

A Review of Flood Vulnerability Mapping. A case study of Toto Local Government of Nasarawa State, Nigeria

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Abstract

Flooding has a variety of effects, including disease outbreaks, property and agricultural land destruction, disruption of socioeconomic activity, and relocation. Planning for sustainable development and disaster risk reduction requires an understanding of the spatial distribution and the factors influencing flood susceptibility. Using the Toto Local Government Area (LGA) of Nasarawa State, Nigeria, as a case study, this paper reviews flood vulnerability mapping. Toto LGA was chosen for this study for several reasons. First, Nasarawa State has seen major and more frequent flooding incidents in recent years, much like many other Nigerian states. Additionally, due to its geography and drainage patterns, Toto LGA, located within the Benue River Basin, is particularly vulnerable to riverine and flash floods during the rainy season. Because of the area's susceptibility to floods, this site was chosen. The study examines a variety of approaches that were employed to locate and define regions with differing levels of flooding susceptibility, such as hydrological analysis, geospatial techniques, and socioeconomic data evaluation. To develop a more comprehensive approach to creating flood vulnerability maps, the work examines terrain, drainage patterns, land use, population density, and current infrastructure. The approach was an essential tool for comprehending how flood risk is distributed geographically and how it could affect resources and communities. By pinpointing the settlements most at risk, this study seeks to give local governments a detailed picture of flood vulnerability. The results will improve the Toto Local Government Area's resilience to future flood disasters, help build efficient flood management measures, and guide land-use planning decisions.

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1. Introduction

Flooding is a frequent and destructive natural disaster that endangers people's lives, livelihoods, infrastructure, and the environment everywhere it occurs, but especially in many areas of Nigeria (Ologunorisa, 2006). Flooding has a variety of effects, including disease outbreaks, property and agricultural land destruction, disruption of socioeconomic activity, and relocation (Adebayo & Tukur, 2011). Planning for sustainable development and disaster risk reduction requires an understanding of the spatial distribution and the factors influencing flood susceptibility. This paper examines flood vulnerability mapping and assessment techniques using the Toto LGA in Nasarawa State, Nigeria, as a case study.

Toto LGA was chosen for this study for several reasons. First, Nasarawa State has seen major and more frequent flooding incidents in recent years, much like many other Nigerian states (Federal Ministry of Environment, 2012). Due to its geography and drainage patterns, Toto LGA, which is part of the Benue River Basin, is especially vulnerable to riverine and flash floods during the rainy season (Nasarawa State Government, 2018). Second, comprehensive and localised vulnerability information is frequently absent or out-of-date, even when broad assessments of flood risk may be available at the state or federal level. By pinpointing the people and regions most at risk, this study seeks to review and come up with suitable methodologies for flood vulnerability. Targeted actions, resource allocation, and the creation of customised mitigation and adaptation plans all depend on this localised data.

In addition, Toto LGA is rapidly becoming more urbanised and populous, which frequently results in uncontrolled development in places that are vulnerable to flooding. Communities are more vulnerable to flood dangers as a result of this (UN-Habitat, 2010). Therefore, to guide infrastructure development, land-use planning, and the deployment of efficient early warning systems, a comprehensive method for the assessment of flood vulnerability is essential.

2. Methods

This study reviews and analyses the literature that is currently available on flooding vulnerability assessment, with an emphasis on identifying dependent and independent variables, important discoveries, and knowledge gaps. Giving a contextual knowledge of the issue within the larger academic discourse is the goal. The concept of flood vulnerability is complicated and influenced by many different aspects. The degree of loss and destruction that a town or area is expected to sustain as a result of a flood event is known as flood vulnerability, and it is the dependent variable (Blaikie et al., 1994). This sensitivity differs across different

socioeconomic categories and is not consistent across space. The elements that affect this degree of vulnerability are known as independent variables. These fall into two general categories: socioeconomic and physical factors. Several important independent variables are consistently identified in the literature:

2.1 Physical Elements:

- i. Elevation and Topography:** Research has indicated that regions with steep slopes and low-lying areas are more vulnerable to flash floods and flooding, respectively (Smith & Petley, 2009). For example, studies conducted in Nigeria's flood-prone areas have emphasised how geography affects flood inundation patterns (Ologunorisa, 2006). Riverine flooding is more likely to occur in areas close to rivers, streams, and other bodies of water (Adebayo & Tukur, 2011). The effects of river overflow have been highlighted in studies conducted in the Benue River Basin, which includes Toto LGA (Federal Ministry of Environment, 2012).
- ii. Drainage Systems:** Reducing the effects of flooding depends heavily on the effectiveness and capacity of drainage systems. Flooding can be made worse by inadequate or obstructed drainage (UN-Habitat, 2010).
- iii. Land Cover and Land Use:** The type of land cover, such as deforestation or impermeable surfaces (urban areas), can affect flood severity and discharge (Kundzewicz et al., 2014).

2.2 Socio-economic Factors:

- i. Population Density:** More people and property are at risk in flood-prone areas when there is a higher population density (World Bank, 2015).
- ii. Housing Quality and Infrastructure:** Communities' ability to withstand floods is influenced by the structural soundness of buildings and the accessibility of essential infrastructure, such as roads and sanitary facilities (UN-Habitat, 2010).
- iii. Poverty and Socioeconomic Status:** According to Chambers (1989), vulnerable groups that have less money and less access to resources are frequently poorly equipped to handle and recover from flood disasters.
- iv. Information and Early Warning System Access:** Vulnerability can be greatly increased by not having timely and accurate flood warnings (UNISDR, 2009).
- v. Community Awareness and Preparedness:** The likelihood of loss and damage is influenced by the degree of community awareness and preparation for flood disasters (Twigg, 2007).

2.3 Findings from the Literature

Key findings from this paper include:

- i. Vulnerability by Spatial Variability:** Research continuously shows that a region's susceptibility to flooding varies; some populations and places are more vulnerable than others because of a mix of socioeconomic and physical factors (Ologunorisa, 2006; Adebayo & Tukur, 2011).
- ii. Importance of Multi-Dimensional Factors:** Research highlights that flood vulnerability is a multifaceted problem that necessitates an integrated strategy that takes into account both the socioeconomic characteristics of the impacted population and physical dangers (Blaikie et al., 1994).

- iii. **Effects of Development and Urbanisation:** Increased flood susceptibility in many urban and peri-urban regions has been attributed to rapid urbanisation and uncontrolled building in floodplains (UN-Habitat, 2010).
- iv. **Disproportionate Effect on Vulnerable Groups:** Studies show that low-income and marginalised populations frequently suffer the most from floods because they have fewer resources and are less able to obtain preventative measures (World Bank, 2015).

The results highlight the necessity of carrying out localised vulnerability assessments in order to guide focused interventions and risk mitigation plans (Twigg, 2007).

2.4 Deficits in Current Literature:

Even with the wealth of information on flood susceptibility, there are still several gaps, especially when it comes to the unique circumstances of Toto LGA and other areas in Nigeria that are comparable:

- i. **Absence of Thorough Localised Research:** Although there are more general studies on flooding in Nigeria (e.g., Federal Ministry of Environment, 2012), there are not many in-depth, regional vulnerability analyses that concentrate on places like Toto LGA. The majority of research is often conducted at a national or regional level.
- ii. **Limited Granular Integration of Socio-economic aspects:** Although socio-economic aspects are recognised, many studies do not explicitly integrate them spatially and in detail at the community level to determine how they specifically affect vulnerability.
- iii. **Lack of Attention to Particular Local Contexts:** Studies frequently do not thoroughly examine the distinct physical and socioeconomic traits that characterise vulnerability in particular local government areas, such as the topography, settlement patterns, and livelihood practices that are common in Toto LGA. The necessity of current vulnerability maps. Modern vulnerability mapping that takes into account recent changes in infrastructure, land use, and population is necessary because many of the assessments that are now in place may be out of date.
- iv. **Limited Use of Geospatial Technologies at the Local Level:** Although remote sensing and GIS are being used more frequently in flood studies, many regions of Nigeria, including the Toto Local Government Area in Nasarawa State, lack the broad use of these technologies for in-depth vulnerability mapping at the local government level.

Conclusion

This paper reviews the previous studies on flood vulnerability, taking the Toto LGA of Nasarawa state, Nigeria, as a case study. It starts by identifying those factors that influence flood vulnerability and categorising them into two. These were the physical and socioeconomic factors. Thereafter, the paper reviews the existing literature on flood vulnerability and identifies the gaps. These include a lack of localised studies, limited integration of socio-economic factors and insufficient focus on the specific local context. Lack of UpToDate vulnerability maps and limited application to geospatial technologies at the local level were also lacking in most of the literature reviewed.

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