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Edited Book

Mc Dowell, L. & Sharp, J.P. (Eds.) (1999). *Afeminist glossary of human geography*. New York, NY: Oxford University Press.

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Journal Articles

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SOCIO-ECONOMIC AND ENVIRONMENTAL VULNERABILITY IN THE SAHELIAN CORRIDOR OF NIGERIA: A GIS-BASED ANALYSIS

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Abstract

Environmental hazards like floods, soil erosion, and desertification pose significant challenges to Nigeria's northern Sahelian Corridor. Traditional disaster risk assessments focus on physical hazard mapping, overlooking socio-economic determinants that influence community resilience. This study employs a multi-hazard, multi-dimensional approach to develop a socio-economic vulnerability index, assess population and infrastructure exposure, and identify regions where vulnerability coexists with hazard-prone environments. The research utilized various datasets, including SRTM DEMs, FAO soil data, and socio-economic data from GRID3/WorldPop and NBS household surveys. The vulnerability assessment disaggregates vulnerability into physical, social, economic, and environmental categories, yielding a composite vulnerability score integrated with exposure analysis. Findings indicate substantial population concentrations in hazard-prone areas, with states like Kano, Borno, Sokoto, and Jigawa exhibiting high densities. Over 1 million individuals in Jigawa reside in high-hazard exposure areas, while in Kano, approximately 38% of cultivated land is situated in these zones, jeopardizing food security and livelihoods. The study reveals that regions with moderate hazard susceptibility can experience elevated disaster risk due to underlying socio-economic weaknesses, including poverty and inadequate infrastructure. The research advocates for a paradigm shift in disaster risk reduction strategies from a hazard-centric framework to a people-centred approach, addressing fundamental drivers of vulnerability through poverty alleviation, investment in resilient infrastructure, diversification of livelihoods, and cohesive urban planning.

Keywords: Disaster Risk Assessment, Environmental Hazards, GIS, Nigerian Sahelian Corridor, Socio-economic Vulnerability.

Introduction

Nigeria faces some of the most complex disaster risk challenges in Sub-Saharan Africa, with hydro-meteorological hazards such as flooding, drought, desertification, and erosion being particularly prevalent. Flooding is the most frequent and devastating hazard, affecting millions of people annually. The catastrophic 2012 nationwide floods impacted 33 states, while the 2022 floods displaced over 1.5 million people and claimed more than 600 lives, underscoring the persistent nature of flood risk(Daniel et al., 2023; Ifiok Enobong Mfon et al., 2022). Soil

erosion, particularly gully erosion, has devastated large portions of southeastern Nigeria, with over 1,000 active erosion sites reported(Peter, 2006). In the arid northern states, desertification is advancing rapidly, with the Sahara encroaching southward at an estimated rate of 0.6 km per year, threatening livelihoods, biodiversity, and food security(Tomalka et al., 2021). These hazards are rarely isolated; they often overlap and compound, resulting in systemic risks that disrupt socio-economic stability across the country.

Disaster risk is a function not only of hazard intensity but also of the degree of exposure and vulnerability of affected populations. Vulnerability is multidimensional, encompassing physical, social, economic, and environmental dimensions (Shawky & Hassan, 2023). In Nigeria's northern Sahelian corridor, socio-economic vulnerability is particularly acute. High poverty levels, reliance on subsistence agriculture, poor housing conditions, and limited access to healthcare and education intensify the impacts of hazards (Tofu, 2024). Rapid population growth and unplanned urban expansion push communities into hazard-prone areas, increasing exposure. Moreover, dependence on rain-fed agriculture ties household income and food security directly to climatic variability, compounding vulnerability to floods, erosion, and desertification (Ojoye et al., 2020). These socio-economic stressors determine not only the likelihood of disaster losses but also the capacity of communities to recover.

While several studies in Nigeria have employed GIS and remote sensing to map hazards such as floods, erosion, or desertification (Chude et al., 2020; Ibrahim et al., 2025; Shawky & Hassan, 2023), most remain hazard-centric and emphasize physical processes. Limited attention has been given to systematically integrating socio-economic datasuch as poverty indices, settlement density, infrastructure access, and livelihood indicatorsinto disaster risk assessments. As a result, there is insufficient understanding of how socio-economic conditions amplify or mitigate hazard impacts, especially in the northern states where vulnerabilities are most pronounced. This gap reduces the utility of hazard maps for decision-making, as they fail to identify *who* is at risk and *why*. Addressing this gap requires a multi-hazard, multi-dimensional approach that combines hazard analysis with socio-economic vulnerability mapping to identify disaster risk hotspots and inform targeted interventions. Therefore, the objective of the study includes to develop socio-economic vulnerability map, assess population, livelihood, and infrastructure exposure to multiple hazards using geospatial datasets and identify areas where socio-economic vulnerability intersects with hazard-prone environments, thereby amplifying disaster risk.

Literature Review

This study adopts the internationally recognized conceptual framework for disaster risk assessment, where Disaster Risk (DR) is understood not as a singular event, but as the potential loss resulting from the interaction between various dimensions. Specifically, disaster risk is commonly expressed as a function of the interaction between Hazard (H), Exposure (E), and Vulnerability (V):

$$DR = f(H, E, V) \qquad (1)$$

Hazard (H): The potential occurrence of a natural or human-induced physical event that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, and services (Nalmpant-Sarikaki et al., 2025). In the Sahelian corridor, key hazards include flooding, drought, desertification, and erosion.

Exposure (E): The presence of people, livelihoods, environmental services, or infrastructure, in places and settings that could be adversely affected by a hazard. In this study, exposure was assessed for population, livelihoods (agricultural land), and critical infrastructure.

Vulnerability (V): The characteristics and circumstances of a community, system, or asset that make it susceptible to the damaging effects of a hazard (M. Ibrahim et al., 2025). The research moved beyond traditional physical risk to systematically integrate socio-economic factors that amplify hazard impacts (Nduji et al., 2023).

Previous disaster risk assessments in Nigeria have primarily been hazard-centric, utilizing GIS and remote sensing to map and model single hazards like floods, erosion, or desertification. While these studies are crucial for understanding physical processes, they often give limited attention to systematically integrating socio-economic data such as poverty indices, livelihood indicators, and access to infrastructure.

This omission is problematic, especially in the northern Sahelian corridor, where high poverty levels, reliance on subsistence agriculture, and inadequate infrastructure acutely intensify the impacts of hazards. The lack of integrated socio-economic data results in an insufficient understanding of who is at risk and why, reducing the utility of hazard maps for effective decision-making and targeted intervention. This research directly addresses this gap by combining multi-hazard analysis with a multi-dimensional socio-economic vulnerability assessment.

Methodology

Study Area

The study concentrates on the Sahelian corridor in Northern Nigeria, a delicate ecological area situated between latitudes 10° and 14°N, bordering the Republic of Niger. This corridor includes seven key states, such as Sokoto, Kano, Katsina, Jigawa, Yobe, Borno, and Zamfara, that are particularly vulnerable to environmental threats such as flooding, erosion, and desertification (Tomalka et al., 2021).

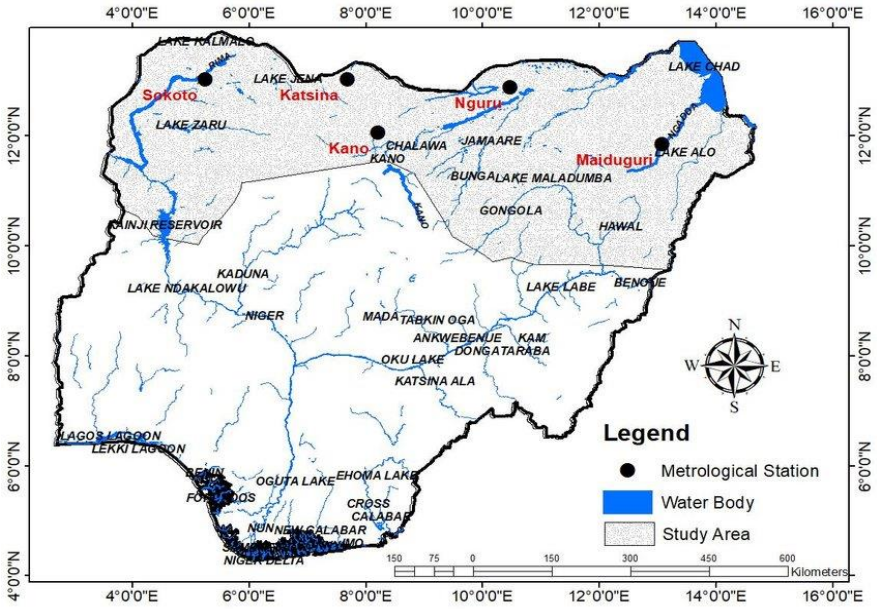
The climate in this region is defined by a semi-arid environment, featuring prolonged dry seasons lasting between 7 to 9 months and brief, intense rainy seasons that generally occur from June to September. Annual rainfall varies from about 200 mm in the far north to approximately 800 mm in the southern regions of the corridor (Peters et al., 2022; Tomalka et al., 2021). These differences significantly increase the zone's vulnerability to droughts, irregular rainfall patterns, and severe flooding incidents.

Topographically, the corridor is primarily flat to gently rolling, with elevations ranging from 200 to 500 meters above sea level. Low-lying floodplains, especially located along the Hadejia-

Nguru wetlands in Jigawa and Yobe, as well as the Sokoto-Rima basin, are notably susceptible to flooding (Shuaibu et al., 2022; Zakaria et al., 2022). The soils in this area are mainly sandy and poorly structured, rendering them highly prone to erosion and land degradation. Desertification is progressing most rapidly in Yobe and northern Borno, where the loss of vegetation and overgrazing have destabilized fragile ecosystems (Audu & Adie, 2018; Eborka, 2024).

In terms of socio-economic conditions, the corridor is inhabited by over 60 million individuals, with livelihoods primarily centered around subsistence farming and livestock rearing, both of which are highly affected by climate variability (Ibrahim et al., 2022). Poverty levels are among the highest in Nigeria, accompanied by limited access to healthcare, education, and resilient infrastructure. Increasing population growth and urbanization are fueling unplanned encroachments into floodplains, erosion-prone areas, and degraded lands, exacerbating vulnerability to hazards. Major urban centers like Maiduguri, Kano, Sokoto, and Damaturu serve as economic hubs but also heighten vulnerability due to their dense populations and insufficient infrastructure.

Figure 1: Map showing the Sudano Sahelian Region of Nigeria



Source: Adapted from Ojoye et al. (2020)

Methods of Data Collection

The multi-hazard risk assessment utilised a variety of spatial and socio-economic datasets that were integrated within a Geographic Information System (GIS) environment. To begin with, topographic and hydrological data were critical, particularly the Digital Elevation Models (DEMs) derived from the Shuttle Radar Topography Mission (SRTM) with a resolution of 90 meters. These models were instrumental in obtaining key parameters such as slope, elevation, drainage density, and flow accumulation, all of which are essential for effective flood and erosion modelling.

In addition to topographic data, soil and environmental factors were also crucial for the analysis. Soil texture and drainage characteristics were extracted from the Food and Agriculture Organization (FAO) soil database, along with information from national geological surveys. These elements proved vital for modelling erosion susceptibility.

The assessment further incorporated socio-economic and population data, allowing for a comprehensive understanding of community exposure. Population density data came from the GRID3/WorldPop datasets, which were disaggregated at the Local Government Area (LGA) level to provide accurate estimates of exposure. Furthermore, poverty and livelihood indicators were drawn from the National Bureau of Statistics (NBS) household survey data, highlighting factors such as income levels, agricultural dependency, and access to essential services.

To evaluate physical exposure and the vulnerability of critical infrastructure, the analysis included spatial datasets on various elements such as settlements, markets, roads, schools, and health facilities. Additionally, information on agricultural land use, including cropland distribution and livestock density, was integrated to reflect livelihood exposure accurately. The combination of these diverse datasets formed a robust foundation for assessing hazard, exposure, and vulnerability. While the environmental data helped characterize the intensity of hazards, the socio-economic indicators shed light on the conditions that influence a community's capacity to endure and recover from disasters.

Methods of Data Analysis

Vulnerability Assessment

This study shifts the focus from traditional hazard-centric assessments to highlight the socio-economic aspects of disaster risk. While understanding hazard intensity is crucial, it is vulnerability and exposure that ultimately dictate the extent of human and livelihood impacts. The methodological framework we use combines socio-economic indicators with hazard data to pinpoint who is most at risk and why. Vulnerability, in this context, is viewed as a multi-dimensional concept, which we break down into four categories: physical, social, economic, and environmental vulnerability. This comprehensive approach allows us to grasp risk in a way that extends beyond mere physical threats.

Physical vulnerability examines the built environment, considering factors such as housing quality and infrastructure density. Poorly constructed buildings are more susceptible to damage (Nalmpant-Sarikaki et al., 2025). Social vulnerability centres on people and their ability to respond to crises, looking at aspects like population density, age, and access to healthcare. Marginalised or disadvantaged groups typically have fewer resources at their disposal during disasters (Nalmpant-Sarikaki et al., 2025). Economic vulnerability assesses the financial stability of a region by exploring poverty rates and reliance on precarious livelihoods, such as rain-fed agriculture, which can restrict a community's ability to bounce back. Lastly, environmental vulnerability evaluates the health of the natural surroundings using indicators like vegetation cover and land degradation; a degraded environment can amplify the effects of hazards (Awal & Awal, 2015; Van Westen, 2013).

To allow for meaningful spatial comparison (the descriptive analysis), each indicator I_i within

these categories (Physical, Social, Economic, Environmental) is transformed into a standardised score on a scale of 1 to 512, using a min-max normalisation technique,

$$Standardisation\ Score\ S_i = 1 + 4 \times \left(\frac{I_i - I_{min}}{I_{max} - I_{min}}\right) \quad (2)$$

where I_i is the original indicator value, I_{min} is the minimum value, and I_{max} is the maximum value observed across the study area. This process ensures all indicators contribute equally before weighting.

For the inferential analysis, the composite vulnerability score (CVS) for each Local Government Area (LGA) was calculated using the Weighted Summation Method, a form of Multi-Criteria Decision Analysis (MCDA). We assigned weights W_i to each standardized indicator, prioritizing those that literature suggested more significantly affect vulnerability (for instance, poverty wields more influence than market access). The final composite vulnerability score was calculated as:

$$CVS = \sum_{i=1}^{n}(W_i \times S_i) \quad (3)$$

where n is the total number of indicators, W_i is the assigned weight for indicator i, and S_i is the standardized score for indicator *i*. These weighted and standardised indicators are combined to generate a single, composite vulnerability score for a specific area. This structured approach ensures that the final risk assessment is grounded in a solid and clearly defined set of criteria16.

Exposure Analysis

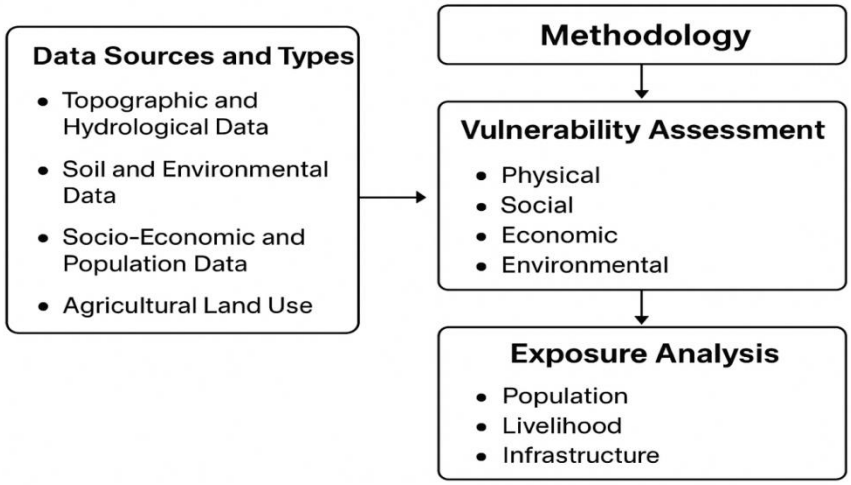
Exposure to hazards was assessed through a comprehensive examination of the people, livelihoods, and infrastructure located within areas prone to risk. First, population exposure was evaluated by using detailed demographic data, such as information from GRID3 and WorldPop, which was then overlaid with maps of hazard-prone zones. This approach allowed the study to identify the number of individuals living in areas susceptible to flooding, erosion, and desertification, providing a clear perspective on the human scale of potential disasters.

The economic implications were analysed by mapping agricultural land and livestock areas within these hazard zones. This step highlighted regions where livelihoods, particularly those reliant on rain-fed agriculture, face direct threats from environmental changes such as erosion and desertification.

Furthermore, the study emphasised infrastructure exposure by mapping critical services, including roads, schools, hospitals, and markets, and comparing their locations to the identified hazard zones. This analysis helped uncover which essential services could be affected by disruptions or damage, thereby impacting the community's ability to endure and recover from disasters.

By employing this dual approach—combining vulnerability indices with exposure mapping—the study provided a multi-dimensional understanding of risk that goes beyond merely assessing hazard intensity. Existing hazard layers, including flood susceptibility, erosion, and desertification, were spatially integrated with socio-economic vulnerability and exposure maps. This integration revealed areas where hazards intersect with high vulnerability, ultimately highlighting disproportionately high disaster risks

Figure 2: Research Methodology Framework



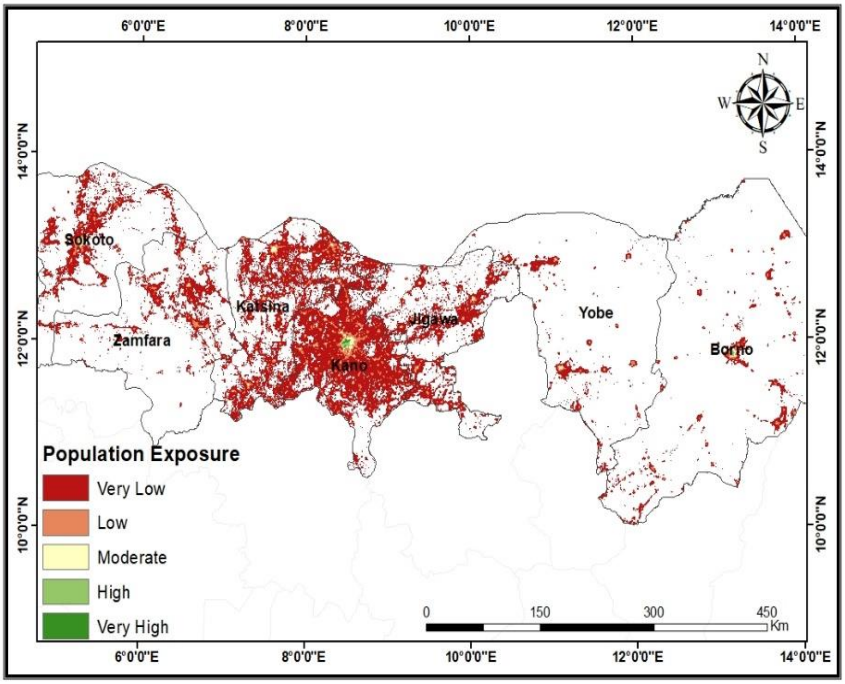
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Source: Authors' design (2025)

Results and Discussion

Across the 7 states, the calculated Composite Vulnerability Score (CVS) for the region ranged from 1.2 (representing Very Low vulnerability) to a maximum of 4.8 (representing Very High vulnerability), with a regional average score of 3.1±0.8. This distribution indicates that the majority of the Sahelian corridor faces above-average systemic fragility, even before accounting for hazard intensity. Statistical comparison of the four primary indices (physical, social, economic, and environmental) revealed that Economic Vulnerability carried the highest mean score (3.5) and was the single largest statistical determinant of overall fragility, showing the dominant role of poverty and precarious livelihoods in driving disaster risk.

The analysis shows that large populations in the Sahelian corridor reside within hazard-prone zones. States such as Kano, Borno, Sokoto and Yobe recorded the highest concentrations of exposed populations, particularly in low-lying floodplains and erosion-prone lands. In Jigawa, more than one million people live in areas classified as high hazard exposure, while Yobe and Borno show similar vulnerability due to both floodplains and advancing desertification(Tofu, 2024). Urban centers such as Kano and Maiduguri further highlight the risks associated with population clustering in fragile environments.

Figure 3: Population Exposure to Hazard

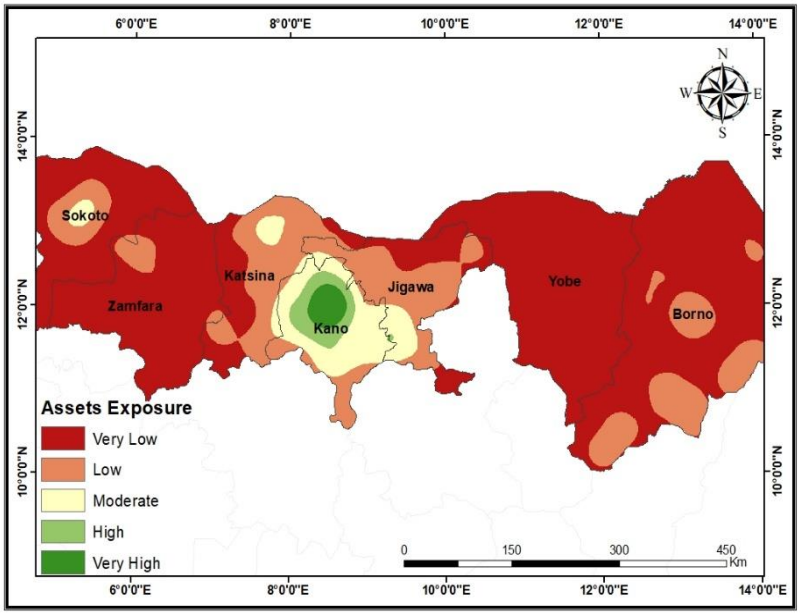


Source: Survey Data (2025)

The spatial overlay analysis confirmed that large populations in the Sahelian corridor reside within hazard-prone zones. The total population exposed in areas classified as 'High' or 'Very High' exposure was estimated at approximately 9.2 million individuals (15% of the total regional population). This was derived by multiplying the percentage of the region within the high and very high with the estimated population within the region which is approximately 49 million (Noor et al., 2015). States such as Kano, Borno, Sokoto, and Yobe recorded the highest concentrations of exposed populations, particularly in low-lying floodplains and erosion-prone lands. In Jigawa, more than one million people live in areas classified as high hazard exposure, while Yobe and Borno show similar vulnerability due to both floodplains and advancing desertification. Urban centers such as Kano and Maiduguri further highlight the risks associated with population clustering in fragile environments. The distribution is clearly visualized in Figure 3.

Agricultural land and livestock resources represent the backbone of livelihoods in Northern Nigeria. The results indicate that croplands in Kano, Sokoto, Katsina, and Jigawa have high exposure of economic assets to hazards. In Kano, up to 38% of cultivated land falls within high hazard exposure areas, threatening food security and rural incomes. The presence of market centers and rural trade routes are also vulnerable, with disruption risks particularly acute in Sokoto and Borno, where economic nodes overlap with high flood and erosion zones.

Figure 4: Assets exposure to Disaster



Source: Author's Computation (2025)

High poverty incidence, dependence on subsistence agriculture, and limited access to markets combine to create severe economic vulnerability across the corridor. Borno and Kano exhibit vulnerability scores above the regional average, driven by access to market exceeding 70% and heavy reliance on rain-fed agriculture. Eborka (2024), also corroboratethis findingsin a similarstudy. In Katsina and Sokoto, recurrent droughts and land degradation further reduce household resilience, trapping communities in cycles of vulnerability. Also, infrastructure networks are unequally distributed across the region, with critical facilities frequently located in hazard-prone zones. The analysis revealed that major road corridors in Sokoto and Borno intersect with flood and erosion-prone landscapes, which could raise concerns over transport disruption during hazard events.

Figure 5: Economic Vulnerability to Hazards

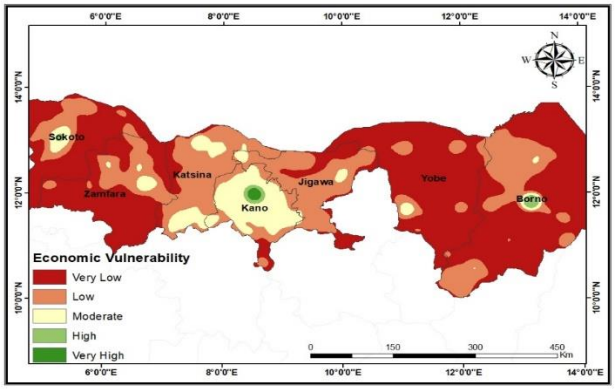
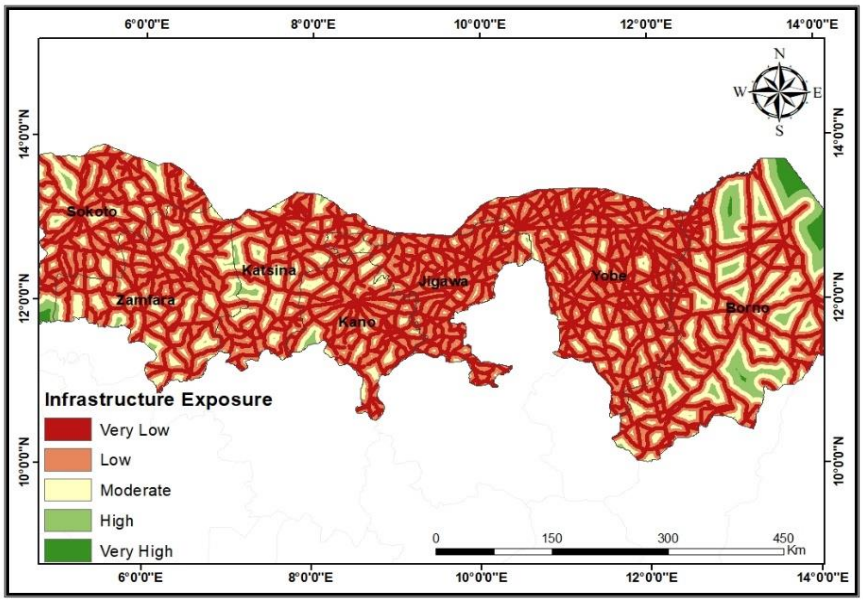


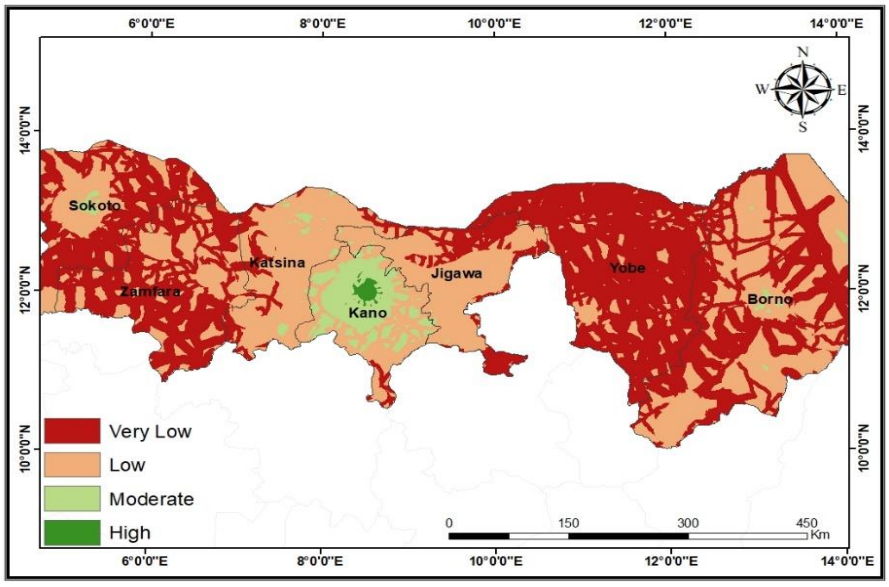
Figure 6: Infrastructure Exposure



Source: Author's Computation (2025)

Physical vulnerability is concentrated in densely populated LGAs with poor housing quality and limited urban planning (Figure 7). Settlements in Sokoto, Maiduguri, and Kano record high vulnerability due to housing clustered near drainage channels and degraded lands. Informal settlements are particularly at risk, as building materials are often substandard and unable to withstand even moderate hazard events(Delves et al., 2025; Peters et al., 2022).

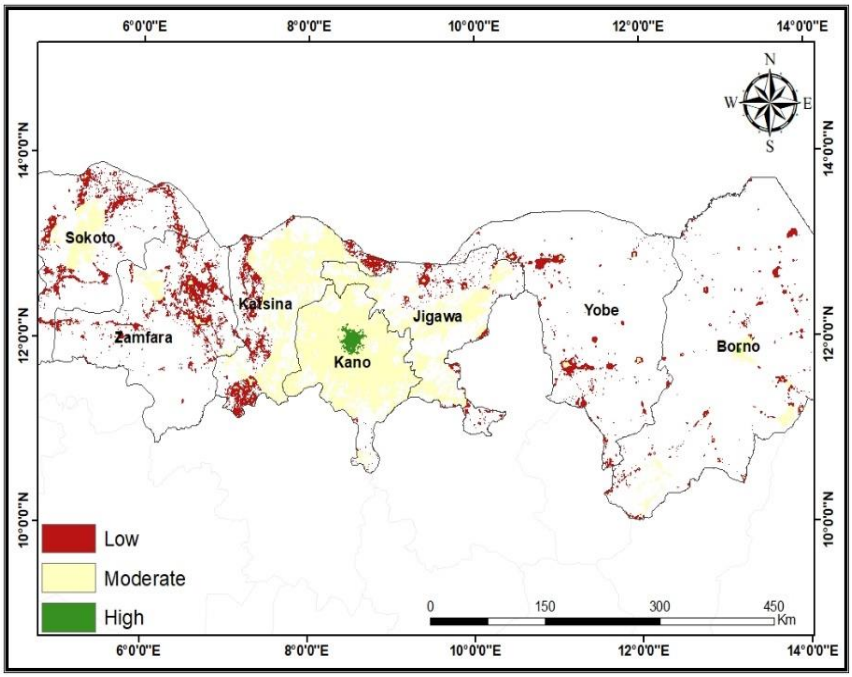
Figure 7: Physical Vulnerability to Hazard



Source: Author's Computation (2025)

When exposure and vulnerability layers are integrated using the weighted risk model, the most fragile areas (Disaster Risk Hotspots) emerge clearly in Jigawa, Kano, Katsina, and Sokoto (Figure 8). These states combine high exposure of populations and livelihoods with systemic socio-economic weakness. Importantly, the analysis shows that disaster risks are not simply a reflection of hazard intensity but are strongly shaped by poverty, infrastructure deficits, and livelihood dependence. A critical insight is that areas of moderate hazard intensity can still record very high disaster risk when socio-economic vulnerability is high. For example, major parts of Kano show only moderate hazard susceptibility, yet poor infrastructure and limited access to healthcare result in significant fragility. This finding supports the argument that disaster risk reduction (DRR) strategies must be reoriented from hazard-focused interventions to approaches that also address vulnerability.

Figure 8: General Exposure and Vulnerability to Hazard



Source: Author's Computation (2025)

An important insight from this study is that areas of moderate hazard intensity can still record very high disaster risk when socio-economic vulnerability is high. For example, major parts of Kano show only moderate hazard susceptibility, yet poor infrastructure and limited access to healthcare result in significant fragility (Shuaibu et al., 2022). This finding supports the argument that disaster risk reduction (DRR) strategies must be reoriented from hazard-focused interventions to approaches that also address vulnerability. Without tackling poverty, infrastructure deficits, and weak social protection, even modest hazards will continue to generate major humanitarian impacts.

Conclusion

This study successfully investigated socio-economic vulnerability and exposure to multiple hazards within Nigeria's Sahelian corridor using a multi-dimensional GIS-based approach. The conclusion aligns with the objectives as follows:

(i) Socio-Economic Vulnerability: The research generated a socio-economic vulnerability map that clearly identifies the most fragile states in the region. Kano, Sokoto, and Jigawa were found to exhibit the highest levels of systemic socio-economic vulnerability, primarily driven by pervasive poverty, heavy reliance on rain-fed agriculture, and inadequate infrastructure. Furthermore, urban centers like Maiduguri and Kano showed increased physical vulnerability due to high-density, unplanned urbanization.

(ii) Exposure Assessment: The analysis revealed significant levels of exposure across the study area. A substantial population (estimated at over 9 million people) and significant agricultural land (e.g., 38% of cultivated land in Kano) are situated within multi-hazard-prone zones, directly threatening food security and livelihoods.

(iii) Integrated Disaster Risk Hotspots: The integration of vulnerability and exposure layers showed that disaster risk is not solely a function of hazard intensity, but is significantly influenced by underlying socio-economic fragility. A crucial insight is that areas of moderate hazard susceptibility can still lead to catastrophic disaster consequences when socio-economic vulnerability is pronounced. This underscores the necessity for Disaster Risk Reduction (DRR) strategies that reorient from a purely hazard-centric focus to one that prioritizes addressing the socio-economic needs of affected populations.

To mitigate disaster risk in Nigeria's Sahelian corridor, it is essential to address the underlying socio-economic determinants of vulnerability alongside hazard management efforts. Poverty alleviation and the diversification of livelihoods are vital to reduce household reliance on climate-sensitive agricultural practices, which currently exacerbate economic instability in states such as Jigawa, Yobe, and Zamfara. The expansion of social protection initiatives and the promotion of alternative income-generating activities are critical to enhancing community resilience and mitigating the cyclical impacts of droughts, floods, and land degradation. Additionally, substantial investment in resilient infrastructure is urgently required. Enhancing the quality of housing in informal settlements, particularly within urban centres like Maiduguri and Sokoto, will diminish physical vulnerability, while reinforcing the resilience of roads, educational facilities, and healthcare services will help safeguard vital resources during hazard events. Enforcement of land-use and urban planning regulations is necessary to deter settlement expansion into flood-prone and erosion-sensitive areas. Providing safe relocation options for communities at high risk will alleviate displacement pressures and minimize long-term disaster-related losses.

Policy frameworks designed for disaster risk reduction should integrate socio-economic vulnerability mapping to ensure that interventions target the most fragile populations effectively. Incorporating vulnerability indices into national and state-level planning will facilitate equitable resource allocation, enhance preparedness, and improve early warning systems. Given that desertification and drought conditions in the Sahel transcend national boundaries, Nigeria should prioritize strengthening cross-border cooperation with neighboring nations such as Niger and Chad. Initiatives such as the Great Green Wall offer valuable

opportunities for coordinated action focused on land restoration and livelihood security.

Lastly, disaster risk reduction initiatives must be rooted in community-based resilience-building efforts. Local communities ought to be empowered through awareness programs, training opportunities, and access to early warning information, enabling them to adopt proactive measures in response to hazards. Supporting grassroots adaptation strategies, which include small-scale irrigation, soil conservation practices, and reforestation, presents cost-effective methods for bolstering local capacity. Collectively, these strategies highlight the dual approach required to reduce disaster risk in Northern Nigeria: addressing the socio-economic vulnerabilities that render communities fragile while simultaneously investing in resilient infrastructure and sustainable environmental management.

References

Audu, I. A. & Adie, L. A. (2018). Desertification in northern Nigeria: Causes and consequences. *The Environmental Studies*, 1(2), 20-37.

Awal, M. A. & Awal, M. A. (2015). Vulnerability to disaster: Pressure and Release model for climate change hazards in Bangladesh. *International Journal of Environmental Monitoring and Protection*, 2(2), 15-21. http://www.openscienceonline.com/journal/ijemp

Chude, V., Ezendu, C. O, Ugadu, M. & Adiaha, M. (2020). A review of the menace of soil erosion in Nigeria with specific reference to Southeastern States. *Colloquia Series*, 44(June), 405-414. https://doi.org/10.36265/colsssn.2020.4455

Daniel, F., Gbuchie, M., Emeruwa, V., Ike, W., Udam, N. & Torubiri, A. (2023). Nigeria's flood disaster unpreparedness: Impacts on health and society. *Cross River Journal of Medicine*, 2(2), 12. https://doi.org/10.5455/crjmed.162000

Delves, J., Renner, K., Campalani, P., Piñón, J., Schneiderbauer, S., Steger, S., Moreno, M., Oterino, M. B. B., Perez, E. & Pittore, M. (2025). Comprehensive multi-hazard risk assessment in data-scarce regions. A study focused on Burundi. https://egusphere.copernicus.org/preprints/2025/egusphere-2024-3445/

Eborka, F. N. (2024). Desertification in northern Nigeria: A study on the effect of desertification on yobe state. *Wukari International Studies*, 8(6), 254-259.

Ibrahim, E. S., Ahmed, B., Arodudu, O. T., Abubakar, J. B., Dang, B. A., Mahmoud, M. I., Shaba, H. A. & Shamaki, S. B. (2022). Desertification in the Sahel region: A Product of climate change or human activities? A case of desert encroachment monitoring in North-Eastern Nigeria using remote sensing techniques. *Geographies*, 2(2), 204-226. https://doi.org/10.3390/geographies2020015

Ibrahim, M., Huo, A., Ullah, W., Ullah, S. & Xuantao, Z. (2025). An integrated approach to flood risk assessment using multi-criteria decision analysis and geographic information system. A case study from a flood-prone region of Pakistan. *Frontiers in Environmental Science*, 12(January), 1-16. https://doi.org/10.3389/fenvs.2024.1476761

Mfon, I. E., Oguike, M. C., Eteng, S. U. & Etim, N. M. (2022). Causes and effects of flooding in Nigeria: A review. *East Asian Journal of Multidisciplinary Research*, 1(9), 1777-1792. https://doi.org/10.55927/eajmr.v1i9.1261

Nalmpant-Sarikaki, D. M., Theocharis, A. I., Koukouzas, N. C. & Zevgolis, I. E. (2025). A Framework for effective multi-hazard risk assessment in post-mining areas. *Safety*, 11(1), 1-23. https://doi.org/10.3390/safety11010018

Nduji, N. N., Madu, C. N., Okafor, C. C. & Ezeoha, M. U. (2023). A geo-hazard risk assessment technique for analyzing impacts of surface subsidence within Onyeama Mine, South East Nigeria. *Land*, 12(3). https://doi.org/10.3390/land12030575

Noor, A. M., Kibuchi, E., Mitto, B., Coulibaly, D., Doumbo, O. K., Snow, R. W. (2015). Sub-national targeting of seasonal malaria chemoprevention in the Sahelian countries of the Nouakchott initiative. PLoS ONE, 10(8): e0136919. doi:10.1371/journal. pone.0136919

Ojoye, S., Ifabiyi, I. P. & Ibrahim, I. (2020). Analysis of Hydro-meteorological variables and runoff characteristics in the Sudano-Sahelian ecological zone of Nigeria. *International Journal of Environment and Climate Change*, 331-341. https://doi.org/10.9734/ijecc/2020/v10i1230309

Peter, O. (2006). An Assessment of the socio economic impacts of soil erosion in South-Eastern Nigeria. *October*, 1-15.

Peters, K., Progida, B., Belval, F., Rossi, L., Royer, L., Oxley, M., Windey, C., Borodyn, O. & Holloway, K. (2022). *Disaster risk reduction in West Africa and the Sahelian Region: A review of progress*. https://www.undp.org/africa/waca/publications/disaster-risk-reduction-west-africa-and-sahelian-region-review-progress

Shawky, M. & Hassan, Q. K. (2023). Geospatial modeling based-multi-criteria decision-making for flash flood susceptibility zonation in an arid area. *Remote Sensing*, 15(10). https://doi.org/10.3390/rs15102561

Shuaibu, A., Hounkpè, J., Bossa, Y. A. & Kalin, R. M. (2022). Flood risk assessment and mapping in the Hadejia river basin, Nigeria, Using hydro-geomorphic approach and multi-criterion decision-making method. *Water (Switzerland)*, 14(22). https://doi.org/10.3390/w14223709

Tofu, D. A. (2024). Evaluating the impacts of climate-induced east Africa's recent disastrous drought on the pastoral livelihoods. *Scientific African*, 24, e02219. https://doi.org/10.1016/j.sciaf.2024.e02219

Tomalka, J., Birner, J., Mar Dieye, A., Gleixner, S., Harper, A., Hauf, Y., Hippe, F., Jansen, L., Lange, S., Laudien, R., Rheinbay, J., Vinke, K., von Loeben, S., Wesch, S., Zvolsky, A. & Gernott, C. (2021). Climate risk profile: Sahel. *United Nations High Commissioner for Refugees*, 1-20. https://www.unhcr.org/61a49df44.pdf

Van Westen, C. J. (2013). Remote sensing and GIS for natural hazards assessment and disaster risk management. *Treatise on Geomorphology: Volume*, 1-14(2004), 259-298. https://doi.org/10.1016/B978-0-12-374739-6.00051-8

Zakaria, A., Umar, N. K., Mohammad, L. A. & Yusuf, R. O. (2022). Flood risks factors and their prevalence in some selected local government areas of Jigawa State, Nigeria. *Dutse Journal of Pure and Applied Sciences*, 7(4b), 68-77. https://doi.org/10.4314/dujopas.v7i4b.8