 CONCLUSION

The study established that flood vulnerability in Uyo Capital City is strongly linked to rapid urbanization, poor land use practices, wetland encroachment, blocked drainage systems, and weak environmental governance. Sustainable environmental planning strategies such as green infrastructure development, sustainable drainage systems, effective land use regulation, and climate adaptation measures can significantly reduce flood risks and improve urban resilience. The study contributes to knowledge by integrating urbanization management, land use planning, and sustainable environmental planning within the context of flood vulnerability reduction in rapidly urbanizing cities.

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