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Assessment of the Vulnerability Level of Nmiata-Anam to Flood Occurrences Using Remote Sensing and Geospatial Analysis

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Abstract
Due to the continuous flooding experienced in Nmiata-Anam, a comprehensive study was conducted to assess the area's vulnerability to flood occurrences using remote sensing. High-resolution satellite images of Nmiata-Anam were acquired and analyzed using the geo-processing and spatial analyst tools available in ArcGIS 10.1. The analysis revealed several critical findings. Firstly, the study area experiences significant flooding every year, disrupting the lives and livelihoods of its residents. Secondly, there is an absence of flood early warning systems and equipment, leaving the community unprepared for impending flood events. Additionally, the local population has not received any education or training on the effectiveness and usage of early warning equipment. Lastly, Nmiata-Anam does not have a detailed flood map, which is crucial for planning and implementing effective flood management strategies. This study underscores the urgent need for the implementation of early warning systems, educational programs on flood preparedness, and the development of comprehensive flood maps to mitigate the adverse impacts of flooding in Nmiata-Anam.

Keywords: Flood Management, Flood Vulnerability, Nmiata Anam, Remote Sensing, Geospatial Analysis

1. Introduction

Flooding is a recurrent natural hazard that has become a major environmental concern globally, particularly in flood-prone regions such as river basins and low-lying areas. Nmiata-Anam, located in Anambra West Local Government Area of Anambra State, Nigeria, is one such region. Its geographical location along the banks of the River Niger makes it particularly susceptible to seasonal flooding, which has severe consequences for agriculture, infrastructure, human lives, and livelihoods (Odume *et al*., 2019) [19]. In recent years, climate change has exacerbated flood occurrences due to increased rainfall intensity, rising sea levels, and altered weather patterns (Adeoye *et al*., 2020) [1].

Flood vulnerability is influenced by several factors, including land use/land cover (LULC) changes, soil permeability, topography, and proximity to water bodies. LULC dynamics significantly affect flood behavior, where deforestation, urbanization, and other anthropogenic activities reduce natural water infiltration and increase surface runoff (Oyegbile & Olayinka, 2022) [11]. In Nmiata-Anam, rapid changes in land use, especially conversion of vegetated areas to agricultural and built-up spaces, have amplified the risk of flooding (Onu *et al*., 2021) [10].

Remote sensing (RS) and Geographic Information Systems (GIS) have emerged as powerful tools in flood hazard and vulnerability assessments. Remote sensing allows for the continuous monitoring of earth surface conditions, enabling the detection of changes in land cover and hydrological patterns over time. In flood-prone areas like Nmiata-Anam, satellite imagery from sensors such as Sentinel-1 and Landsat can be used to track flood extents, identify vulnerable zones, and monitor the impact of mitigation efforts (Ekenta *et al*., 2019) [5]. Additionally, GIS-based multi-criteria evaluation (MCE) provides a framework for integrating multiple spatial datasets, including rainfall patterns, elevation, and proximity to rivers, to assess vulnerability levels and identify high-risk zones (Usman & Abdulkarim, 2022) [12].

Several studies have utilized remote sensing data to model flood risks and vulnerabilities in different parts of Nigeria. For instance, Akinyemi and Akintunde (2021) [3] employed Landsat imagery to assess flood risks in the Niger Delta, while Ukwandu *et al*. (2020) [13] applied Sentinel-1 data to map flood-prone areas in the Sokoto River Basin. These studies highlight the effectiveness of remote sensing in flood risk assessment, particularly in areas with limited access to ground-based hydrological data. Furthermore, satellite-based data provides timely information on flood extents during flood events, which is crucial for early warning systems and disaster response (Adeoti *et al*., 2018) [2].

Nmiata-Anam's vulnerability to floods is further heightened by the socio-economic characteristics of the area. The community's reliance on subsistence agriculture, which is highly susceptible to flood damage, combined with inadequate infrastructure, exacerbates the impacts of flooding. Furthermore, the absence of adequate flood control measures, such as dykes and drainage systems, has left the region exposed to the full brunt of seasonal floods (Nwosu & Onyekuru, 2021) [8]. Climate-induced factors such as unpredictable rainfall patterns and increasing storm intensity further compound the region’s flood vulnerability (Ezebilo *et al*., 2020) [6].

Despite these challenges, there has been a paucity of studies focusing on flood vulnerability assessment in Nmiata-Anam using remote sensing and GIS technologies. Most existing flood-related studies in Nigeria focus on urban centers and large river basins, with limited attention given to rural communities such as Nmiata-Anam (Iwuoha & Okorie, 2021) [7]. Consequently, there is an urgent need for localized flood vulnerability assessments that can inform flood management strategies, improve community resilience, and guide policy-making. This study, therefore, seeks to assess the flood vulnerability level of Nmiata-Anam by leveraging remote sensing and GIS-based analysis. It aims to provide a detailed understanding of the spatial distribution of flood risk and recommend appropriate mitigation measures to reduce the impacts of flooding on the community.

2. Study Area

This study is conducted in Nmiata-Anam, a community located within Anambra West Local Government Area (LGA) of Anambra State, Nigeria. Anambra West LGA lies between latitudes 6°15′N and 6°45′N and longitudes 6°40′E and 6°60′E. The area is strategically positioned in the northwestern part of Anambra State, sharing boundaries with Ayamelum LGA to the northeast, Anambra East LGA to the southeast, and Kogi State to the northwest. Anambra State itself is situated in southeastern Nigeria, with its geographic coordinates extending from latitudes 5°45′N to 6°45′N and longitudes 6°40′E to 7°15′E.

Anambra West LGA, and specifically Nmiata-Anam, is located in a floodplain along the River Niger, making it particularly vulnerable to annual flooding events, which are exacerbated by both natural and anthropogenic factors. The region’s low-lying topography, combined with proximity to major water bodies like the Niger and Anambra rivers, contributes to frequent inundation during the rainy season, especially when water levels rise upstream (Onyeka *et al*., 2021). The region is also characterized by rich alluvial soils, which, although highly fertile for agriculture, are prone to erosion and waterlogging, further increasing its susceptibility to floods.

The geographical features of Anambra West LGA are typical of a tropical rainforest climate, with a wet season from April to October and a dry season from November to March. The annual rainfall averages between 1,800 mm and 2,000 mm, contributing significantly to the flooding issues in the area. The presence of numerous rivers and streams that crisscross the LGA also plays a critical role in the hydrological dynamics of the region. Consequently, Nmiata-Anam is part of a broader floodplain that experiences seasonal floods driven by river overflows, heavy rainfall, and poor drainage systems.

The LGA is predominantly rural, with the majority of its population engaged in subsistence farming and fishing. The fertile floodplains support crops such as rice, yam, cassava, and maize, making agriculture the economic backbone of the area. However, this dependence on agriculture also makes the community highly vulnerable to the impacts of flooding, as farmlands are regularly submerged, leading to crop loss and food insecurity. The recurrent floods not only affect agricultural productivity but also damage infrastructure, displace residents, and disrupt socio-economic activities, necessitating a thorough assessment of the area’s flood vulnerability for sustainable development planning.

3. Methodology

The hydrological analysis involved critical processes such as flow direction, flow accumulation, and stream network generation, which were instrumental in identifying areas with varying water accumulation rates and delineating the main tributaries in the study area. The flow direction analysis provided insights into the pathways water follows across the landscape, helping to determine how surface runoff is channeled toward rivers, streams, or other water bodies. Flow accumulation, on the other hand, quantified the amount of water that accumulates at any given point, making it possible to pinpoint areas where water is likely to pool or inundate, particularly during heavy rainfall events or river overflows. By combining these datasets with stream network mapping, a comprehensive understanding of water movement within the area was developed, allowing for the identification of zones prone to high or low water accumulation.

In addition to the hydrological analysis, the study incorporated the creation of a watershed map for the entire study area. This watershed delineation was key in understanding the spatial distribution of flood-prone zones, especially in relation to major water bodies and the confluence points where tributaries merge. Watershed mapping provided a detailed visualization of the land surface that drains into specific water bodies, offering a predictive tool for flood modeling. By identifying the spatial extent of watersheds, it became possible to estimate which areas would be most vulnerable to flooding, particularly during events when rivers exceed their banks due to excessive rainfall or upstream water releases. The watershed analysis was thus essential in delineating the boundaries of flood-prone regions, contributing to the identification of areas at risk of flooding under different scenarios.

Surface analysis further enhanced the understanding of flood risks by focusing on the topographic characteristics of the region. This analysis involved generating key topographical outputs such as slope maps, contour maps, and a Triangulated Irregular Network (TIN) model. Slope analysis revealed how the steepness of the terrain influences water flow velocity and direction, with steeper areas channeling water more quickly towards lower regions, increasing the likelihood of flooding in flatter, low-lying areas. Contour mapping helped to visualize the elevation variations across the study area, providing further context for water flow dynamics and potential flood zones. The TIN model was particularly useful in representing the three-dimensional terrain of the region, allowing for a more detailed and nuanced understanding of the area's topographical features.

The integration of these surface and hydrological analyses provided a multi-dimensional perspective on flood vulnerability in the study area. The slope analysis, for example, not only identified potential flood hotspots but also informed flood mitigation strategies by highlighting areas where artificial drainage channels or other infrastructure might be most effective in controlling water flow. Similarly, the contour and TIN models provided a structural basis for understanding water movement, helping to predict how water would behave under different flood scenarios, including overflow events at the confluence of major rivers and tributaries.

4. Result and Discussion

Remotely sensed data used for this assessment is the Advanced Spaceborne Thermal Emission and Reflection Radiometer Global Digital Elevation Model (otherwise known as ASTER GDEM-V2) data of 2011, obtained from the United States Geological Survey (USGS) website (www.earthexplorer.usgs.gov). The ASTER GDEM data was preprocessed and resampled to 30 meters. This data aided the computation of digital elevation model (DEM) of the area in a Geographic Information System (GIS) environment (figure 1). ArcGIS 10.5 software was deployed for this activity.

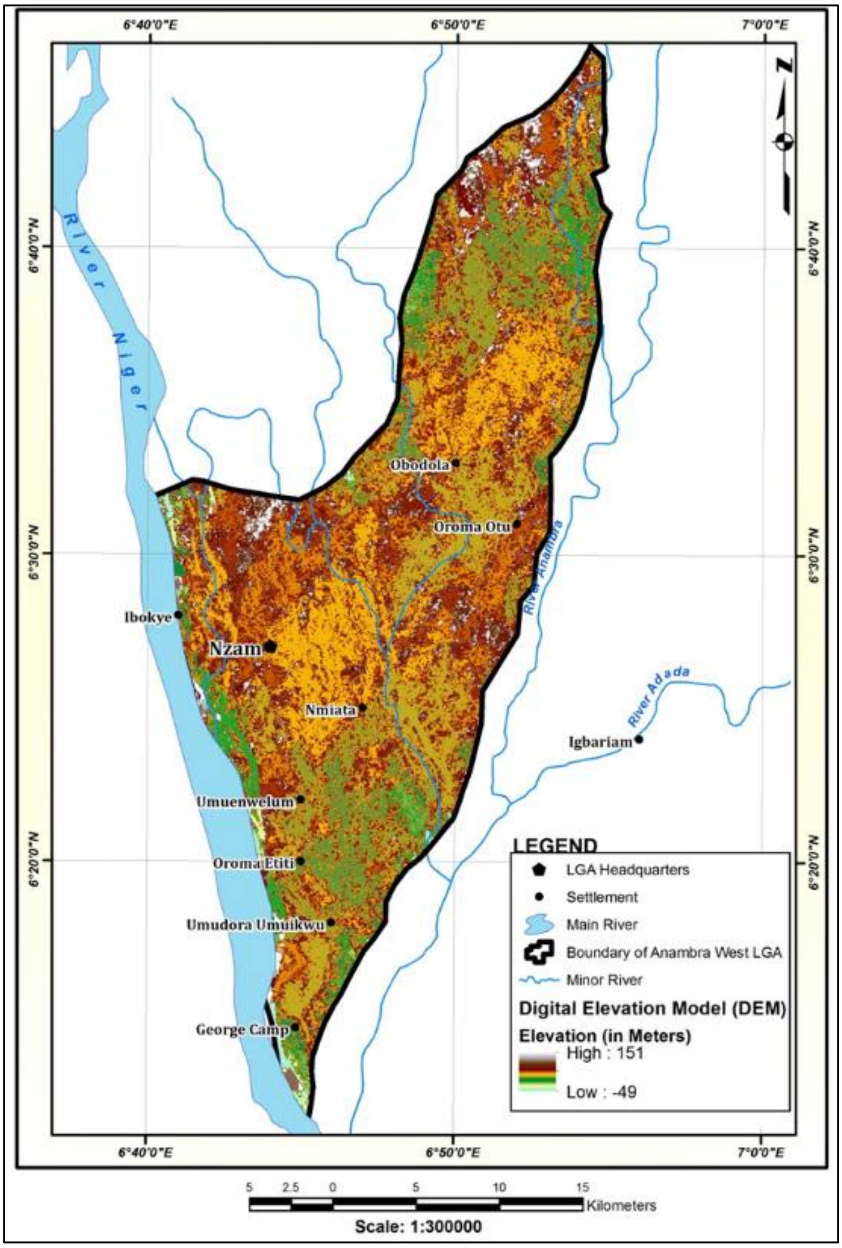

Fig 1: Digital Image of Anambra West L.G.A.

From Figure 1, which depicts the Digital Elevation Model (DEM) of Anambra West L.G.A., it is observed that the elevation in the area ranges from -49 meters to 151 meters. A significant portion of the central region, represented by a yellowish color on the DEM, falls at approximately 51 meters above sea level. This elevation is notably low, particularly for locations situated near the riverbanks, such as Ibokye, George Cap, and Orama Etiti. These areas, due to their proximity to the river and relatively low elevation, are highly susceptible to flooding, making them less favorable in terms of flood risk management and resilience.

4.1. Spatial Analysis Techniques

The hydrological analysis like the flow direction, flow accumulation and stream networks were used to determine areas with high or low water accumulation rate and its tributaries. The analysis of the inundations areas was conducted by generating watershed map of the study area. The watershed map determines the spatial coverage or extent of areas liable for flooding in the event of overflow especially at the confluence. Surface Analysis was carried out to determine the slope, contour and TIN (Triangulated Irregular Network) of the study area.

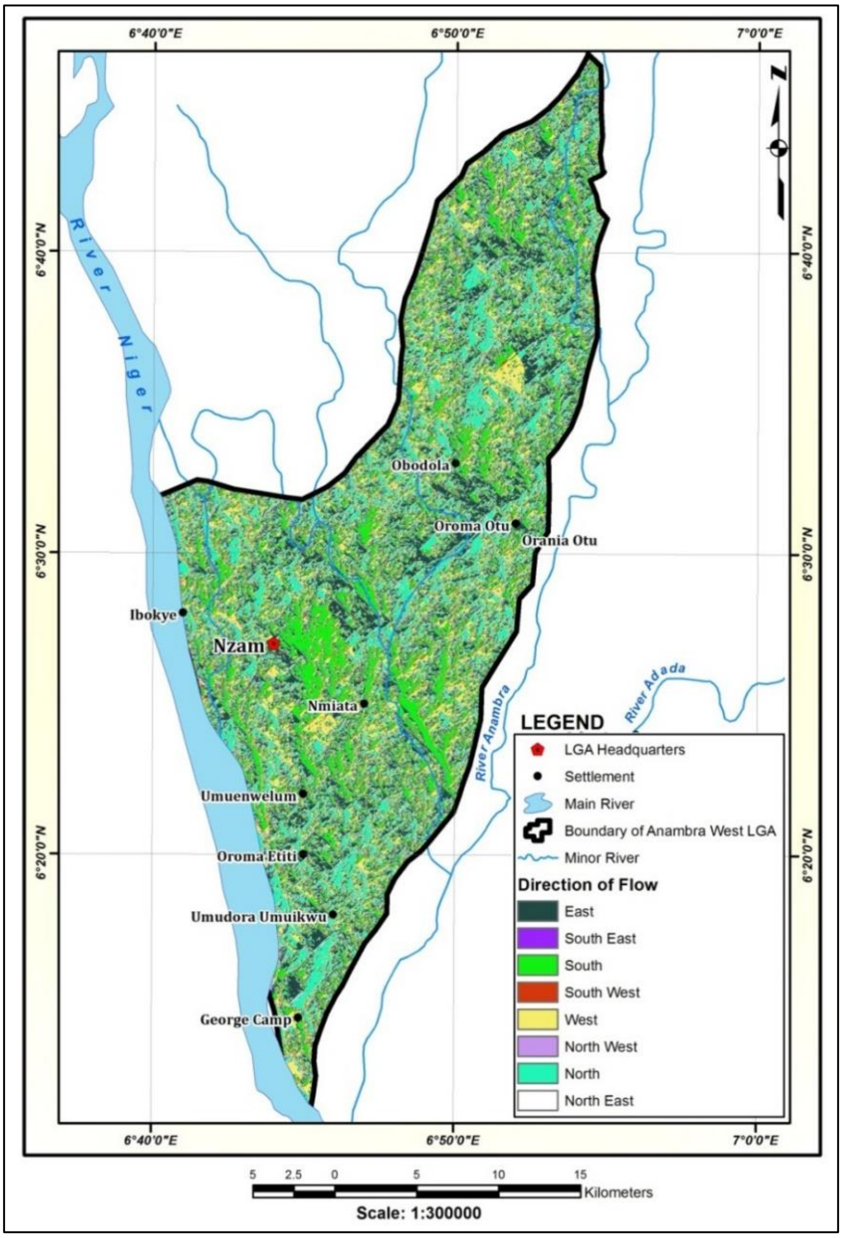

Fig 2: Flow Direction Map of Anambra West L.G.A

From flow direction map as shown in figure 3, it was noticed that more of the area within the study area (areas that appear in green) always have water flowing into/to the area after every rain or during flood occurrence. This implies that most of the water within the water watershed flows to the south. This could result in the area experiencing frequent inundation more than other areas.

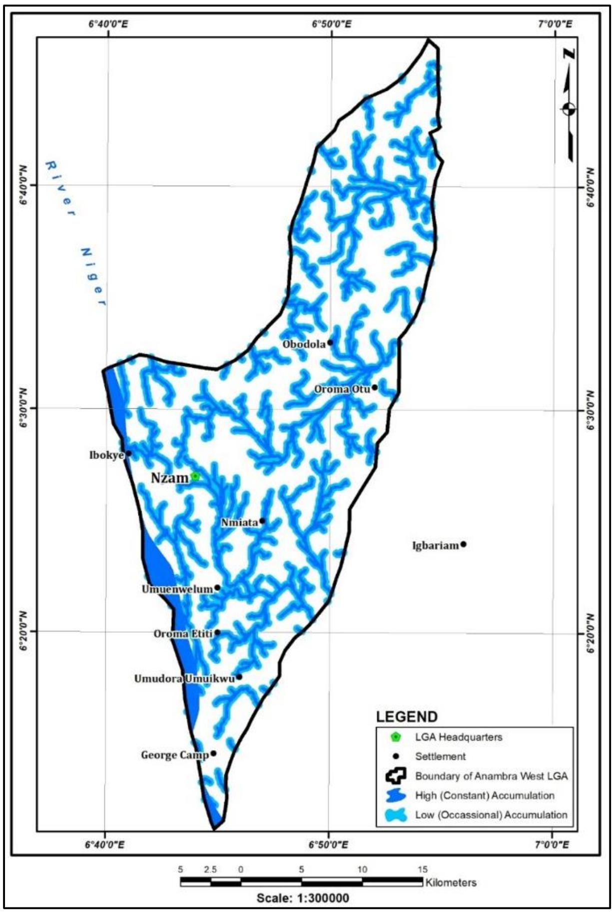

Fig 3: Flow Accumulation Map of Anambra West L.G.A

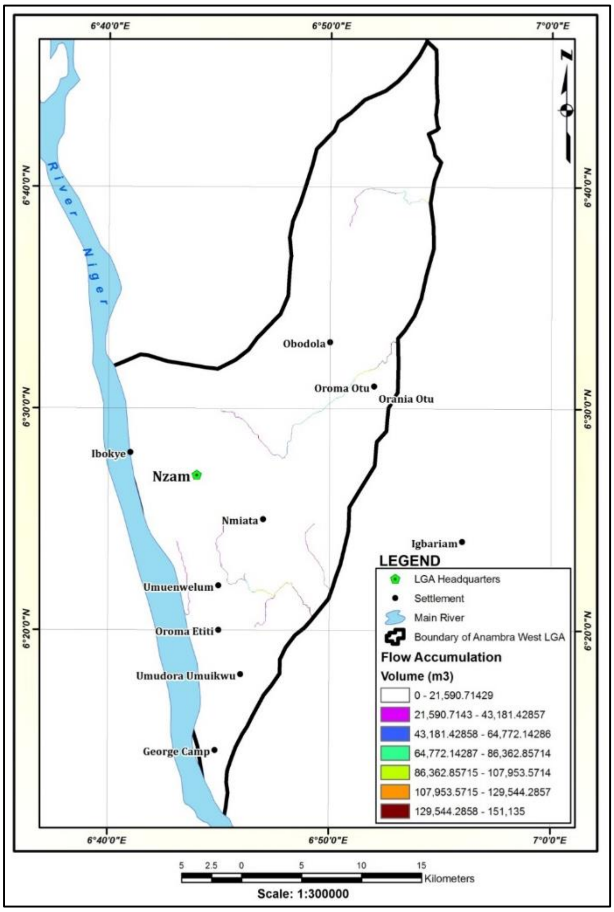

Fig 4: Flow Accumulation Map of Anambra West L.G.A

From figures 4, it was noticed that water accumulates in most part of the Local Government**.** This results in flood water accumulation and as such the flood occurrence in most parts of the L.G.A., but the accumulation within the area of study and the L.G.A. as a whole range between 0 to 21,590 cubic meters as can be seen from figure 5. The presence of the streams/ rivers within the L.G.A. also has an effect on the flow accumulation.

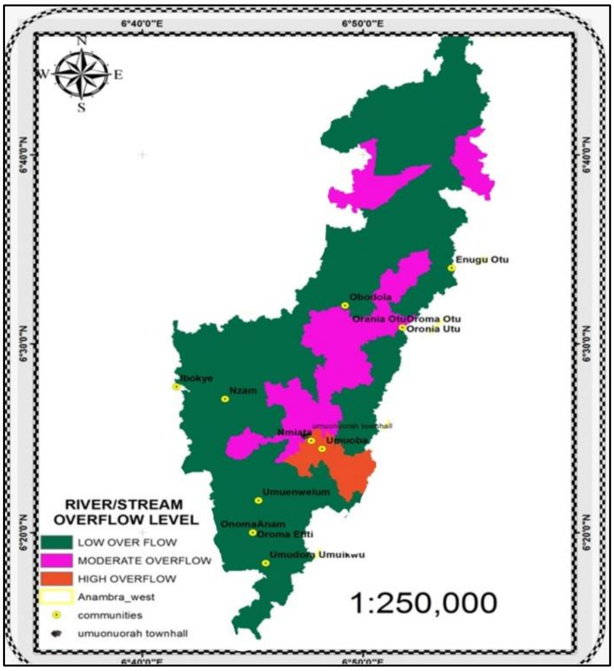

Fig 5: River Overflow Level

Figure 5 shows the areas that experiences various degrees of overflow after excessive rains. From the map analysis, it was noticed that Nmiata Anam and Umuoba fall within the area that experiences the highest degree of over flow. This makes these areas susceptible to flood occurrence since the highest over flows are experienced in these places. The overflows are coming from the various streams and rivers that are located within the Local Government.

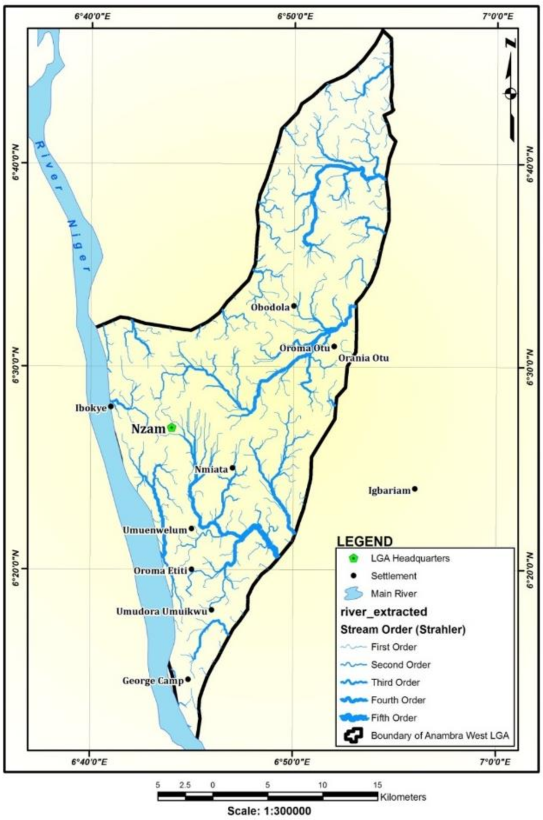

Fig 6: Map of Stream Network in Anambra West L.G.A.

Figure 6 shows the various major and minor streams present in Anambra West L.G.A. From the map it was noticed that a high degree of the available streams is concentrated at the central part of the L.G.A., followed by stream concentration at the north. The southern part of the L.G.A. has the least concentration of streams.

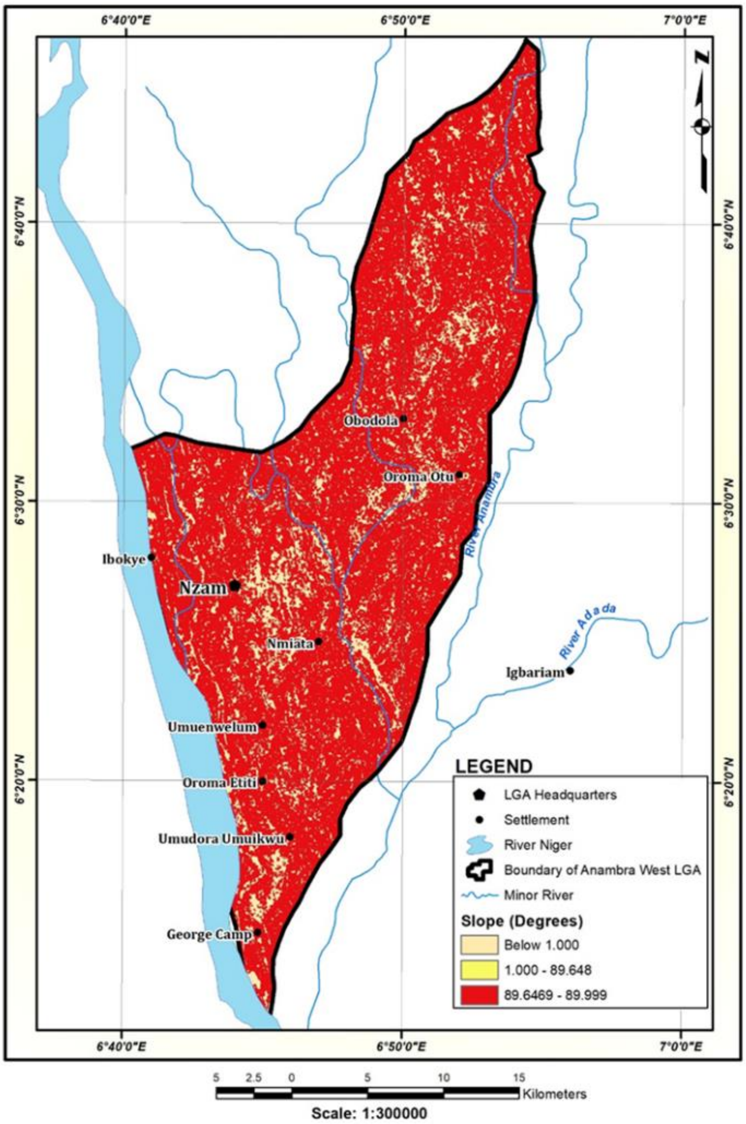

Fig 7: Map of Slope of Anambra West

Figure 7 shows the slope map of Anambra West in degrees. The map showed that virtually every part of Anambra West falls within the slope 89.64 degrees to 89.99 degrees except very few areas that have slope degrees of less than 1 degree. These areas that have slopes less than 1degree tend to be easily flooded. The higher the degree of slope the less vulnerable a place will be. This is because water will find it difficult to flow out of a particular area when the slope is low or around 0º.

4.2. Overlay Analysis

This was carried out using weighted overlay method in which the Reclassified slope of the study area was overlaid on the watershed map of same area to generate Vulnerability Map of Anambra West L.G.A. which is categorized into low, moderate and high vulnerability level as shown in figure 8. The vulnerability of an area to flood (or flash flood) is related to so many factors however, four main parameters were considered in mapping the vulnerability of Anambra West LGA to flooding. These include elevation, slope and the proximity to river and streams in the area.

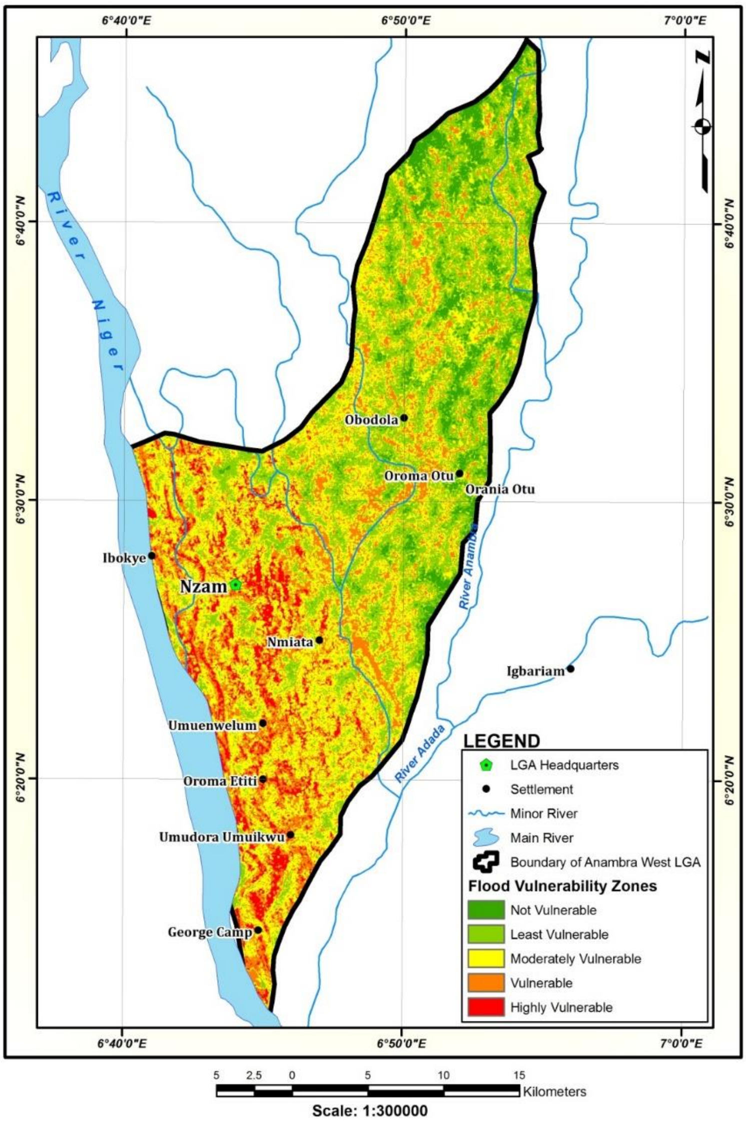

Fig 8: Flood Vulnerability map of Anambra West

The application of the reclassification algorithm in ArcMap played a crucial role in assessing flood vulnerability by allowing for the assignment of a score to each pixel (the smallest unit area, 30m) within the study area. This process began with the reclassification of the slope map, which involved dividing the map into distinct slope categories. The slope of the land is a significant factor in flood risk; areas with lower slopes are more likely to experience water accumulation and, therefore, higher flood vulnerability. In this study, the central parts of the study area were identified as mostly flat, and therefore more prone to flooding, particularly if slope alone is considered as the primary determinant.

However, the slope classification was only one of several factors used to generate the final flood vulnerability map. Before the vulnerability scoring was assigned to each pixel, various vulnerability zones were defined based on specific assumptions and parameters, as illustrated in figure 9. These zones helped guide the scoring process, ensuring that each pixel's vulnerability was assessed within the context of multiple criteria rather than relying solely on the slope.

The final stage of the analysis involved using a Multi-Criteria Evaluation (MCE) technique. This approach integrated several parameters—such as slope, elevation, proximity to water bodies, and land use—into a Weighted Sum overlay algorithm. The algorithm computed an overall score for each pixel, which represented the combined impact of all the components considered in the study. These scores were then reclassified according to a 5-point scale, similar to the one presented in figure 9. This reclassification process allowed the identification of areas with varying degrees of flood vulnerability. Pixels that received higher scores were categorized as highly vulnerable to flooding, while those with lower scores were rated as having minimal or no flood risk.

This method of analysis offers a comprehensive approach to flood risk assessment by combining multiple layers of information. The integration of various parameters ensures a more accurate and reliable identification of flood-prone areas, providing valuable insights for flood management and mitigation efforts. The final flood vulnerability map serves as a critical tool for urban planners, policymakers, and local communities, enabling targeted interventions in the most vulnerable areas to reduce flood impacts and protect lives and property.

S/No.	Spatial Component	Gradation	Zone/Category	Reclassification Score	Assumption
1	Slope (Degrees)	0 - 20	Highly Vulnerable	5	The lower the slope, the more vulnerable the environment to flooding
		21 - 40	Vulnerable	4	
		41 - 60	Moderately Vulnerable	3	
		61 - 80	Least Vulnerable	2	
		81 - 90	Not Vulnerable	1	
2	River Niger (Kilometers)	5	Highly Vulnerable	5	Buffer analysis within specified radius
		10	Vulnerable	4	
		15	Moderately Vulnerable	3	
		20	Least Vulnerable	2	
		30	Not Vulnerable	1	
3	Streams (Meters)	300	Highly Vulnerable	5	
		600	Vulnerable	4	
		900	Moderately Vulnerable	3	
		1200	Least Vulnerable	2	
		1500	Not Vulnerable	1	
4	Elevation (Meters Above Sea Level)	Below 25	Highly Vulnerable	5	Lower terrains are more susceptible to flood than their surrounding higher areas
		26 -50	Vulnerable	4	
		51 - 75	Moderately Vulnerable	3	
		76 - 100	Least Vulnerable	2	
		Above 101	Not Vulnerable	1	

Fig 9: Multi Criteria Decision Analysis

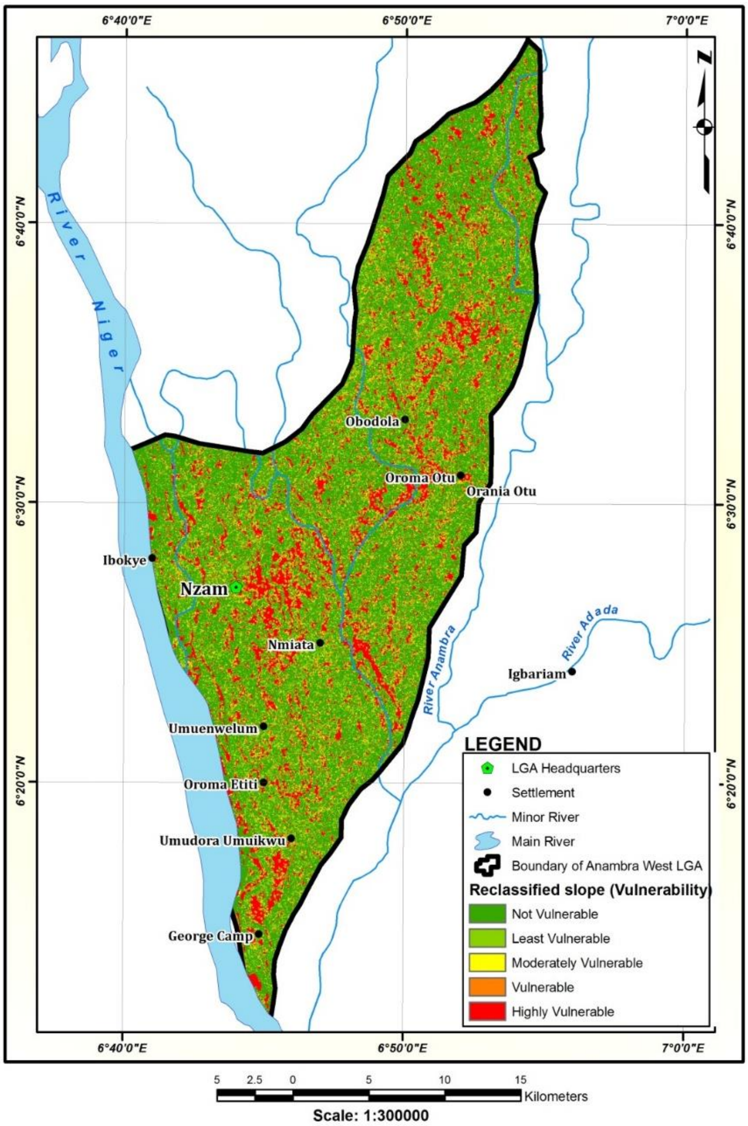

Fig 10: Reclassified Slope (Vulnerability)

The Digital Elevation Map (DEM) of Anambra West LGA, as illustrated in Figure 1, offers a detailed topographical representation of the study area, including Nmiata Anam. The majority of the landmass falls within the darker (black) regions, which signify low-lying areas. These areas, particularly in the central part of the LGA, are situated at very low elevations, making them especially prone to water accumulation and flooding. The terrain in this region lacks significant elevation changes, which exacerbates the region's susceptibility to flood events, particularly in periods of heavy rainfall and river overflow. These findings align with the area's geographic setting, being located in close proximity to the River Niger and other smaller rivers, placing it squarely within a high-risk floodplain.

The flow direction map, presented in Figure 2, further emphasizes this flood risk. The predominance of green colors in the central area indicates that a substantial amount of surface runoff is directed towards the southern part of the LGA. This is consistent with the low-lying nature of the terrain, as water from higher elevations flows downwards, pooling in these lower regions. This continual influx of water, especially during the rainy season, exacerbates the flood risk across much of Anambra West, including Nmiata Anam.

In Figure 3, the flow accumulation map shows that water is being funneled into the study area from multiple directions. As water moves across the landscape, it accumulates in various locations, particularly in low-lying areas, creating a high potential for waterlogging and subsequent flooding. The presence of both surface runoff and tributary inflows leads to substantial water accumulation throughout the LGA. The hydrological dynamics of the region are such that during peak periods of rainfall, the land cannot adequately drain the excess water, leading to significant flooding events that impact the area’s agricultural land, infrastructure, and settlements.

The river and stream overflow map, shown in Figure 5, highlights the severity of the overflow situation in the central region of Anambra West. The map identifies areas, particularly around Nmiata Anam, that experience moderate stream overflow, meaning that during periods of peak rainfall or river swelling, these areas are consistently inundated with water. This frequent overflow is linked to the presence of numerous river tributaries in the area, as shown in Figure 6. The dense network of these tributaries exacerbates the flood risks, as they contribute to water volume and flow during rainy seasons, further flooding the central part of the LGA.

The flood vulnerability map, generated through the integration of the reclassified slope map and the watershed map, reveals that nearly the entire Anambra West LGA is at risk of flooding. The majority of the land area, over 60%, is classified as moderately vulnerable, meaning that floods are a regular occurrence during the rainy season. The low elevation, combined with poor drainage and the proximity to water bodies, creates an environment where even moderate rainfall events can lead to significant flooding. This persistent flooding has become so commonplace that the local population, particularly in communities like Nmiata Anam, regard it as a normal, recurring event. They refer to the seasonal floods as "iji," a term in their local dialect that conveys the regularity of these occurrences. However, the community only expresses significant concern when faced with extreme flooding events, such as the devastating floods of 2012/2013, which resulted in widespread displacement and destruction. To the local population, these catastrophic events represent what they consider a "real" flood, due to the scale of damage and disruption caused.

In this context, the researcher employed satellite imagery and geospatial analysis to produce several important maps that offer a clearer understanding of the hydrological and topographical dynamics at play. The flow accumulation map, flow direction map, mass movement map, reclassified slope map, watershed map, and flood vulnerability map together provide a comprehensive visual and analytical framework for assessing flood risks in Anambra West LGA. These tools allow for the identification of the most vulnerable areas and contribute valuable data for flood mitigation planning. The maps offer insights into how water moves across the landscape, where it tends to accumulate, and which areas are at the highest risk of inundation during peak rainfall and river overflow events.

The combination of these geospatial tools not only aids in understanding current flood dynamics but also provides a foundation for future planning. By identifying flood-prone areas, local authorities and planners can develop strategies to mitigate the impact of flooding. This could include infrastructure improvements such as enhanced drainage systems, flood barriers, and the construction of retention basins to control the flow and accumulation of water. Moreover, the insights gained from these analyses can inform early warning systems, helping the community prepare for potential flooding events and minimize loss of life and property.

Given the area's heavy dependence on agriculture, these flood risk assessments are crucial for ensuring food security and protecting livelihoods. By understanding where water is likely to accumulate and flood, farmers can make informed decisions about where to plant crops and how to protect their land from flood damage. In addition, these insights can guide local authorities in designing flood management policies that balance the needs of the community with the imperative of protecting the natural environment. The integration of remote sensing and geospatial technologies in this analysis provides a powerful approach for addressing the challenges posed by flooding in Anambra West LGA and offers a pathway for developing sustainable flood management solutions.

5. Conclusion

The assessment of flood vulnerability in Nmiata Anam within Anambra West LGA, using remote sensing and geospatial analysis, led to several important conclusions. First, the Digital Elevation Model (DEM) revealed that much of Anambra West, including Nmiata Anam, is situated at low elevations, especially in the central region. This low-lying terrain significantly increases the area's susceptibility to flooding, as it lacks the necessary elevation and drainage to handle large volumes of water during heavy rainfall or river overflow.

Additionally, the flow direction and flow accumulation maps indicate that water from higher elevations converges in the central parts of the LGA, further aggravating flood risks. This results in water pooling in low-lying areas like Nmiata Anam, where accumulation occurs more frequently, leading to more severe flooding.

The study also highlighted the significant role that river tributaries play in contributing to flood events. The dense network of tributaries in the region amplifies the flood risk, as these water channels tend to overflow during the rainy season, resulting in moderate to high levels of flooding. The hydrological analysis confirms that this situation is especially critical in central areas of the LGA, where river overflow is more prevalent.

Moreover, the flood vulnerability map generated from the study indicates that over 60% of Anambra West LGA is moderately vulnerable to flooding, with all areas subject to some level of flood risk. The combination of low elevation, poor drainage, and the proximity to water bodies makes seasonal flooding a regular occurrence. This has led to a normalization of flood events within the community, where the population regards seasonal flooding, locally referred to as "iji," as an expected and manageable event. However, extreme floods, like those that occurred in 2012 and 2013, are considered more serious and are associated with significant damage and disruption.

The use of remote sensing and geospatial technology in this research provided valuable insights into the area's flood dynamics, offering critical tools for better understanding water flow patterns and flood susceptibility. These technologies facilitated the creation of several important maps, including those that show water flow direction, accumulation, and overall flood vulnerability. The study underscores the effectiveness of these tools in guiding future flood preparedness, infrastructure development, and flood mitigation planning.

Lastly, the findings emphasize the urgent need for sustainable flood management strategies in Anambra West LGA. Given the widespread flood vulnerability, local authorities need to prioritize improved drainage systems, the construction of retention basins, flood barriers, and early warning systems. Such measures will help mitigate the impact of flooding on agriculture, infrastructure, and the local population. The data generated through this research provides a strong foundation for future flood management and climate resilience initiatives in the region.

6. Recommendations

Based on the findings of the study, several key recommendations are proposed to mitigate the flood vulnerability of Nmiata Anam and the wider Anambra West LGA. First, the local government should invest in improving the drainage infrastructure. The low elevation and poor drainage systems in the area exacerbate flood risks, so creating more efficient drainage channels and expanding existing ones will help manage excess water, particularly during the rainy season.

Second, flood control structures, such as retention basins and flood barriers, should be constructed in vulnerable areas. These structures can help contain excess water during heavy rainfall and reduce the likelihood of river and stream overflows. Special attention should be given to areas in the central part of Anambra West, where water accumulation is more frequent, as identified in the flow accumulation and flow direction maps.

Another recommendation is to implement a comprehensive early warning system for floods. By using satellite data and real-time monitoring of river levels and rainfall patterns, authorities can give timely warnings to residents about impending flood events, allowing communities to prepare and take necessary precautions. This would be especially important for preventing the catastrophic impacts of major floods, like those that occurred in 2012 and 2013.

Additionally, public awareness campaigns should be launched to educate local communities about the dangers of seasonal flooding and how to protect their homes and property. While the local population considers seasonal flooding to be a normal occurrence, they must understand the risks of more severe flood events and be prepared to take action when needed.

Furthermore, land-use planning should incorporate flood risk assessments to guide the development of infrastructure and housing. New construction should avoid the most vulnerable areas, particularly low-lying zones near riverbanks and tributaries, and should adhere to guidelines designed to minimize flood risks.

Finally, the local government should partner with environmental and urban planning experts to develop long-term strategies that incorporate climate resilience. These plans should address both current and future flood risks, as climate change is likely to exacerbate flooding in the region. By adopting these recommendations, the authorities can reduce flood vulnerability, protect the population, and safeguard infrastructure in Nmiata Anam and Anambra West LGA.

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