



Assessing the Impact of Land Administration on Flood Risk Management: A Review

Olatunde, F.O.^{1*}, Olatunde, M.B.¹, Eshiemokhai, I.T.¹, Okpugwo, E.T.¹

¹Department of Surveying and Geoinformatics, Auchi Polytechnic, Auchi, Nigeria
Corresponding author: olatundefaith511@gmail.com

Abstract Building resilient communities and protecting human habitations from the damaging effects of natural and man-made disasters require effective flood risk management. The way that flood risk management strategies and results are shaped is largely dependent on effective land administration. This review offers a thorough analysis of how land administration affects flood risk management, looking at how it affects resilience overall as well as preparedness, response, and recovery from floods. Land use planning, land registration, regularisation of land tenure, and spatial data management are just a few of the many tasks that fall under the broad category of land administration. This review examines best practices and successful case studies where efficient land management has improved flood risk management. Additionally, it points out weaknesses and makes recommendations for possible improvements to the way land administration is incorporated into flood risk reduction plans. In summary, there is no denying the influence of land administration on flood risk management. The enhancement of flood preparedness, response, recovery, and community resilience is contingent upon the proper management of land resources and the acquisition of precise spatial data. Policymakers, land administrators, and disaster management authorities must work closely together to reduce flood risk in a sustainable manner while utilising land administration's full potential to create safer and more resilient communities.

Keywords Land, Management, Flood risk, Administration, Resilience

1. Introduction

Since efficient land use and management can have a major impact on a region's resilience and vulnerability to natural disasters, land administration is essential to the management of flood risk. Reducing vulnerability and increasing resilience to natural disasters can be achieved through effective land administration. Reducing flood risk requires careful land use planning. It entails locating hazardous locations and avoiding or restricting construction there. Hazard zone delineation, building code establishment, and zoning regulation enforcement are made possible by land administration systems. This guarantees that infrastructure is constructed to withstand possible disasters and helps prevent development in high-risk areas (UN-Habitat, 2009). It is crucial to evaluate how land policies, rules, and practices affect a community's capacity to anticipate, respond to, and recover from floods in order to comprehend how they affect flood risk management. This analysis explores the complex relationship between flood risk management and land administration by delving into previous studies and literature. In addition, studying case studies and experiences from various nations offers insightful information about how land administration functions in flood risk reduction. The Asian Disaster Preparedness Centre (ADPC) has conducted research that provides empirical evidence of the ways in which land administration techniques, like zoning and mapping, have reduced the effects of floods, landslides, and other disasters in areas that are susceptible to them (ADPC, 2020).



The significance of appropriate land administration in disaster risk reduction (DRR) initiatives has been emphasised by a number of studies. Research conducted by UN-Habitat, which is the United Nations Human Settlements Programme, highlights the importance of secure land tenure systems in fostering resilience and improving community adaptation during disasters (UN-Habitat, 2019). Comparably, studies by the World Bank have shown that effective land governance can lessen the effects of natural disasters by improving disaster preparedness and response systems through streamlined land administration procedures (World Bank, 2017). Property rights are essential for disaster risk management, particularly in informal settlements, according to Durand-Lasserve (2019). Residents are more inclined to make long-term preparations for disasters and invest in resilient infrastructure when their land and property are recognised legally. Land administration systems can facilitate access to credit for risk-reducing measures, help formalise tenure, and lessen land tenure insecurity. Effective early warning systems, response planning, and disaster risk assessment depend on current, accurate geospatial data. Spatial data, including cadastral records and land use maps, are managed by land administration systems and form the basis of disaster risk management initiatives (Asian Development Bank, 2017).

After a disaster, land management is essential to the rehabilitation and resettlement of affected areas. Relocating displaced populations to safer areas and providing them with infrastructure and services can be made easier with the help of efficient land administration systems, which can also make it easier to identify and allocate suitable land (UNESCAP, 2013). Additionally, in 2018, Payne and Durand-Lasserve expressed the opinion that land administration, by means of land-based financing mechanisms, can also assist disaster risk management. One way to finance risk reduction initiatives and construct resilient infrastructure is by designating funds from land transactions, property taxes, or land value capture. Understanding and reducing flood risks requires effective land use planning, precise cadastral mapping, and adequate land record management. Land administration can assist in lowering exposure to possible flood disasters by identifying hazard-prone areas and guaranteeing safe land-use practices. The availability of precise and current land data is essential for planning and responding to disasters. Land administration supports evacuation planning, post-disaster recovery, and disaster response coordination by enabling prompt and well-informed decision-making. Additionally, it helps to minimise the socioeconomic effects of flood disasters by assisting in the effective distribution of aid and the efficient allocation of resources.

Moreover, land administration contributes significantly to the development of community resilience. It encourages a sense of ownership and accountability among inhabitants by addressing concerns of land tenure security and rights. In turn, this strengthens community bonds and gives people the confidence to finance flood risk mitigation strategies, like constructing sturdy infrastructure and implementing sustainable land-use techniques. However, combining land administration with flood risk management comes with a number of restrictions and challenges. The efficient use of land information for flood disaster planning and response is hampered by informal settlements, undocumented land rights, inadequate data sharing, and a lack of coordination among pertinent authorities.

1.1 Statement of the Problem

Through the Nigerian Meteorological Agency (NIMET, 2023) and the Nigerian Hydrological Services Agency (NIHSA, 2023), the Federal Government of Nigeria had issued warnings about the devastating floods that would occur in certain states, particularly those that are on the banks of the River Niger, such as Edo State. Usually, people in rural communities ignore these warnings because they do not know what to do or have anywhere to go. The National Emergency Management Agency (NEMA) typically takes proactive steps to assist affected areas through the zonal offices. They provide for their basic needs and aid in the residents' evacuation from the affected area. According to the Nkwunonwo (2016) report, the July 2012 floods in Nigeria impacted 32 states, including Edo. Farmlands were destroyed and over 2 million people were displaced, causing a \$16.9 billion economic loss. The yearly flooding that affects communities such as Udaba, Anegbette, Osomegbe, and Agbabu-Ekperi causes hardship for the locals. Many of the unplanned and underdeveloped communities in Edo State are a result of natural disasters. These communities' lack of social life is a factor in their poverty.

This ultimately results in unofficial settlements, where residents reside in hazardous regions and dangerous settings where all kinds of vice are common. In Edo State, where nearly 90% of the land is used for agriculture,



the land provides the majority of both employment and income. The most susceptible populations to the effects of flooding in their communities are typically farmers. They often make their unofficial home on riverbanks and other places vulnerable to flooding. The yearly disaster typically has an impact on their yearly output, making it nearly hard for the farmers to compete with those in areas free from disasters. When accurate warnings are issued on time, actions are taken to save lives, minimise losses, expedite response times, and lessen human suffering. Improved dynamic models, expanded knowledge of disaster causes, and the use of sensors to evaluate critical factors can all lead to more accurate warning systems using space-derived information, such as tenure security and land administration data. In Edo State, various agencies arrange and are ready to lessen flood disasters of this nature. Although communities are also involved in providing palliative measures in the event of any kind of disaster, the agencies operate at the state and local government levels. The state of affairs is unchanged in spite of the communities' and agencies' best efforts. Relocation and relief supplies are yearly necessities for these communities to prevent food shortages and disease outbreaks. There have been thousands of people displaced from their ancestral homes and farmlands in the riverine communities as a result of the extremely destructive flood disaster. In Anegbette, farm products mostly rice, cassava, yams, pepper, tomatoes, and other items have been lost to flooding, and hundreds of homes have been submerged.

2. Overview of flood routing

The relationship between disaster risk reduction and secure land tenure is examined in the UN-Habitat (2019) report. It looks at how land administration procedures, like property rights and land tenure schemes, support a community's ability to withstand natural disasters. Presenting case studies and best practices from different regions, the report offers insightful information about the significance of efficient land administration in disaster risk reduction.

According to Komolafe *et al.* (2015), more study is needed to determine how floods affect Nigerian environment and public health. Additionally, efficient flood models that take into account all hydrological processes are required for more accurate flood prediction and risk mapping. One aspect of flood risk that Ilesanmi (2014) empirically examined in his research was Kosofe LGA's susceptibility to flooding. Using a wide range of data and a multi-scale set of indicators, he based his analysis and assessment of vulnerability. He described the process of creating vulnerability maps for the twenty-one administrative wards of Kosofe LGA in Lagos State, Nigeria, using information from household surveys, GIS, census, and remote sensing data. Using GIS and remote sensing technologies, Raufu *et al.* (2023) created a flood vulnerability map of the Akure South metropolis. To map areas at risk of flooding, field and GIS data were combined. The different weights of the factors that contribute to floods in the study area were ascertained using the pairwise comparison method. The flood vulnerability and hazard maps were created using an analytical hierarchical process and a weighted linear combination. The software ArcGIS Pro 2.7.3 was utilised for the collection, processing, and display of spatial and attribute data. Twar (2020) used digital elevation modelling and buffer creation to map areas that are prone to flooding (relief map). ArcGIS 10.1 GIS software and image processing were employed. The Shuttle Radar Topography Mission (SRTM) at a 90-meter resolution and satellite imagery were used in the study. Its main objectives were to identify flood-prone areas and estimate the vulnerable land uses (farmlands and buildings) within those areas. The vulnerable areas most likely to be impacted in the event of a flood hazard were predicted using the Geographic Information System (GIS) and the findings of the flood analysis.

Twar (2020) mapped areas prone to flooding and estimated the vulnerable land uses under severe threat to flooding, and recommendations were made. Raufu *et al.* (2023) produced the flood vulnerability map as an effective tool for analysis and decision-making on floods. Furthermore, Ouma and Tateishi (2014) did not model or predict the model design for resilience and flood mitigation; instead, they only modelled and predicted the extent of flood risk areas. There are still gaps in the literature when it comes to the integration of disaster risk management and land administration. Previous studies and publications (Unger *et al.*, 2020; Sayhid, 2011; Su *et al.*, 2021; and Sutanta *et al.*, 2009) concentrated on earthquakes as the disaster in question. Even at the global level, models and prototypes have been created using a variety of techniques, including GIS, machine learning, computer programmes, and algorithms (Unger *et al.*, 2019; Umar and Grey, 2023). However, agencies and departments of land and disaster have struggled to apply, use, and access these models and prototypes, so this



research focuses on these issues. There are still gaps in the literature when it comes to the integration of disaster risk management and land administration. They relied on the efforts of experts and pioneers in the fields of land administration and disaster risk management, with an emphasis on temporal dimensions (Mfon *et al.*, 2022; Unger *et al.*, 2021). They based their studies on both theoretical (journals and papers) and practical (case study) areas. However, this research intends to focus on flooding as a natural disaster ravaging the study area. The research approach of Ilesanmi's (2014) thesis was on an aggregate number of selected datasets with physical, social, economic, and ecological variables and analyses of GIS data layers to depict different ranges of percentages of 'flood vulnerability' (low-high vulnerability) and not on modelling for creating resilience and mitigation.

Only a small number of researchers have explored this field in Nigeria, and those that have not yet established a connection between the fields of disaster risk management and land administration. These research gaps point to areas that, with more study, could help us comprehend how land administration affects disaster risk reduction in Nigeria's Edo State. Policymakers, practitioners, and researchers can create more effective strategies and policies for lowering the risk of disasters and promoting sustainable land administration practices by conducting research in these areas.

2.1 Focus of the Research

The impact of land administration on flood risk management is a critical aspect that requires in-depth exploration and analysis. Despite its importance, there remains a gap in comprehensive research and understanding of how land administration practices, policies, and regulations directly influence a community's vulnerability and resilience to flood disasters. Understanding the intricacies of land-use planning, property rights, land tenure systems, and access to information is crucial in evaluating their role in flood risk reduction. Identifying the obstacles and constraints faced by policymakers, land administrators, and communities is essential to developing actionable solutions for improvement. Evaluating existing coordination mechanisms and proposing innovative approaches to foster collaboration is vital for building more resilient communities. Understanding the repercussions of poor land governance can highlight the urgency of implementing effective measures. By addressing these fundamental questions, this research aims to provide a comprehensive and evidence-based understanding of the relationship between land administration and flood risk management. The findings will offer valuable insights to policymakers, urban planners, disaster management practitioners, and researchers to strengthen disaster resilience and reduce the impact of flooding on communities.

3. Pioneers in the Field of Disaster Risk Management and Land Administration Integration

The following leaders in the field of evaluating how land administration affects disaster risk management are highlighted with special attention to their contributions:

Information management are Voigt and Rajabifard (2015). The significance of precise land data and mapping for disaster preparedness and response was emphasised in their research on the integration of land administration and disaster risk management. Professors and researchers with expertise in cadastral systems and land administration are Williamson and Rajabifard (2013). By highlighting the importance of accurate land information for successful disaster risk reduction, they have significantly advanced our understanding of the relationship between land administration and disaster risk management. Prominent figures in the domains of geographic information management and land administration are Enemark *et al.* (2014). They put a lot of effort into comprehending the function of land administration in disaster risk reduction and promoted the integration of land administration with these strategies. Land administration consultants McLaren and Rajabifard (2017) are specialists in geospatial analysis. Using geospatial technology and land information systems, they have been involved in a number of projects and research initiatives that evaluate the effect of land administration on disaster risk management. Rajabifard teaches and conducts research in the fields of land administration and geographic science. By highlighting the importance of spatial data infrastructure and geospatial information in disaster risk reduction, he has made substantial contributions to our understanding of the relationship between land administration and disaster risk management (Rajabifard *et al.*, 2014). According to Unger *et al.* (2018), knowledge of land tenure is essential for disaster response, mitigation, and recovery. They noticed that when it comes to risk management, the government regularly ignores vulnerable populations. A design approach was



used to develop the model, which began with an adaptation of the global Land Administration Domain Model (LADM) standard. Fit-for-purpose approaches and interventions in land administration (FFP LA) were examined by Unger *et al.* (2019) as a potential tool for enhancing community resilience in Nepal during the earthquake recovery process. Four communities impacted by the earthquake in April 2015 in Nepal's Dolakha district were taken into consideration. Unger *et al.* (2019b) provided evidence of the 2030 Agenda's and its SDGs' compatibility with LADM-based models. Their study's goal is to integrate current models and assess their potential rather than developing a brand-new data model. According to Unger *et al.* (2019), knowledge of land tenure is essential for disaster response, mitigation, and recovery. They noticed that when it comes to risk management, the government regularly ignores vulnerable populations. As of right now, there is no specialised tool available to support the recording of all land tenure relationships between people and land for disaster risk management. According to Unger *et al.* (2021), most people won't have secure land tenure by 2030 because individual land titling is both implicit in and deeply ingrained in the Sustainable Development Goals (SDGs) of the 2030 Agenda for Sustainable Development.

Unger *et al.* (2017) developed a unified conceptual framework that identified the disaster risk drivers (vulnerability, exposure, and hazard) and the global change forces (people, land, and disaster). The two domains were linked together (WB and GFDRR, 2012). Unger *et al.* (2020) found that over the past ten years, there has been a strong argument that disaster risk management (DRM) and land administration must be integrated due to the rise in large-scale natural disasters and the expansion of land administration policies, practices, and personnel. Their study is focused on bridging land administration and disaster risk management for equity and resilience. The paper identified important obstacles, opportunities, and paths for implementing the model. These innovators have made a substantial contribution to our understanding of how geospatial data and land administration techniques can be critical components of disaster risk reduction. Through their advocacy and research, the gap between land administration and disaster management practices has been filled, resulting in more integrated and successful approaches to sustainable development and disaster resilience.

4. Basic Knowledge in Assessing the Impact of Land Administration on Flood Risk Management

In order to evaluate the effect of land administration on flood risk management, one must comprehend the ways in which land policies, practices, and regulations affect the susceptibility and adaptability of a community to natural disasters. To learn more about the topic, take a look at this basic knowledge:

Land Use Planning and Zoning: Appropriate land administration requires both land use planning and zoning. Communities are exposed to different hazards depending on where and how development occurs. The risk of natural disasters like floods, landslides, and earthquakes can be decreased by putting in place zoning laws and land use plans that are resistant to hazards (UNDRR, 2017). **Secure Land Tenure and Property Rights:** By encouraging long-term investment and providing incentives for sustainable land management techniques, secure land tenure gives people and communities legal rights to their land, which can improve resilience. On the other hand, unstable housing can make people more vulnerable and make it more difficult to prepare for and recover from disasters (UN-Habitat, 2019). Disaster risk management initiatives are supported by spatial data infrastructure (SDI), which makes geospatial data collection, management, and sharing easier. Authorities can evaluate risks, make well-informed decisions, and create effective disaster response plans with the help of timely and accurate geospatial information (Rajabifard *et al.*, 2003). **Community Involvement and Local Knowledge:** It is essential to include local communities in land administration and disaster risk reduction procedures. Local expertise can contribute to more contextually appropriate and successful disaster risk reduction strategies by offering insightful information about past disaster patterns and adaptation strategies (Wisner *et al.*, 2004). **Multi-Stakeholder Collaboration:** In order to effectively manage the risk of disaster, cooperation between a range of stakeholders is needed, including local communities, government agencies, businesses, and civil society organisations. According to the Australian Government Department of Home Affairs in 2019, collaboration between these organisations is necessary to incorporate land administration into disaster risk management frameworks. Through an examination of the aforementioned fundamental concepts and the references provided, scholars and professionals can acquire a deeper understanding of the intricacies involved in evaluating the influence of land administration on flood risk management. Evidence-based policies



and strategies that aim to improve community resilience and flood preparedness can be informed by these insights.

5. Land Administration and Flood Risk Management's Relationship

The theoretical workflow of the research is based on the concepts of land administration and flood risk management that overlap, as illustrated in Figure 1. There is a strong correlation and mutual influence between the policies of land administration and flood risk management. Governments can reduce vulnerabilities, increase resilience, and promote sustainable land development practices that are more resistant to flood disasters in the future by integrating land administration and flood risk management policies.

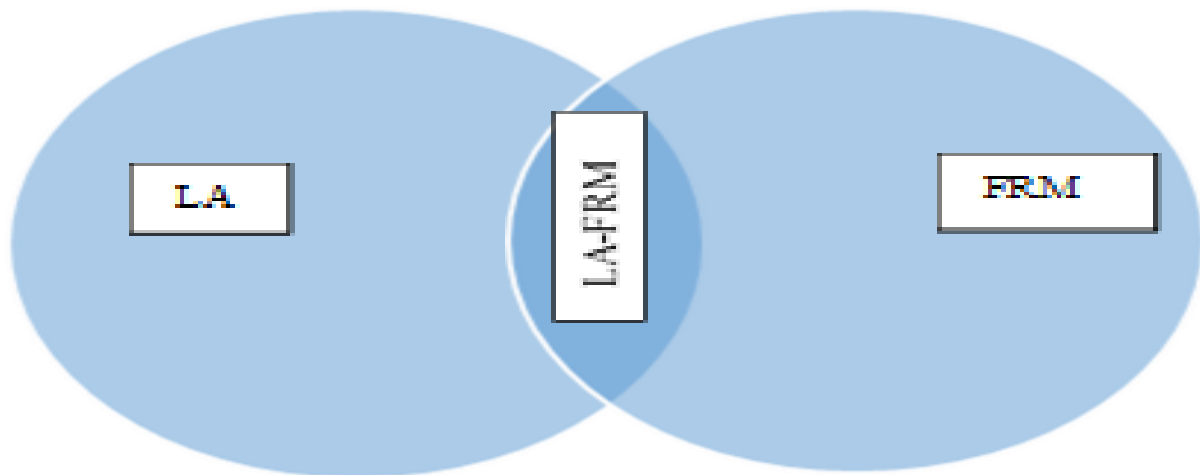


Figure 1: Research Setting of LA-FRM

Effective management of natural disasters requires the integration of land administration and flood risk management. Improved preparedness, response, and recovery are made easier by this integration, which boosts community resilience and lowers vulnerabilities.

6. Conclusion

The implementation of land use planning strategies that take potential risks and natural hazards into account is made possible by the integration of flood risk management and land administration. Plans for land use that is resistant to hazards can reduce exposure to high-risk areas and lessen the effects of flooding, thereby enhancing overall resilience to disasters. Accurate and timely geospatial data is essential for effective flood risk management. Decision-makers can make educated decisions during disaster events by having access to vital information such as property records, hazard assessments, and land-use maps when land administration systems are integrated with geospatial data infrastructure. Property rights and a secure land tenure are crucial for communities affected by floods and other disasters. By guaranteeing that those impacted by a disaster have legal rights to their land, integrating land administration with flood risk management initiatives can help resolve land disputes, ease post-disaster reconstruction, and promote recovery efforts. Interacting with local communities is necessary to integrate land administration with flood risk management. A deeper comprehension of regional contexts, customary knowledge, and adaptation techniques is fostered by inclusive and community-centric approaches, which results in more contextually relevant and successful flood disaster risk reduction plans.

6.1 Recommendations

Therefore, in order to improve cooperation and coordination, it is advised that government agencies, businesses, civil society organisations, and local communities be brought together through integrated land administration and flood risk management approaches. Together, we can fortify the framework for disaster management and guarantee a more thorough reaction to flood-related incidents. By combining land administration with flood risk management, one can maximise resources, minimise redundant work, and enable communities to become more



resilient and prepared for natural disasters. By ensuring that land-related factors are effectively incorporated into disaster risk management plans, flood risk management is made more effective and efficient.

References

- [1]. Asian Development Bank. (2017). Geospatial Information for Improved Disaster Risk Management. Retrieved from <https://www.adb.org/sites/default/files/publication/354476/geospatial-information-disaster-risk-management.pdf>
- [2]. Asian Disaster Preparedness Center (ADPC). (2020). Land Administration and Disaster Risk Reduction. Asian Disaster Preparedness Center.
- [3]. Badenhorst, J., & Sutherland, C. (2018). The role of land administration in disaster risk management. *International Journal of Disaster Risk Reduction*, 28, 862-871.
- [4]. Cirella, G. T., And Iyalomhe F. O. (2018): "Flooding Conceptual Review: Sustainability focalized Best Practices in Nigeria." *Applied Sciences* 8 (9): 1558. doi: 10.3390/app8091558. (Accessed April 10th, 2023)
- [5]. Cook, J., & Bakker, K. (2012). Water security: Debating an emerging paradigm. *Global Environmental Change*, 22(1), 94-102.
- [6]. Durand-Lasserve, A. (2019). *Secure Land Tenure for All*. Washington, D.C.: World Bank. Retrieved from <https://openknowledge.worldbank.org/handle/10986/31337>
- [7]. Enemark, S., McLaren, R. A., & Lemmen, C. (Eds.). (2014). *Fit-For-Purpose Land Administration*. FIG Publication No. 60.
- [8]. Ilesanmi, O.T (2014): *Assessment of Urban Vulnerability Towards Flood: A Case Study of Kosofe LGA, Lagos State*. M.Sc. Geography (Remote Sensing), Department of Geography, University of Lagos.
- [9]. Isere V.O and Imonikhe J.S (2020): *Socio-Economic Impact of Flooding on Edo State: Case Study of Anegbette, Osomegbe, Udaba Communities and Environs*. *Journal of Economics and Sustainable Development*. ISSN 2222-1700 (Paper) ISSN 2222-2855 (online). Vol. 11 No. 22. www.iiste.org.
- [10]. Komolafe, A.A; Adegboyega, S.A and Akinluyi, F.O (2015): *A Review of Flood Risk Analysis in Nigeria*. *American Journal of Environmental Sciences*. 11 (3): 157-166. Doi: 10.3844/ajessp.2015.157.166
- [11]. McLaren, R. A., & Rajabifard, A. (Eds.). (2017). *Land Administration for Sustainable Development*. Esri Press. Mfon I.E.; Oguike, M.C.; Eteng, S.U and Etim, N.M (2022): *Causes and Effects of Flooding in Nigeria: A Review*. *East Asian Journal of Multidisciplinary Research (EAJMR)* Vol. 1, No. 9, 2022: 1777-1792.
- [12]. News Agency of Nigeria (2018): *more than 35 communities in the esan south east l.g.a of edo state were sackedby flooding*. Accessed 11/3/23.
- [13]. NIHSA, (2023): *The Nigerian Hydrological Services Agency News*. Accessed 12/3/23
- [14]. NiMet, (2023): *The Nigerian Meteorological Agency News*. Accessed 12/3/23
- [15]. Nkeki, F.N.; Henah, P.J.; Ojeh, V.N. (2013): *Geospatial Techniques for the Assessment and Analysis of Flood Risk along the Niger-Benue Basin in Nigeria*. *J. Geogr. Inf. Syst.*, 5, 123–135.
- [16]. Nkwunonwo, U., W. Malcolm, and B. Brian. (2015): "Flooding and Flood Risk Reduction in Nigeria: Cardinal Gaps." *Journal of Geography & Natural Disasters* 5: 136.
- [17]. Nkwunonwo, U.C. (2016). *A review of flooding and flood risk reduction in Nigeria*. *Global Journal of Human Social Science, Geography, Geo-science, Environmental Science and Disaster Management*. 16 issue 2 version 1.0.
- [18]. Payne, G., & Durand-Lasserve, A. (2018). *Land Tenure Regularization in the Context of Urban Informal Settlements: A Contribution to the Global Land Tool Network*. Rome: Food and Agriculture Organization of the United Nations. Retrieved from <http://www.fao.org/3/i8621en/I8621EN.pdf>
- [19]. Rajabifard, A., Williamson, I. P., & Feeney, M. E. (Eds.). (2014). *Spatially Enabled Society*. CRC Press.
- [20]. Rajabifard, A., Williamson, I. P., & Binns, A. (2003). *Integrating Land Information Infrastructures for E-Government*. *Journal of Land Use Policy*, 20(2), 157-167.
- [21]. Raufu, I.O. , Mukaila, I., Olaniyan, K., and Awodele, Z. (2023): *Application of Remote Sensing and Geographical Information System (GIS) in Flood Vulnerability Mapping: A Scenario of Akure South, Nigeria*, *International Journal of Environmental and Geoinformatics (IJECEO)*, 10(1):090-099 doi.10.30897/ijegeo. 1073697
- [22]. Syahid H.L (2011): *Land Administration And Disaster Risk Management: Case Of Earthquake In Indonesia*. A thesis submitted to the Faculty of Geo-Information Science and Earth Observation of the



- University of Twente in partial fulfillment of the requirements for the degree of Master of Science in Geo-information Science and Earth Observation. Enschede, The Netherlands.
- [23]. Twar, M.M. (2020): A GIS-Based Flood Vulnerability Assessment. In part of Ibadan Metropolis, Nigeria. <https://www.researchgate.net/3415>.
- [24]. Unger, E.M (2019). Responsible Land Administration In Disaster Risk Management. Approaches For Modelling, Integrated Governance And Policy Transfer Of People, Land And Disasters. Being ITC Dissertation, University of Twente.
- [25]. Unger, E.M; Bennett, R.; Lemmen, C.; Zevenbergen, J.; Mitchell D and Dijkstra, P. (2020). Bridging Land Administration And Disaster Risk Management For Equity And Resilience. *Annual World Bank Conference on land and poverty, Washington DC. Institution for Equity and Resilience 16-20, March 2020*.
- [26]. Unger E.M, Chhatkuli, R.R, Antonio D, Lemmen C.H.J, Zevenbergen J.A, Bennett R., And Dijkstra P. (2019a). Creating Resilience To Natural Disasters Through Fit-Forpurpose Land Administration In Nepal. *Annual World Bank Conference on land and poverty, Washington DC. Catalyzing Innovation*.
- [27]. Unger, E.M; Bennett, R.; Lemmen, C.; Zevenbergen, J.; Dijkstra, P. and Zeeuw, K. (2019). LADM Based models for sustainable development. LA-DRM for disaster-prone areas and communities (an example for SDG 1 and SDG 13). 8th International FIG workshop on the Land administration domain model 1-3 October 2019, Kuala Lumpur, Malaysia.
- [28]. Unger, E.M., Zevenbergen, J., Bennett, R., & Lemmen, C. (2018). Application of LADM for disaster-prone areas and communities. *Land Use Policy*, 80(January), 118-126. <https://doi.org/10.1016/j.landusepol.2018.10.012>
- [29]. Unger, E. M., Zevenbergen, J., & Bennett, R. (2017). On the need for pro-poor land administration in disaster risk management. *Survey Review*, 49(357), 437-448.
- [30]. United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP). (2013). Land Administration and Management for Equitable and Sustainable Development. Retrieved from <https://www.unescap.org/sites/default/files/Land%20Administration%20and%20Management.pdf>
- [31]. UN-Habitat. (2019). Secure Land Tenure and Disaster Risk Reduction: Good practices and lessons learned. Retrieved from: <https://unhabitat.org/secure-land-tenure-and-disaster-risk-reduction-good-practices-and-lessons-learned>
- [32]. UN-Habitat. (2009). Planning for Risk: Land Use Planning for Disaster Risk Reduction. Retrieved 20/7/23 from <https://unhabitat.org/planning-for-risk-land-use-planning-for-disaster-risk-reduction>
- [33]. UN-Habitat. (2019). Secure Land Tenure and Disaster Risk Reduction: Good practices and lessons learned. United Nations Human Settlements Programme.
- [34]. United Nations Office for Disaster Risk Reduction (UNDRR). (2017). Words Into Action Guidelines: Land Use Planning for Disaster Resilient Communities. Retrieved from: <https://www.preventionweb.net/publications/view/55314>
- [35]. World Bank. (2017). Securing Land Tenure and Property Rights for Improved Disaster Resilience. World Bank Group.
- [36]. Wisner, B., Blaikie, P., Cannon, T., & Davis, I. (2004). At Risk: Natural Hazards, People's Vulnerability, and Disasters. Routledge.
- [37]. World Bank. (2017). Securing Land Tenure and Property Rights for Improved Disaster Resilience. World Bank Group.
- [38]. UN-Habitat. (2019). Secure Land Tenure and Disaster Risk Reduction: Good practices and lessons learned. United Nations Human Settlements Programme.
- [39]. Voigt, R. A., & Rajabifard, A. (2015). Integrating land administration and disaster management. *Land Use Policy*, 49, 535-545.
- [40]. Williamson, I. P., & Rajabifard, A. (2013). Spatially enabling land administration: The role of spatial information in land governance and development. GSDI Association Press.

