

Urbanisation as a Factor of Flooding in Developing Countries: Experience from Makurdi, Nigeria

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ABSTRACT

Rapid urban expansion in Makurdi has significantly altered land use patterns, increasing flood vulnerability and exacerbating environmental, economic, and social risks. This study examines urbanisation as a factor of flooding by analyzing land cover changes, and the encroachment of built environments into flood-prone zones within the frame of demographic trend. A mixed-methods approach was employed in data collection. This involved spatial analysis and survey-based assessments to provide a multidimensional perspective on urbanization-driven flood risk. Findings indicate that unregulated urban sprawl, deforestation, impervious surface expansion, and inadequate drainage infrastructure are key contributors to increasing flood frequency and severity. Poor enforcement of zoning laws, ineffective land use planning, and socio-economic disparities further exacerbate the problem, leaving vulnerable communities disproportionately affected. Additionally, climate change-induced variations in rainfall patterns intensify flood hazards, highlighting the need for proactive risk management strategies. To mitigate these risks, this study recommends a multi-pronged approach, including enforcing stringent zoning and land-use policies, investing in flood-resilient infrastructure, and adopting nature-based solutions such as wetland restoration and sustainable drainage systems. Furthermore, strengthening early warning systems, enhancing community awareness, and integrating flood resilience measures into urban planning frameworks are critical for sustainable urban development. By adopting an integrated and science-driven approach, policymakers and urban planners can improve adaptive capacity, minimize flood-related losses, and ensure long-term resilience in the Benue.

Keywords: Urbanisation, Land Cover, Encroachment, Flooding and Makurdi.

INTRODUCTION

Rapid expansion of urban areas, driven by population growth and increasing demand for residential and commercial spaces, has significantly altered land use patterns, often at the expense of natural flood buffers such as wetlands and river floodplains (Douglas et al., 2008; IPCC, 2022). The rapid and often unregulated expansion of built environments has led to widespread encroachment into ecologically sensitive areas, including wetlands and floodplains, reducing the landscape's natural capacity to absorb excess water during heavy rainfall. As noted in literature, the consequences of unregulated sprawl include increased impervious surfaces, higher surface runoff, and overwhelmed drainage infrastructure, which collectively contribute to more frequent and severe flooding events (Shabu 2021; Odufuwa et al. 2024). There appears to be absence of strict zoning regulations and the attendant enforcement mechanisms which perhaps has allowed settlements like Makurdi to expand into high-risk flood zones, increasing both human and economic exposure to flood disasters.

The conversion of plains and wetlands into built-up areas, reducing the capacity the land to absorb rainfall have been blamed on rapid urbanization and poor planning (Adeoye et al., 2009). According to Adelekan, (2016) Poor planning, inadequate drainage, and encroachment on waterways have worsened the vulnerability of riparian cities to flooding. Climate change has further exacerbate extreme weather events, overwhelming outdated or poorly maintained drainage systems (IPCC, 2022; Ajibade et al., 2020). The combined effects of climate change, extreme weather events, and population-driven urbanization demand urgent, sustainable planning and resilient

infrastructure development to mitigate future flood hazards (Adeoye et al., 2009; Adelekan, 2016; Nkwunonwo et al., 2020; IPCC, 2022; Ajibade et al., 2020; UN-Habitat, 2021).

Many urban areas suffer from lack of adequate drainage infrastructure, drainage channels are often undersized, blocked by waste, or poorly designed for increasing rainfall (Adelekan, 2016). This disrupts water flow, reduces infiltration, and increases runoff, elevating flood hazards (Douglas et al., 2008). Wetlands naturally absorb rainfall and mitigate weather events (IPCC, 2022), but urbanization has led to deforestation, soil compaction, and impervious surfaces, reducing ecosystem functions (Nkwunonwo et al., 2020). Loss of wetlands increases peak flood discharges and duration during rainfall (Ajibade et al., 2020) and leads to environmental degradation, biodiversity loss, water pollution, and climate disruption (UN-Habitat, 2021).

As cities expand into ecologically sensitive areas like floodplains, the ability to absorb rainfall decreases, and inadequate infrastructure heightens vulnerability (Douglas et al., 2008; Aderogba, 2012). Impervious urban surfaces reduce groundwater recharge and increase runoff, often causing flash floods in the absence of sustainable drainage (Adelekan, 2010; Abaje et al., 2018). These risks are worsened by the lack of integrated land-use and flood risk policies. Marginalized populations in informal settlements near rivers are disproportionately affected and excluded from planning processes, increasing their vulnerability (Ajibade et al., 2013). Scholars call for climate-resilient urban planning that integrates environmental, hydrological, and social data, which is crucial for fragile systems like those in Benue (Douglas et al., 2008; Adelekan, 2012). This study examines urbanisation as a factor of flooding in developing countries within the framework of, the role of urban expansion in exacerbating flood risks, analyzing spatial growth patterns and their impact on flood vulnerability through an integrated approach combining geospatial analysis and hydrological assessment. Nigeria has also witnessed increasingly frequent and severe urban flood disasters in recent years, largely due to unchecked urban growth and inadequate flood management (Jinadu, 2015; Aliyu & Suleiman, 2016).

METHODOLOGY

This study employed a mixed-methods research design combining descriptive and analytical approaches to understand patterns of urban expansion and flood vulnerability in Makurdi. The descriptive approach documented land use changes, population trends, and flood events, while the analytical approach interpreted spatial data and survey responses. The study used spatial data of (1976–2016), and socio-economic information. Structured questionnaire captured household flood experiences, housing conditions, and coping strategies. In the absence of hydrological tools, long-term residents (20+ years) provided perception-based indicators on flood frequency and water levels. Using Israel's (1992) formula, a sample of 400 households was drawn from an estimated 61,784 households (2016 population estimate). A multi-stage sampling method was applied - Stratification into high, moderate, and potential flood-risk zones. Purposive selection of two communities per zone. Random selection of households (~66 per community). Communities included Wadata, Wurukum, Idye, Ankpa Ward, Agan, and Modern Market.

RESULT AND DISCUSSION

The data collected speaks to critical issues necessary for understanding the urbanisation factor of flooding in Makurdi, the capital of Benue state, Nigeria. The discussion is anchored on the objectives of the study which basically situates in the realm of urban spatial expansion, population growth and the emerging spatial pattern of vulnerability in the city.

Urban Expansion and the Spatial Pattern of Flood Vulnerability in Makurdi

Urban expansion in Makurdi has been driven primarily by rapid population growth and extensive horizontal development. As in many urban centres across Sub-Saharan Africa, this growth has translated into the physical expansion of built-up areas, often at the expense of vegetation and natural drainage systems. The data presented in this study show a strong correlation between population increase and spatial growth, both of which have contributed to the city's heightened exposure to flooding.

Table 1: Population versus Built-Up Area of Makurdi (1976–2016)

Year	Population	% Average Growth Rate	Built-Up Area (Km ²)	Growth Rate (%)
1976	85,993	-	12.96	-
1986	123,916	4.4	29.17	5.5
1996	178,563	4.4	40.79	2.8
2006	257,309	4.4	69.74	7.09
2016	370,702	4.4	105.96	5.19

Source: Researchers computation 2023 derived from NPC (2006); Landsat Data (2020).

Information on table 1 shows that the population of Makurdi increased from 85,993 in 1976 to 370,702 in 2016, maintaining an annual growth rate of about 4.4%. Correspondingly, the city’s built-up area expanded from 12.96 km² to 105.96 km² within the same period — a remarkable 717% increase over four decades. This expansion reflects both natural population growth and significant in-migration following Makurdi’s designation as the Benue State capital in 1976, which attracted civil servants, traders, and investors from across Nigeria.

Table 2: Land Use and Land Cover Area of Makurdi (1976–2016) in (KM2)

Landuse/cover	1976	%	1986	%	1996	%	2006	%	2016	%
Water	21.98	2.27	25.15	2.60	26.59	2.75	35.98	3.73	36.99	3.83
Built-up	12.96	1.34	29.17	3.02	40.79	4.22	69.74	7.22	105.96	10.98
Vegetation	782.69	81.14	769.42	79.76	761.32	78.92	718.56	74.49	664.68	68.90
Bare Surface	146.98	15.23	140.87	14.60	135.91	14.08	139.98	14.51	156.98	16.27
Total	964.61	100								

Source: Landsat Data (2020); Researcher’s Work (2023)

Spatial Dynamics of Urban Growth

The analysis in Table 2 shows a consistent decline in vegetation cover and a corresponding increase in built-up area from 1976 to 2016. The built-up area rose from 1.34% to 10.98%, while vegetation decreased from 81.14% to 68.90%. This indicates the continuous conversion of natural landscapes into residential, commercial, and industrial zones. The most notable expansion occurred between 1996 and 2006, coinciding with the return to democratic governance and increased infrastructural development.

The transformation of Makurdi from a local government headquarters following the creation of Benue state in 1976 and the emergence of Makurdi as the state capital spurred spontaneous population and spatial growth. The new status as a state capital, led to the establishment of administrative institutions and new residential layouts—such as Judges Quarters Extension – see figure 1 (Tse Ayu), Yaikyor, Kanshio, Apir, Fiidi, Agan, Achusa, and Nyiman—opened new areas for development. Beyond the presence of administrative and the new residential layouts, daily residential neighbourhood retail needs and services have to be met. The concomitant multiplier effect of this development include the encroachment on flood-prone lands.



Fig.1: 1976 landuse structure of Makurdi.

Source: Makurdi Capital Development Board, Pre-Final Master Plan for Makurdi.

Urbanisation and Flood Vulnerability

The rapid urbanisation of Makurdi has altered its natural drainage systems. Uncontrolled physical development and the conversion of floodplains and wetlands into residential areas have increased surface runoff and blocked natural waterways, making the city more prone to flooding. During heavy rainfall, low-lying areas such as Fiidi, Kanshio, and Wurukum experience recurrent flooding due to in-fills, poor drainage, and encroachment into marginal lands. In Makurdi, the interaction between population pressure, land conversion, and inadequate flood management infrastructure demonstrates how urbanisation acts as a major factor intensifying flood risks. These patterns reflect a broader trend in developing countries, where urban growth often outpaces planning and infrastructural capacity.

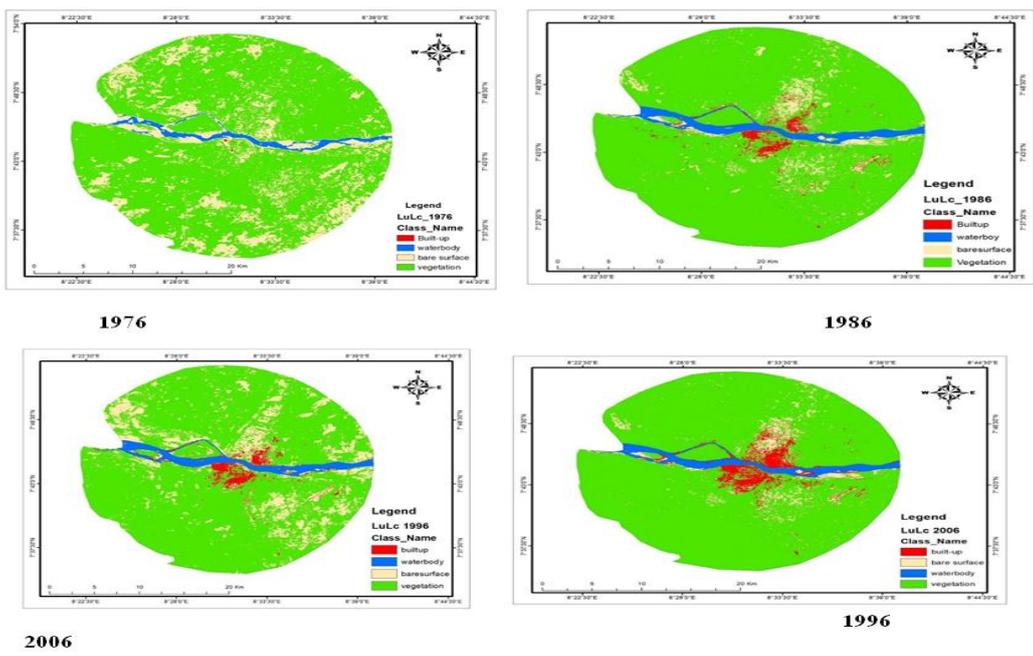


Figure 2: Trend in Makurdi Land use land cover 1976 -2006,

Source: Derived from Landsat Data (2020).

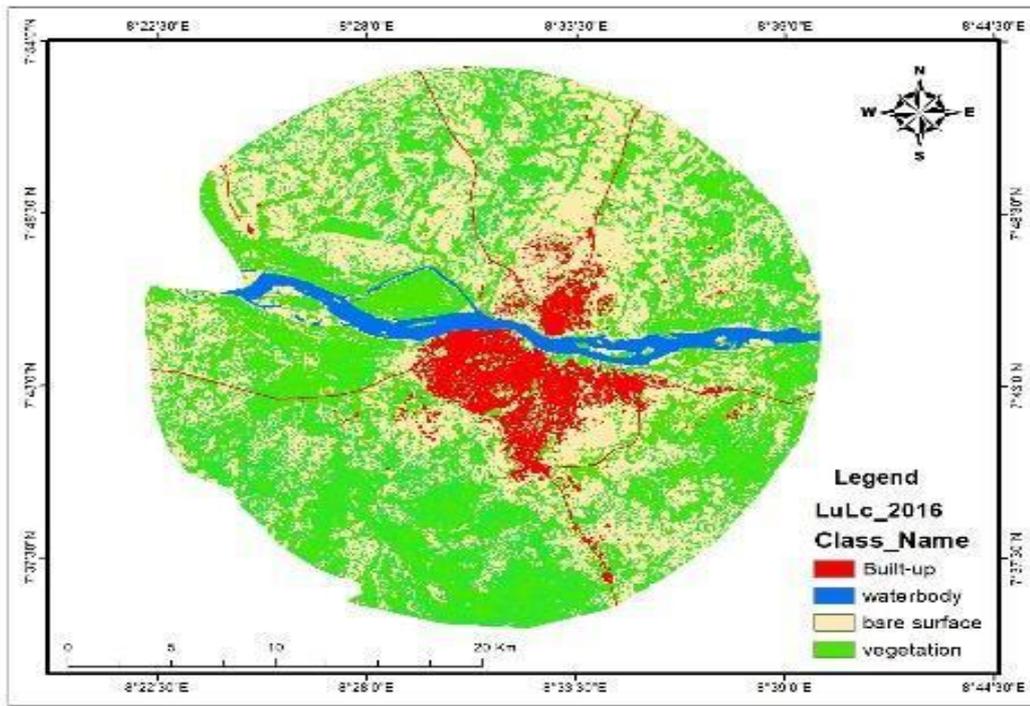


Figure 3: 2016 Makurdi Land use and Land cover 2016

Source: Derived from Landsat Data (2020).

In terms of the pattern of expansion, the result as depicted in Figures 2 and 3 shows that spatial expansion has taken a southwards direction. There has been increased urban expansion/built-up southwardly along the Makurdi – Gboko road all through the study (1976 to 2016). Another area of huge expansion is towards the north. Although at a slower pace, there appears to be conscious expansion farther away from the river course.

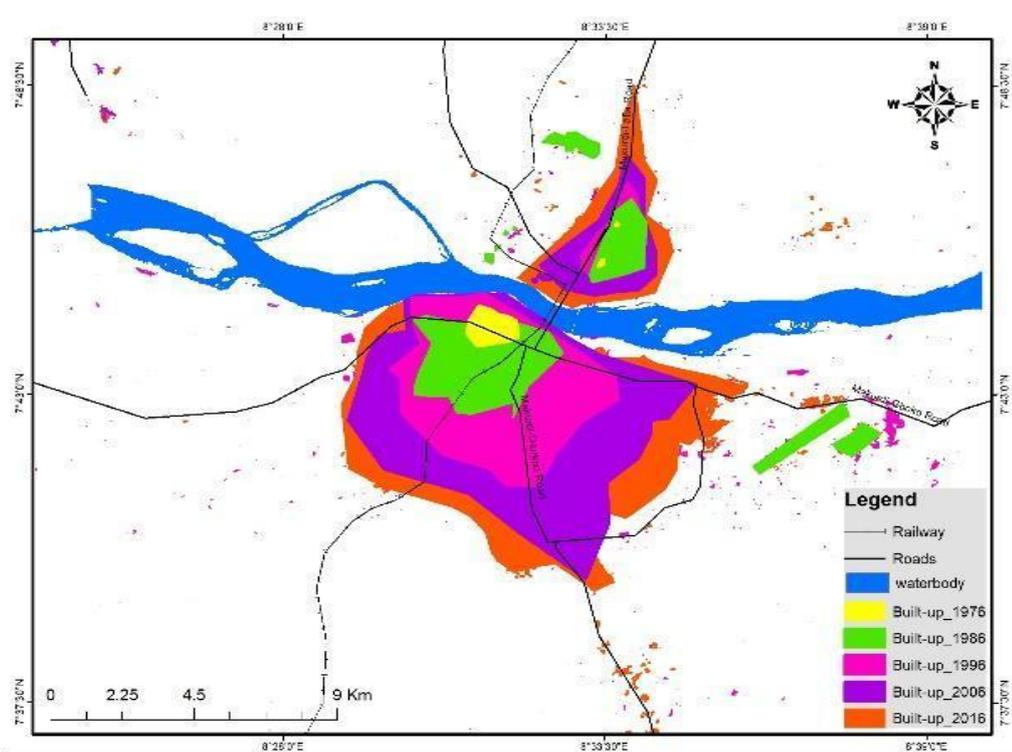


Figure 4: Decadal comparative analysis of Urban Expansion in Makurdi

Source: Derived from Landsat Data (2020).

From the analysis shown in Figure 4, the spatial expansion of Makurdi has primarily followed the major road networks, indicating that roads play a key role in directing urban growth. The River Benue serves as a major physical barrier that has restricted expansion towards the north, resulting in more pronounced urban development toward the southern parts of the city. However, despite this natural constraint, some degree of urban growth is still occurring beyond the river, extending northward as bridge connections and road infrastructure improve. Overall, the map illustrates that Makurdi's expansion pattern is both road-oriented and influenced by the presence of the river, leading to a southward-dominated but gradually spreading urban form.

Flood Vulnerability Analysis in Makurdi

Building on the analysis of land use and land cover changes over the years, a flood vulnerability map for Makurdi provides insight into the extent to which various locations are exposed to flooding. The map serves as a spatial tool that highlights the degree of susceptibility across different parts of the city and identifies areas requiring varying levels of attention in terms of flood management and urban planning. The results clearly demonstrate that the continuous expansion of Makurdi's built-up area has been accompanied by a corresponding increase in flood vulnerability, especially in low-lying zones along the River Benue and its tributaries.

As illustrated in Figure 5, the flood vulnerability map of Makurdi categorizes the city into four levels of susceptibility, ranging from highly vulnerable to non-vulnerable zones. The spatial pattern observed indicates that urban expansion has increasingly encroached into floodplains and natural drainage channels. Over the years, the growing demand for land has exerted immense pressure on available space, forcing developments into marginal lands and areas that were once natural water retention zones. Consequently, a substantial portion of the city's built-up area now lies within the highly vulnerable and vulnerable zones, making these locations more prone to recurrent flooding during periods of intense rainfall.

In many parts of Makurdi, residential, commercial, and infrastructural developments have spread across areas that were originally unsuitable for such uses. The expansion of community infrastructure such as roads, housing layouts, and industrial facilities has extended across the different vulnerability layers, often obstructing natural drainage paths and intensifying the risk of surface water accumulation. Notably, low-lying neighborhoods such as Fiidi, Wadata, Nyiman, Kanshio, and Wurukum are among the most affected, experiencing frequent and severe flooding that leads to property damage, displacement of residents, and disruption of socio-economic activities. The increasing encroachment into these flood-prone zones reflects how unplanned urbanisation, combined with inadequate drainage infrastructure, amplifies the city's exposure to flood hazards.

This situation in Makurdi is reflective of a broader challenge common to many developing countries, where rapid urban growth often occurs in the absence of effective spatial planning and environmental control. The continuous conversion of floodplains and wetlands into residential and commercial areas demonstrates the extent to which urban expansion can transform natural landscapes into zones of vulnerability. In essence, the pattern of urbanisation in Makurdi driven by population growth, administrative importance, and economic activities has significantly altered the city's hydrological balance, increasing the frequency and intensity of flooding. The findings emphasize the urgent need for sustainable urban planning strategies that integrate flood risk assessment into land use decisions to mitigate the adverse impacts of urbanisation on the environment and human settlements. Similar urbanization–flood dynamics have been observed in other Nigerian cities; Jinadu (2015) noted that the catastrophic 2012 floods were exacerbated by uncontrolled development, and Dodman et al. (2017) similarly reported that many rapidly growing African cities face rising flood risks due to unplanned urban expansion.

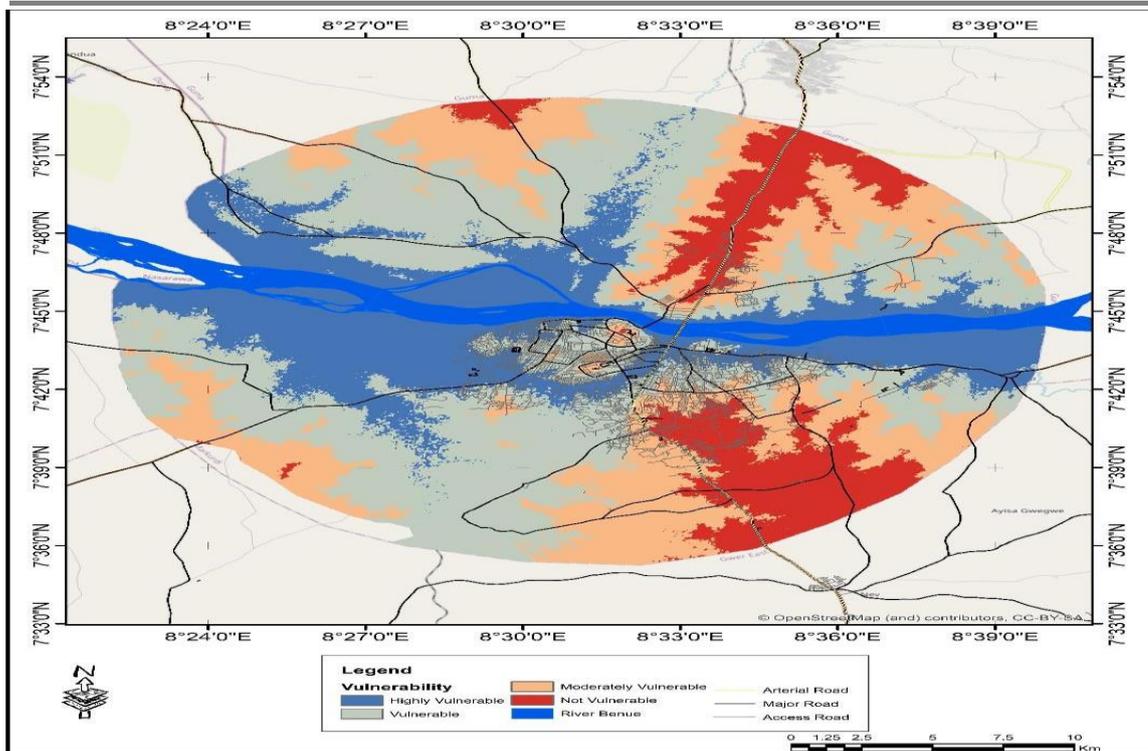


Figure 5: Flood Vulnerability map of Makurdi

Source: Derived from landsat image (2020)

The situation of flooding in Makurdi is more severe on the southern bank of the town due to its low-lying and waterlogged nature. This area serves as the major drainage outlet for the River Benue and its tributaries, which makes it naturally prone to flooding. The topographic formation of Makurdi, characterized by elevation ranging between 73 and 167 metres above sea level, significantly influences flood incidence across the city. During periods of heavy rainfall, water rapidly accumulates in these low-lying zones, leading to flash floods that submerge homes, roads, and farmlands. The vulnerability of these areas is further heightened by intense anthropogenic activities that interfere with the natural drainage systems. Much of the land use in these highly exposed areas is now dominated by both commercial and residential developments, which increases the level of human and infrastructural exposure to flood hazards.

In recent years, the practice of sand filling in previously reserved flood-prone areas for the construction of petrol stations, schools, shopping complexes, and residential structures has been on the rise in Makurdi. Such developments not only reduce natural flood storage capacity but also redirect water flow into surrounding neighborhoods, increasing the frequency and severity of urban flooding. Consequently, neighborhoods such as Wurukum, Angwan Jukun, Wadata, Logo I and II, Akpehe, Achusa, Idye, Gyado Villa, and Nyiman fall within the highly vulnerable and vulnerable zones. The increase in human activities and settlements in these environmentally fragile areas has exacerbated the city’s overall flood risk. These communities are physically characterized by the absence or poor condition of drainage systems, indiscriminate dumping of solid waste into water channels, and the silting up of existing drains. This observation aligns with Adelekan (2016), who found that poorly maintained drainage systems and weak planning controls significantly increased flood risks in Lagos, Nigeria. The combined effect of these factors contributes to the recurrent flooding that has become a defining feature of urban life in Makurdi.

Most of the built-up areas of the city now lie within these highly vulnerable locations, as clearly depicted in Figure 5, where flood-prone zones correspond with the densest sections of urban development. This spatial overlap between urban growth and flood vulnerability underscores the central argument of this study—that rapid and unplanned urbanisation has significantly increased the flood risk in Makurdi, similar to the experience of many developing cities across Sub-Saharan Africa. Additionally, the disproportionate impact on the poorest

neighborhoods in Makurdi reflects a broader pattern: Roy and Ferland (2015) observation that the urban poor often settle on high-risk, degraded land and therefore suffer most from floods resonates strongly with this finding.

Residents' Perception of the Causes of Flooding in Makurdi

Urban expansion in Makurdi represents a gradual but sustained lateral growth in the city's spatial extent, primarily driven by population increase and administrative importance. This growth has, over time, extended into marginal and flood-prone areas, transforming wetlands and riverbanks into residential and commercial zones. Residents' perceptions of the causes of flooding were analyzed through field surveys, and the results are presented in Table 3. The data reveal that respondents overwhelmingly attribute flooding in Makurdi to unplanned urban development, inadequate drainage, and the conversion of low-lying lands for construction purposes.

Table 3: Causal Factors of Flooding in Makurdi

Variables	V	SA	A	N	D	SD	Total
Construction of unplanned housing and drainage causes flooding	F	205	142	15	19	07	388
	%	52.8	36.6	03.9	04.9	1.8	100
Construction of unplanned roads and drainage causes flooding	F	145	178	32	25	08	388
	%	37.4	45.9	08.2	06.4	02.1	100
Indiscriminate earth filling in the low-lying areas of the town increase chances of flooding	F	85	188	61	40	14	388
	%	21.9	48.5	15.7	10.3	03.6	100
Urban development of flood plains fuel flooding	F	89	169	68	44	18	388
	%	22.9	43.6	17.5	11.3	4.6	100
Urban growth and expansion is a driving force to flooding	F	70	180	81	35	22	388
	%	18	46.4	20.9	9.0	05.7	100
Increase concentration of population on marginal lands stimulate flooding	F	70	189	65	40	24	388
	%	18	48.7	16.8	10.3	06.2	100
Land cover changes increase run off and flood intensity	F	67	172	90	41	18	388
	%	17.3	44.3	23.2	10.6	4.6	100
Unplanned urban expansion directly fuels flooding	F	85	193	57	40	13	388
	%	21.9	49.7	14.7	10.3	3.4	100
Unguided urban development. changes the morphology and hydrology of the town thereby causing flooding	F	85	176	61	54	12	388
	%	21.9	45.4	15.7	13.9	3.1	100
	F	129	160	63	24	12	388

Drainage infrastructure with limited capacity unable to evacuate runoff from on-going urbanisation escalating flood	%	33.2	41.2	16.2	06.2	03.1	100
Urbanisation induced changes in land use led to increased peak stream flow	F	71	187	65	55	10	388
	%	18.3	48.2	16.8	14.2	2.6	100
Human encroachment on urban spaces makes urban communities more vulnerable to floods	F	83	193	60	40	12	388
	%	21.4	49.7	15.5	10.3	3.1	100
Landuse changes from non-urban to urban areas increase total runoff	F	68	155	88	58	19	388
	%	17.5	39.9	22.7	14.9	4.9	100

Source: Researcher’s Field survey, 2023.

Table 3: reveals that the construction of unplanned houses and drainages is the major factor causing flooding in Makurdi, as a combined 89.4% of respondents either *strongly agreed* or *agreed* with the claim. Conversely, only 6.7% of the respondents *disagreed* or *strongly disagreed*. Similarly, regarding unplanned roads and drainage systems as contributors to flooding, 37.4% of respondents *strongly agreed*, while 45.9% *agreed*. These findings highlight that uncoordinated urban development—particularly the unguided construction of buildings, roads, and drainage infrastructure—are perceived by residents as major drivers of flooding in Makurdi. This is not unexpected as both urbanisation and population growth are natural factors for increased anthropogenic activities and ecological footprints. This pattern of encroachment into natural flood buffers mirrors observations by Nkwunonwo et al. (2015), who noted that unplanned development on floodplains and loss of wetland storage are major drivers of urban flood hazards in Nigeria. These manifests as increasing built surfaces e.g buildings and roads construction, resulting in declining green cover.

This finding aligns with local studies; for instance, Aliyu and Suleiman (2016) reported that frequent flooding in Nigerian cities like Kaduna is largely due to unchecked settlement in flood-prone areas and weak enforcement of land-use plans. However, while our study emphasizes these land-use and planning factors, Ajibade et al. (2020) argue that climate change – through more intense rainfall and extreme weather – is an equally critical driver of recent urban flooding. This contrast suggests that both unplanned urban growth and climate-induced hazard changes must be addressed to reduce flood risks in Nigerian cities.

CONCLUSION

This study critically examined the relationship between urban expansion and flood vulnerability in Makurdi, a rapidly growing city in Benue State, Nigeria. The analysis revealed that unregulated urbanisation has significantly increased flood risks by altering the city’s natural hydrological systems. Over the past four decades, Makurdi’s built-up area has expanded rapidly, encroaching upon floodplains, wetlands, and marginal lands due to population pressure, poverty, and weak planning control. This spatial transformation has intensified exposure to recurrent flooding, particularly during the peak rainfall months of July to September.

The study further established that the absence of effective urban governance structures—such as a functional master plan, enforcement of planning regulations, and institutional coordination—has exacerbated the city’s flood vulnerability. Infrastructural developments like roads, housing, and drainage systems have been poorly coordinated. **Source: Field Work 2023** drainage channels and increasing surface runoff. The findings revealed that although climatic variability contributes to flooding, anthropogenic factors such as unplanned development, land-use change, and indiscriminate sand-filling of floodplains are the principal drivers of flood disasters in Makurdi.

Additionally, socio-economic factors play a major role in shaping flood vulnerability. Low-income residents, unable to afford housing in safer areas, are forced to settle in high-risk flood zones, thereby increasing their exposure to hazards. This situation reflects broader patterns of social inequality and inadequate urban planning common to many developing cities. The statistical analyses confirmed that effective land use planning, supported by sound governance and public awareness, is crucial to mitigating flood risks.

In essence, the study concludes that flood vulnerability in Makurdi is primarily a product of urbanisation consequent upon uncontrolled urban expansion and weak institutional regulation. Addressing these challenges requires an integrated approach that aligns spatial planning, environmental management, and socio-economic development with principles of resilience and sustainability. For Makurdi to become a flood-resilient city, it must transition from reactive flood response to proactive, data-driven, and participatory urban planning.

RECOMMENDATIONS

In line with the findings of this study, the following key recommendations are proposed to mitigate the impact of urbanisation-induced flooding and promote sustainable urban development in Makurdi:

Integrate Risk-Sensitive Land Use Planning (RSLUP)

Urban planning in Makurdi should adopt a Risk-Sensitive Land Use Planning framework that embeds flood risk assessments into all development decisions. Flood-prone areas, wetlands, and natural drainage corridors must be clearly identified, mapped, and legally protected from inappropriate development. The formulation of a new comprehensive master plan for Makurdi should prioritize resilient infrastructure, enforce zoning standards, and ensure that floodplains remain ecological buffers rather than construction sites.

Strengthen Development Control and Institutional Capacity

The city's development control mechanisms must be reinforced to curb illegal construction and unregulated expansion. The Makurdi Capital Development Board (MCDB) and the Ministry of Lands and Urban Development should be equipped with adequate technical capacity, trained personnel, and digital monitoring tools such as GIS-based cadastral systems for real-time surveillance of land-use changes. Effective enforcement of planning laws and the removal of illegal structures obstructing drainage paths are essential to restoring natural flood buffers.

Promote Green Infrastructure and Ecosystem Restoration

To address the ecological dimension of urban flooding, Makurdi should invest in green and blue infrastructure such as wetlands restoration, urban forests, riparian buffers, and permeable pavements. The adoption of Sustainable Urban Drainage Systems (SUDS) including rain gardens, retention ponds, and bio-swales will complement conventional stormwater management and restore the city's natural ability to absorb and regulate water flows.

Foster Political Commitment and Community Participation

Flood resilience in Makurdi depends on strong political will and active community engagement. The Benue State government should prioritize flood management in its development agenda by allocating dedicated budgets and enforcing compliance with planning standards. Local communities, traditional leaders, and civil society organizations must be involved in planning, monitoring, and evaluating flood risk reduction initiatives to ensure inclusiveness and sustainability. Collaborative governance that bridges state and community efforts will enhance both accountability and long-term resilience.

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