reviewed paper

An Analysis of the Role of Spatial Planning in Enhancing Rural Resilience to Flooding: A Case Study of South Africa

Takalani Mugada, Trynos Gumbo, Retsepile C. Kalaoane, Thembani Moyo

(Takalani Mugada, Department of Urban and Regional Planning, University of Johannesburg. Cnr Siemert & Beit Streets, Doornfontein, 0184 Johannesburg, South Africa, mugadatakalani1@gmail.com)
(Prof Trynos Gumbo, Department of Urban and Regional Planning, University of Johannesburg. Cnr Siemert & Beit Streets, Doornfontein, 0184 Johannesburg, South Africa, tgumbo@uj.ac.za)
(Retsepile V. Kalaoane, Department of Urban and Regional Planning, University of Johannesburg, Cnr Siemert & Beit Streets, Doornfontein, 0184, Johannesburg, South Africa, retseplik@uj.ac.za)
(Thembani Moyo, Department of Urban and Regional Planning, University of Johannesburg. Cnr Siemert & Beit Streets, Doornfontein, 0184 Johannesburg, South Africa, tmoyo@uj.ac.za)

DOI: 10.48494/REALCORP2026.1127

1 ABSTRACT

In developing countries, human settlements are increasingly becoming more vulnerable to high flood risks and damages, especially those who are situated near rivers, flood-prone areas, and at low elevations. Correspondingly, South Africa is one of the developing countries that often experience devastating impacts of climate-related disasters, such as significantly heavy rainfall-induced flooding. However, floods persist, repeatedly affecting the residents despite the existing mitigation measures such as spatial planning. In addressing these ongoing challenges, this paper aims to analyse the effectiveness of spatial planning in enhancing rural resilience to flooding in South African rural areas and identify opportunities for improvement. Using a mixed methods approach, the role of spatial planning in enhancing rural resilience to flooding is assessed in relation to spatial development and flood risk management of rural areas in South Africa. Findings highlight that spatial planning frameworks in rural areas often lack clear consideration of flood risks, resulting in increased vulnerability. Most rural areas are situated in areas that are vulnerable to flooding, highlighting the necessity for enhanced planning. Limited and poor infrastructure provision in rural areas also hinders rural resilience to flooding. This paper recommends the incorporation of flood risk management into spatial planning frameworks, enhancing green infrastructures, raising awareness among residents about flood risks, and promoting collaborative spatial planning. This paper emphasises the necessity for incorporating spatial planning and flood risk management in rural South Africa, contributing to more rural resilience and sustainable rural development.

Keywords: Flooding, Flood Risk Management, Rural Areas, Rural Resilience, Spatial Planning

2 INTRODUCTION

In developing countries, human settlements are more vulnerable to flood disasters due to the combined consequences of climate change, rapid land-use change, and socioeconomic vulnerabilities (Ananwa, 2023). In South Africa, rural communities located near rivers, low-lying areas, and flood-prone areas are particularly at risk, frequently sustaining repeated flood damage with limited ability to adapt and recover (Chakwizira et al., 2021). Worldwide, flood damages and risks are increasing as climate change increases the frequency and severity of heavy rainfall events, leaving pressure on both urban and rural communities (Raphela, 2025). In South Africa, rural human settlements are increasingly vulnerable to flooding due to inadequate infrastructure delivery, a lack of adaptability, and underfunded institutions (Ampofo et al., 2024). To address the increasing flood risks and damage, researchers and policymakers have devoted substantial focus to flood risk reduction and climate adaptation strategies, notably on governance arrangements and planning tools employed to manage development in areas vulnerable to flooding (Loschner, 2020). Among these planning tools, spatial planning is commonly known as a main mechanism for preparing for flood risk and shaping land use patterns in a way that minimises exposure and long-term vulnerability (Roosimagi, 2021). Spatial planning is a tool that can play a critical role in prevention and transformation in flood risk management through guiding settlements in areas that are feasible for residing, regulating land use, and incorporating environmental challenges into development decision-making (Kodag, 2022). Existing literature largely conceptualises spatial planning as a technical and physical intervention tool, mainly concentrating on spatial design measures such as buffer zones, flood-resistant building standards, and stormwater management systems (Meng, 2020). Although these approaches are essential for flood resilience, they tend to overlook the governance, political, and institutional aspects of planning that shape how such tools are enforced in practice.

Consequently, limited focus has been given to how spatial planning systems, decision-making processes, and institutional capacity influence flood resilience outcomes, especially in areas characterised by poor resources and weak governance. In addition, flood risk management research persistently focuses much on urban areas, with rural areas receiving limited scholarly attention despite facing persistent exposure to flooding, poor infrastructure investment, and poor planning and governance systems. This gap is particularly evident in South Africa, where flooding is the most frequent and damaging natural disaster. Between 2000 and 2016, floods accounted for nearly 42% of all natural disasters worldwide and 35% of those recorded in South Africa (EM-DAT, 2017). In South Africa, rural areas mostly operate under complex land tenure arrangements, poor technical capacity, and fragmented institutional responsibilities, conditions that cater to an urban-centred planning model that cannot address rural areas flood vulnerability.

South Africa exemplifies the aforementioned challenges. The country experiences recurring flood risks and damages due to the combination of climatic stressors, historical spatial planning inequalities, and continuing institutional and governance challenges (Raphela, 2025). Provinces in South Africa, such as Limpopo, KwaZulu-Natal, North West, and the Eastern Cape, are disproportionately affected by more extensive flood risks due to a combination of geographic and government-related weaknesses, and limited adaptation capacity (Munyai et al., 2021). Despite spatial planning being formally known as a vital mechanism for enhancing flood resilience, many rural municipalities struggle to translate planning regulations into efficient flood risk reduction practices due to weak inter-sectoral collaboration and poor incorporation of flood risk consideration into land use decision-making (Munyai et al., 2021). As a result, flooding continues to have impacts on rural settlements repeatedly, raising questions about the effectiveness of existing spatial planning techniques. Despite the growing recognition of spatial planning as the main mechanism for flood risk management, there is limited empirical knowledge about how spatial planning is being implemented in rural South African contexts, the institutional challenges that hinder its effectiveness, and the extent to which current spatial planning frameworks support rural flood resilience. This signifies a vital gap in the literature, especially considering the accelerating climate change impacts and the disproportionate vulnerability in rural human settlements. Addressing these challenges, this study aims to analyse the effectiveness of spatial planning in enhancing rural resilience to flooding in South Africa.

3 LITERATURE REVIEW

3.1 Climate change and flooding in developing countries

Worldwide, flooding is known to be one of the most frequent and catastrophic natural disasters, emerging when water temporarily overwhelms normally dry land due to heavy rainfall, river overflow, or inadequate drainage systems (Ran & Nedovic-Budic, 2016). This statement simply emphasises that globally, floods affect more residents than any other type of natural disaster. UNISDR (2018) reported that floods are the most frequently reported natural disasters, repeatedly affecting a large number of people. According to the United Nations (2015) and Abdrabo et al. (2020), between 1995 and 2015, floods were reported to be 43% of all natural disasters, impacting over half of the residents experiencing any other natural disasters and resulting in more than a quarter of all disaster-related deaths. As mentioned above, climate change continues to increase the flood risks by increasing the frequency and severity of heavy rainfall events, leaving pressure on both urban and rural communities (Raphela, 2025). Worldwide, between 2000 and 2022, floods resulted in inflation-adjusted economic loss equal to US$929 billion, illustrating 3852 floods (Centre for Research on the Epidemiology of Disasters (DRED, 2023). In South Africa, floods and storms are the most frequent natural disasters, resulting in 71.2% of the total disasters in the country (CRED, 2023). In the Global South, flood risks and damages are intensified by structural and socioeconomic aspects, encompassing inadequate infrastructures and weak governmental regulations, and unplanned rural settlements that usually encroach on natural floodplains (Nuissl, 2020). According to Liu (2024), globally from 1990 to 2022, 168 countries experienced 4,713 flood events, impacting more than 3.2 billion residents, resulting in over 218, 000 deaths, and economic losses exceeding $1.3 trillion. Africa continues to be vulnerable to flooding, experiencing the third-highest proportion of global flooding events and associated deaths (Hamidifar and Nones, 2021). In 2024 alone, floods impacted over 8.5 million residents and claimed more than 1,460 lives across 20 countries in West and Central Africa, emphasising the combined impacts of climate variability and inadequate infrastructures (Ramadane, 2024). These flooding statistics highlight that flooding is not only a repeated

environmental disaster but also a pressing developmental and governance challenge, especially in areas with limited adaptive capacity.

3.2 Role of spatial planning in flood risk management

Spatial planning is known as a process in which public and private sectors influence the spatial allocation of activities, people, and land uses to guide long-term development outcomes (Roosimagi, 2021). In addition to oversight, spatial planning signifies a coordinated and strategic approach aimed at shaping spatial patterns of settlement growth to enhance resilience, efficiency, sustainability, and safety of human settlements (Thistlethwaite, 2019; Roosimagi, 2021). This has placed spatial planning as a possible vital tool in addressing complex environmental risks and damages, including flooding. Considering flood risk management, spatial planning is known as a preventive tool that can minimise exposure by directing human settlement developments away from areas vulnerable to flooding and incorporating environmental challenges into land use decision-making (Ran, 2016). Spatial planning operates proactively by directing where and how human settlement developments should occur, unlike structural flood control tools such as dams, levees, and drainage systems, which minimise flooding probability but cannot fully stop risks and damages (Sayers et al., 2013; Thistlethwaite, 2019). Therefore, it plays an enhancing role in engineering-based interventions by tackling the fundamental drivers of flood vulnerability. Notwithstanding the recognised capability, the literature repeatedly emphasises major challenges in translating spatial planning principles into successful flood risk management practice. One of the most commonly quoted challenges is the weak collaboration and communication among spatial planning officials and flood risk management institutions, which usually work within incoherent government systems (Ran & Nedovic-Budic, 2017). This institutional disconnect is worsened by varying professional viewpoints, with town planners and flood risk officials mostly holding contrasting perspectives on the role and scope of spatial planning in enhancing flood risk (Solin, 2023). These issues are overlooked and threaten the incorporation of flood risk consideration into spatial development processes and minimise the effectiveness of planning interventions. The mutual reliance between spatial planning and flood risk management highlights the necessity for more integrated mechanisms that correspond to spatial planning, environmental management, and governance processes (Ran, 2016). Effective spatial planning needs to balance environmental, social, and economic aspects while concurrently tackling the current vulnerabilities and hindering the creation of new risks and damages (Thistlethwaite, 2019). Incorporating flood risk management into spatial planning regulations is therefore vital for minimising long-term exposures and enhancing the rural resilience and sustainability of human settlements. These challenges are frequently seen in Africa, where flooding is the most common natural hazard and usually leads to notable loss of lives, property damage, and disturbance of livelihoods (Cilliers, 2019). Under these circumstances, spatial development planning has a vital role in hindering unsuitable settlement development in areas that are vulnerable to flooding and supporting disaster risk reduction efforts. When executed correctly, spatial planning can contribute not only to minimising flood risks and damages but also to addressing social vulnerabilities and reinforcing societal resilience to flooding (Priest et al., 2016; McEwena et al., 2018).

4 APPROACH AND METHODOLOGY

An exploratory research design was adopted in this study to allow for a flexible and in-depth examination of the role of spatial planning in enhancing rural resilience to flooding in South Africa. This design is particularly suitable for gaining new insights, clarifying concepts, and identifying patterns, relationships, or factors influencing complex phenomena (Saunders, Lewis, & Thornhill, 2019). The study employed a mixed-methods research approach, integrating both quantitative and qualitative techniques to provide a comprehensive understanding of the research problem. Mixed methods research is especially valuable for addressing complex issues that cannot be sufficiently explored through a single methodological approach (McLeod, 2024). The quantitative component focused on collecting data related to flood risks, infrastructure availability, and spatial planning indicators, while the qualitative component involved semi-structured interviews with town planners to explore perceptions of flood risk, the effectiveness of spatial planning interventions, and barriers to implementation. A random sampling technique was used to select South African residents for the quantitative survey to ensure representativeness, while purposive sampling was employed to select town planners with relevant expertise for the qualitative interviews. Data analysis involved the use of descriptive statistical tools, including SPSS and Microsoft Excel, for quantitative data,

while qualitative data were analysed using thematic analysis to identify recurring themes and patterns. Ethical considerations were rigorously observed throughout the study. Participants were fully informed about the purpose of the research and assured that they would not be deceived in any way. Participation was entirely voluntary, and respondents were informed of their right to withdraw from the study at any stage without any consequences. To avoid coercion or undue influence, participants were provided with adequate information to make informed decisions and were allowed to ask questions and seek clarification regarding any aspect of the study.

4.1 Data Collection Methods

Data collection refers to the systematic process of gathering, evaluating, and analysing accurate information using established and validated research methods (Mazhar, 2021). This study employed both primary and secondary data sources to ensure a comprehensive and well-rounded analysis of the role of spatial planning in enhancing rural resilience to flooding in South Africa. Primary data were collected through surveys, interviews, and field observations. Secondary data were obtained from policy documents, local government reports, and existing scholarly studies related to spatial planning, flooding and rural resilience.

4.2 Survey Questionnaires

A questionnaire is a research instrument used to collect data through a structured series of questions (Hussain, 2022). In this study, structured survey questionnaires comprising both closed-ended and open-ended questions were used to collect data from South African residents living in rural areas vulnerable to flooding. The mixed question format allowed for the collection of both quantifiable data and contextual insights. A total of 20 questionnaires were distributed to participants residing in flood-prone rural areas. Each questionnaire was designed to take approximately 5–10 minutes to complete.

4.3 Interviews

Interviews are a qualitative data collection method that utilises open-ended questions to obtain in-depth information from participants (George, 2022). Semi-structured interviews were conducted with five town planners, selected due to their role in spatial planning and flood resilience in both rural and urban contexts. The semi-structured format enabled flexibility, allowing participants to elaborate on their experiences, perceptions of flood risk, the effectiveness of spatial planning measures, and challenges in implementation. Each interview was expected to last between 10 and 15 minutes.

4.4 Literature Sources

A comprehensive review of existing literature was conducted to establish a strong theoretical and contextual foundation for the study. This review focused on spatial planning, rural resilience, flooding, land-use planning, and climate change at global, national, and local levels. Key policy documents, including the Spatial Planning and Land Use Management Act (SPLUMA, 2013), Spatial Development Frameworks (SDFs), and Integrated Development Plans (IDPs), were analysed to understand the role of spatial planning in enhancing rural resilience to flooding in South Africa. Additionally, the study was framed within the existing research on theoretical viewpoints in land-use planning, rural resilience, flooding and climate change found in academic literature.

5 RESEARCH FINDINGS

5.1 Flood experience among residents

The findings highlight that flooding is a common experience among most of the participants. The majority of respondents, 83%, stated that they have been exposed to flooding in their communities, while only 17% highlighted that they have not. The absence of “not sure” responses highlights that participants were confident about their responses, emphasising the tangible and memorable nature of flooding events within their communities in South Africa. The majority of affirmative responses emphasise the repeated occurrence of flooding in the study area and confirm that flooding is a common and lived challenge for residents who stay in rural communities. These results further highlight the need for effective flood risk management and spatial planning intervention, as flooding is not a hypothetical risk but a repeated reality impacting most of

the residents in rural communities in South Africa, mostly those who reside in areas vulnerable to flooding or low-lying areas.

5.2 Frequency of flood occurrence

The following figure shows that flooding occurs with different regularity in the study area. Half of the participants (50%) reported that they experience flooding every year due to heavy rainfall, highlighting that flooding is a common and recurring event for a significant portion of rural South Africa. About one third of participants (33%) experience flooding occasionally throughout the year, highlighting irregular but still noteworthy exposure to flooding events. 17% reported that they experience flooding rarely, highlighting that a smaller portion of the rural South Africa population faces infrequent flood events. Overall, the data shows that flooding is the most frequent natural disaster in South Africa, with most of the rural communities' residents affected regularly, emphasising the necessity for robust flood risk management and resilience strategies.

5.3 Impacts of flood encountered

The figure below highlights that housing damage during flooding is the most major impact of flooding, affecting 50% of the participants. This emphasises that human settlements in rural areas are highly developed in areas that are vulnerable to flood events, possibly because of weak construction materials used or the location in flood-prone areas and poor infrastructure, such as drainage systems. The loss of crops and livestock is reported to be the second most common impact in rural South Africa, reported by 33.3% of participants. This shows that the negative impacts of flooding on agricultural livelihoods and food security are particularly significant for households that rely on farming and livestock rearing. Displacement of residents affected 16% of the participants, highlighting that fewer households had no choice but to relocate due to flooding, causing damage to living arrangements and community stability. Notably, no participants reported health problems or loss of income (0%). This may highlight effective coping mechanisms and timely evacuation. Overall, the results highlight that flood impacts were primarily physical and livelihood-related, with housing and agriculture being the most affected aspects.

5.4 Challenges of flooding in South Africa

5.4.1 Settlement Patterns in Flood-Prone Areas

The results highlight that settlements developed in areas vulnerable to flooding are strongly affected by land allocation, poor awareness, and weak governmental challenges. All surveyed participants (100%) stated that they were not informed about flood risks and had no idea that they were being placed in flood-prone areas before residing in their respective communities. This shows an urgent gap in risk communication and public awareness about the flood risks, highlighting that flood risk information is not effectively shared with residents before settlement decisions are made. The responses further highlight that the lack of knowledge is a main issue contributing to continued residential development in flood-prone areas. As highlighted by one resident, due to an absence of information pertaining to flood risks, it hinders residents' ability to make informed settlement choices (Resident 16, 2026). This result emphasises that the tribal authorities in rural communities continue to allocate land in areas that are vulnerable to flooding, leaving residents being the ones to experience the challenges. Viewpoints from town planners point to systemic and governmental challenges within spatial planning and human settlement delivery processes. Backlogs in the delivery of properly demarcated and serviced human settlements have resulted in residents settling in available land despite flood risk and damage exposures (Town Planner 1, 2026). This scenario is worsened by repeated housing delays, which drive communities to prioritize having shelters rather than considering their safety. Additionally, it emphasises that municipal planning priorities are more focused on urban areas, leaving rural communities with limited planning support and awareness initiatives. According to Town Planner 3 (2026), weak spatial planning practices in local municipalities, lack of land for development, and poor community awareness programme lead to the continued allocation of stands in flood-prone areas. This shows a broader spatial inequality between rural and urban areas in South Africa. The role of tribal authorities was also mentioned as one of the major aspects influencing settlement patterns in areas that are vulnerable to flooding. Town Planner 4 (2026) emphasised that tribal authorities often lack adequate knowledge of environmental buffers and disaster-prone areas when they allocate stands to residents under their jurisdiction. This

Editors: M. Schrenk, C. Beyer, T. Popovich, J. Ryser, D. Mawlood
ISBN 978-3-9504945-5-6

emphasises the disconnect among formal spatial planning, disaster risk management regulations, and customary land allocation practices, further exacerbating settlement vulnerability. Overall, this analysis shows that human settlement in flood-prone areas is not solely a result of individual choice but rather a combination of poor awareness, poor spatial planning, inadequate governmental collaboration, and land scarcity. These results highlight the necessity for improved flood risk communication, stronger coordination among municipalities and tribal authorities, and proactive spatial planning intervention to avoid further human settlement in areas vulnerable to flooding.

5.4.2 Inadequate Integration of Flood Risk into Spatial Planning Frameworks

This paper found that flood risk management is poorly incorporated into rural spatial planning regulations, significantly restricting their effectiveness in minimising flood vulnerability. Spatial Development Frameworks and Land Use Schemes in most rural communities lack comprehensive flood risk assessments, up to flood hazard mapping, and clearly elaborated settlement development guidelines for areas vulnerable to flooding. This absence of risk-informed planning mechanisms leads to human settlement development decisions that do not adequately account for current and potential flood risks and damages. Therefore, spatial planning tools fail to effectively guide human settlement development away from high-risk areas or encourage adaptive land use practices such as controlled development, buffer zones, or flood-resilient human settlement patterns. Instead of spatial planning operating as a proactive and preventive mechanism, spatial planning regulations mostly respond reactively after flood events have already happened. This responsive approach threatens the core objectives of spatial planning in enhancing safety, sustainability, and resilience. Additionally, the results show a disconnect between spatial planning and disaster risk management regulations. Although there is the existence of national and local disaster management frameworks, their principles are not enforced within spatial planning tools at the rural community level. This poor incorporation results in recurrent flood challenges in rural communities, as human settlements continue to be exposed to flood risks without adequate preventive planning mechanisms. Overall, the paper emphasises the immediate necessity for incorporated, risk-sensitive spatial planning approaches that coordinate land use planning with flood risk management and climate change adaptation measures.

5.4.3 Poor Infrastructure Provision and Maintenance

The results of this study confirm that poor infrastructure provision and maintenance significantly challenge rural resilience to flooding. Survey findings highlight that 66.7% of participants have drainage infrastructure to help during flooding, while only 33.3% show the presence of some form of drainage infrastructure. This imbalance emphasises the widespread absence of basic flood mitigation infrastructure in rural areas and underscores the vulnerability of these communities to heavy rainfall events.

Inadequate drainage infrastructures increased flood impacts by allowing stormwater to accumulate within human settlements, exacerbating surface runoff and prolonging inundation periods. These results align with broader observations that infrastructure developments in rural communities commonly lag behind urban areas in both delivery and maintenance. Furthermore, poor infrastructure hinders access to essential services during flooding events in rural communities. Poorly maintained roads and the absence of stormwater systems impede mobility, delay emergency response, and restrict access to healthcare and markets. As a result, flooding not only leaves physical consequences but also threatens socioeconomic status, further minimising the adaptive capacity of rural communities. From spatial planning viewpoints, these results highlight a disconnect between human settlement development and infrastructure planning in rural areas. The absence of incorporated infrastructure planning within SDF undermines long-term sustainability and resilience objectives. Overall, the findings highlight the necessity for enhanced investments in rural drainage and stormwater infrastructure, alongside regular maintenance, to enhance flood resistance in rural areas and support sustainable rural development.

5.4.4 Weak Stakeholder Coordination and Governance

The paper highlighted that poor collaboration between key stakeholders undermines the effectiveness of spatial planning and flood risk management in rural communities. Coordination among town planners, disaster management officials, environmental officials, and local government departments is often weak, leading to fragmented planning processes and poor enforcement of flood resilience mechanisms. The absence of incorporated government structures, formal communication channels, and shared data systems

further heightens these impacts, resulting in duplicated efforts in some areas while leaving critical policy gaps in others. This lack of collaboration not only limits the effective execution of flood mitigation strategies but also minimises the capacity of rural communities to benefit from available resources and expertise. For example, without collaborative planning, disaster management units may enforce emergency approaches that are not aligned with spatial development priorities, while environmental officials may fail to protect natural flood buffers critical for minimising flood challenges. The results emphasize the need for strengthened intergovernmental and cross-sectoral coordination, including the establishment of shared information platforms, joint planning committees, and regular stakeholder engagement forums. By encouraging incorporated governance and cooperative decision-making, rural flood-prone areas can achieve more coherent spatial planning outcomes, enhancing overall community resilience to flooding.

5.4.5 Limited Community Awareness and Participation

Limited community awareness and participation emerged as a significant challenge affecting rural flood resilience. The findings indicate that many residents have insufficient knowledge of flood risks, early warning systems, and appropriate preparedness measures, which reduces their ability to anticipate, respond to, and recover from flood events. The lack of accessible and targeted risk communication in rural areas contributes to this knowledge gap, leaving communities unprepared for recurring flooding. In addition, community involvement in spatial planning processes is often minimal. Residents are seldom actively engaged in decision-making related to land-use planning, settlement development, and disaster risk management. This limited participation restricts opportunities to incorporate local knowledge and lived experiences into planning processes, which are essential for identifying context-specific flood risks and feasible adaptation strategies. When residents are not involved in planning decisions, they are less likely to understand, support, or comply with planning regulations and risk reduction measures. As a result, spatial planning strategies aimed at enhancing flood resilience become less effective and more difficult to sustain over the long term. Overall, the findings highlight the need for participatory and inclusive planning approaches that prioritise community awareness, education, and involvement as central components of rural flood resilience.

6 IMPLICATIONS AND RECOMMENDATIONS

The results of this paper have several implications for spatial planning in rural communities in South Africa. The repeated flood impacts highlight that the existing spatial planning approaches insufficiently consider environmental risks and damages. The town planners and tribal authorities must therefore prioritise flood risk assessment when allocating land uses to residents under their jurisdictions and approving developments, especially in rural and low-lying areas. This paper suggests a necessity for stronger implementation of spatial planning regulation and frameworks. Despite spatial planning regulations, their limited consideration of flood risks and poor enforcement contribute to continued human settlement in areas vulnerable to flooding. Municipal town planners must enhance compliance monitoring and make sure that planning decisions align with disaster risk reduction principles. Exacerbated heavy rainfall variability and extreme weather events require spatial planning regulations and policies that are flexible and responsive to changing climatic conditions. Spatial planning tools such as the Spatial Development Framework and Land Use Schemes should be regularly reviewed and updated to reflect the evolving flood risk and damage. The results suggest that infrastructure planning must be treated as a priority tool for spatial planning, rather than as a split sectoral mechanism. Inadequate infrastructure in rural communities exacerbates vulnerability to flooding, highlighting the necessity for collaborative planning among town planners, engineers, and disaster management officials. Also, the paper emphasises the need for an inclusive and collaborative spatial planning process. Weak community awareness of flood risks and damages shows a gap in public engagement. Spatial planning should then actively collaborate with rural communities to incorporate local knowledge and enhance preparedness and resilience to flooding. The results show that nature-based and green infrastructure resolution should be widely adopted in spatial planning decisions. Protecting wetlands, river buffers, and natural drainage systems can minimise flood risks and damages while supporting sustainable land use and environmental protection. Overall, these implications highlight that spatial planning in rural South Africa must be integrated, proactive, and resilient to effectively minimise flood vulnerability and support rural developments in South Africa.

Flood risk management should be incorporated into rural spatial planning frameworks and policies. SDF and LUS must explicitly identify areas that are vulnerable to flooding and restrict settlement development in high-risk areas. In areas where relocating is unfeasible, spatial planning frameworks and policies must enhance flood-resilient settlement patterns and implement development control measures that minimise exposure to flood risks and damages. There is a need to enhance infrastructure development in rural communities, especially drainage systems, roads, bridges, and stormwater management infrastructure. Enhanced infrastructure will minimise flood impacts and enhance accessibility during and after flood events, thereby heightening the adaptive capacity of rural communities. Green infrastructure and nature-based solutions should be enhanced as part of spatial planning strategies to minimise flooding in rural communities in South Africa. Tools such as wetland restoration, riparian buffer zones, reforestation, and sustainable land management practices can minimise surface runoff, promote water absorption, and minimise flood risks while supporting environmental sustainability. Rural community residents should be educated about flood risks, early warning systems, and appropriate response strategies, and also enhance community awareness and participation. Participatory spatial planning processes that actively include local communities can enhance local knowledge incorporation and ensure that spatial planning interventions are socially acceptable and contextually relevant. Effective flood resilience needs collaboration among town planners, disaster management authorities, environmental officials, and local governments. Enhanced data sharing and governmental capacity building will support informed decision-making and the enforcement of incorporated flood risk management strategies.

7 CONCLUSION

This paper analysed the role of spatial planning in enhancing rural resilience in South Africa, with particular emphasis on settlement patterns, spatial planning regulation and policies, infrastructure delivery, and community involvement. The results present that flooding continues to be a lived reality for many rural communities in South Africa, with repeated challenges to housing, agriculture, livelihoods, and human settlement stability. Although formal recognition of spatial planning as the main mechanism for flood risk management exist, its practical effectiveness in rural communities remains weak. This paper shows that many rural communities persist in areas that are vulnerable to flooding due to limited awareness of flood risks and damages, poor incorporation of flood risk management into spatial planning regulations and policies and weak governance systems. SDF and LUS in rural local municipalities commonly lack detailed flood risk assessments and hazard mapping, leading to reactive rather than preventative spatial planning approaches. This weakens the capacity of spatial planning to guide safe human settlement development and minimise long-term flood vulnerability. Poor infrastructure delivery and maintenance further increase rural flood risks. The absence of effective drainage systems, inadequate road networks, and poor stormwater management infrastructure exacerbate the frequency and intensity of flood impacts and limit emergency response and recovery. This infrastructural impact shows broader spatial inequality among urban and rural communities and emphasises the necessity for incorporated infrastructure and land use planning.

This paper also identifies the poor collaboration among key stakeholders, including tribal authorities, municipal officials, and environmental and disaster management officials. This poor collaboration weakens the implementation of spatial planning regulations and hinders the effectiveness of flood risk reduction measures. Furthermore, limited community awareness and involvement in the spatial planning process limit local preparedness and weaken the sustainability of planning involvement. Overall, the paper results highlight that spatial planning in rural South Africa has major potential to enhance flood resilience, but it is currently hindered by institutional, infrastructural and governance impacts. Enhancing the incorporation of flood risk management into spatial planning, investing in resilience and green infrastructure, enhancing intergovernmental collaboration, and promoting inclusive and participatory planning processes are important to minimising rural flood vulnerability. By integrating a more proactive, incorporated and risk-sensitive spatial planning approach, rural South Africa can move towards greater resilience, safety, and sustainable human settlement development.

8 REFERENCES

Abdrabo, K. I., Kantosh, S. A., Saber, M., Sumi, T., Elleithy, D., Habiba, O. M., and Alboshy, B. (2022). The role of urban planning and landscape tools concerning flash flood risk reduction within arid and semiarid regions. Wadi Flash Floods, 283-

316. Available from: https://library.oapen.org/bitstream/handle/20.500.12657/51002/1/978-981-16-2904 4.pdf#page=299
Ampofo J.A., Sekyere E.O., and Adongo R. (2024). Human settlement in high-risk floodplains in countries: A systematic review. Available from: https://www.academia.edu/117464636/Human_Settlement_in_High_Risk_Floodplains_in_D eveloping_Countries_A_Systematic_Review
Anwana, E. O., and Owojori, O. M. (2023). Analysis of Flooding Vulnerability in Informal Settlements Literature: Mapping and Research Agenda. Social Sciences, 12(1), 40. Available from: https://doi.org/10.3390/socsci12010040
Byaruhanga, N., Kibirige, D., and Mkhonta G. 2025. Understanding South Africa's Flood Vulnerabilities and Resilience Pathways: A comprehensive overview.17(17), 2608. https://doi.org/10.3390/w17172608
Centre for Research on the Epidemiology of Disasters (CRED) (2023) The international disaster database. Centre for Research on the Epidemiology of Disasters, Brussels, Belgium
Cilliers, D.P., 2019, 'Considering flood risk in spatial development planning: A land use conflict analysis approach', Jàmbá: Journal of Disaster Risk Studies 11(1), a537. https://doi.org/10.4102/jamba.v11i1.537
Chakwizira, J. and Tshivhase, F. (2024). Review of Traditional Authority Customary Land Management Practices in Limpopo Province of South Africa. Available from: https://pari.org.za/wp-content/uploads/2024/11/20241125_LandPolicy Brief_ChakwiziraTshivhase.pdf
EM-DAT, 2017, International disaster database, from http:// emdat.be/emdat_db/
Hamidifar, H. and Nones, M., 2021. Global to regional overview of floods fatality: the 1951–2020 period. Natural Hazards and Earth System Sciences Discussions, 2021, pp.1-22. https://nhess.copernicus.org/preprints/nhess-2021-357/
Löschner, L. and Nordbeck, R., 2020. Switzerland's transition from flood defence to flood-adapted land use–A policy coordination perspective. Land Use Policy, 95, p.103873. https://www.sciencedirect.com/science/article/pii/S0264837718313802
Meng, M., Dabrowski, M. and Stead, D., 2020. Enhancing flood resilience and climate adaptation: The state of the art and new directions for spatial planning. Sustainability, 12(19), p.7864. https://www.mdpi.com/2071-1050/12/19/7864
Nuissl, H. and Siedentop, S., 2021. Urbanisation and land use change. Sustainable land management in a European context, 8, pp.75-99. https://library.oapen.org/bitstream/handle/20.500.12657/41734/2021_Book_SustainableLandManagementInAEu.pdf?sequence=1#page=81
Priest, S. J., Suykens, C., Van Rijswick, H. F. M. W., Schellenberger, T., Goytia, S. B., Kundzewicz, Z. W., Van Doorn-Hoekveld, W. J., …, & Homewood, S. (2016). The European Union approach to flood risk management and improving societal resilience: lessons from the implementation of the Floods Directive in six European countries. Ecology and Society, 21(4), 50. https://www.jstor.org/stable/26270028
Ramadane, M.; Prentice, A., 2024. Monsoon havoc exposes West and Central Africa's rising flood risks. https://www.reuters.com/world/africa/monsoon-havoc-exposes-west-central-africas-rising-flood-risks-2024-10-15/
Ran, J., & Nedovic-Budic, Z. (2016). Integrating spatial planning and flood risk management: a new conceptual framework for spatially integrated policy infrastructure. Computers, Environment and Urban Systems, 68, 79–57. https://doi.org/10.1016/j.compenvurbsys.2016.01.008
Ran, J., & Nedovic-Budic, Z. (2017). Integrating flood risk management and spatial planning: legislation, policy and development practice. Journal of Urban Planning and Development, 143, 3. https://doi.org/10.1061/(ASCE)UP.1943-5444.0000376
Raphela, T.D. (2025). The causes and impacts of flood risks in South Africa. Available from: https://doi.org/10.3389/frwa.2024.1524533
Solín, Ľ. and Madajova, M.S., 2023. Spatial planning as a tool of flood risk management in rural landscapes? Position, limitations, and other findings: The case of Myjava Region (Slovakia). Moravian Geographical Reports, 31(2), pp.106-117. https://sciendo.com/pdf/10.2478/mgr-2023-0010
UNISDR, C., 2018. Economic Losses, Poverty and Disasters 1998-2017. The Centre for Research on the Epidemiology of Disasters (CRED): Brussels, Belgium. https://scholar.google.com/scholar_lookup?title=Poverty%20and%20Disasters%201998-2017&publication_year=2018&author=UNISDR%2C%20Economic%20Losses