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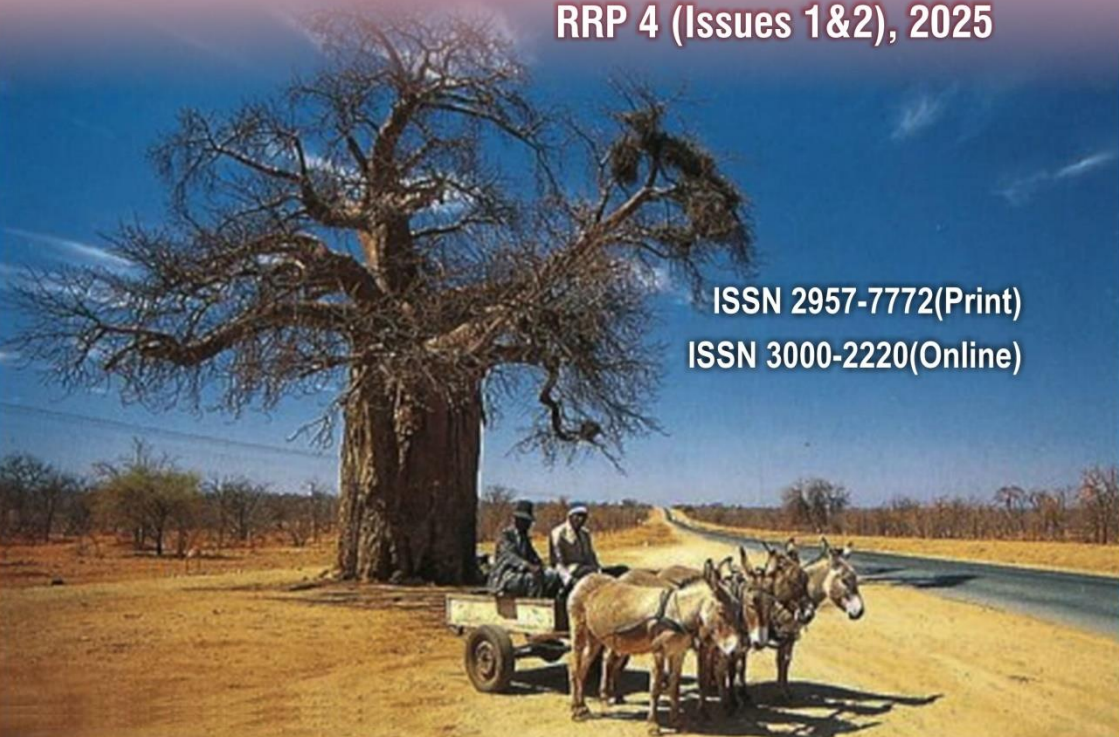

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About the Journal

JOURNAL PURPOSE

The purpose of the *Review of Rural Resilience Praxis is* to provide a forum for disaster risk mitigation, adaptation and preparedness.

CONTRIBUTION AND READERSHIP

Sociologists, demographers, psychologists, development experts, planners, social workers, social engineers, economists, among others whose focus is that of rural resilience.

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SCOPE AND FOCUS

As much as the urban territory is increasing by each day, the rural economy, especially in many developing countries, still retains a great proportion of the extractive and accommodation industry. Retaining some space as rural remains critical given the sectors role in providing ecosystem services to both wildlife and humanity. In this light, rural resilience as practice beckons for critical studies especially in the face of the ever-threatening extreme weather events and climate change that then impact on the livelihoods and lifestyles of the rural communities. Review of Rural Resilience Praxis (RRRP) comes in as a platform for critical engagement by scholars, practitioners and leaders as they seek to debate and proffer solutions of the rural sector and trying to champion the philosophy of the right to be rural. The issue of conviviality between the different constituencies of the sectors, compiled with the competing challenges of improving rural spaces while also making the conservation and preservation debates matter is the hallmark of this platform of criticality. The journal is produced bi-annually.

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Articles must be original contributions, not previously published and should not be under consideration for publishing elsewhere.

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A total number of words: 5000-7000 words and set in 12-point font size width with 1.5 line spacing.
Language: British/UK English
Title: must capture the gist and scope of the article
Names of authors: beginning with the first name and ending with the surname
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Abstract: must be 200 words
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Sustainable Construction of Rural Building Structures under the Impact of Increased Tropical Cyclonic Events

MARCYLINE CHIVENGE[1], ROSELIN KATSANDE-NCUBE[2] AND HALLELUAH CHIRISA[3]

Abstract

The increasing frequency and intensity of tropical cyclones in Zimbabwe, driven by climate change, have highlighted the need for sustainable construction practices. While modern construction techniques and advanced materials are becoming more prevalent, traditional building methods remain widely used, particularly in rural areas, due to economic constraints and cultural perceptions. Using secondary data sources, the study examines the interplay between traditional and modern construction approaches. There is need for strategies, materials and practices which contribute to environmental sustainability and social cohesion in rural communities. The findings indicate that while advanced materials and technologies enhance resilience, traditional practices also offer valuable, sustainable solutions. Achieving a balance between these approaches is crucial for promoting environmental sustainability, reducing construction costs and improving access to financing. The study highlights the need for well-defined strategies that integrate both traditional and modern construction methods to enhance resilience in rural communities.

Keywords: *resilience, climate adaptation, disaster mitigation, eco-friendly materials*

INTRODUCTION

Climate change is significantly altering weather patterns, leading to an increase in the frequency and intensity of tropical cyclones. In Zimbabwe,

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these extreme weather events pose severe challenges to rural communities, where traditional building structures are often ill-equipped to withstand strong winds and flooding (Haque and Hostetler, 2021). The damage caused by cyclonic events frequently results in the displacement of communities, loss of livelihoods and heightened poverty levels (Nyahuda, 2025). These recurring disasters highlight the urgent need for disaster preparedness strategies, with sustainable construction emerging as a key intervention for enhancing resilience, reducing vulnerability and promoting long-term environmental and economic sustainability.

Traditional rural structures in Zimbabwe are typically built using low-cost materials such as wood, mud and grass thatch. While these materials are locally available and affordable, they offer limited resistance to extreme weather conditions. The construction sector, as a major contributor to both environmental degradation and economic development, plays a crucial role in addressing these vulnerabilities. A shift towards sustainable building practices is essential to mitigate and adapt to climate-related challenges (Wang *et al.*, 2020; Elkharboutly and Wilkinson, 2022). Sustainable construction not only improves the durability of structures, but also integrates principles such as the use of locally sourced materials, energy efficiency and effective water management, all of which contribute to environmental sustainability.

This study investigates sustainable construction practices for rural buildings in Zimbabwe, focusing on strategies that enhance resilience against the increasing frequency and intensity of tropical cyclones. By examining both traditional and modern construction techniques, the research identifies methods that balance economic feasibility with environmental and social sustainability. The study also explores community perceptions and economic constraints that influence construction choices in rural areas.

The article is structured as follows: The introduction outlines the impact of climate change on Zimbabwe, with an emphasis on the rising occurrence of tropical cyclones and their effects on rural communities. The conceptual framework analyses key concepts such as resilience and sustainability, providing the foundation for the study. The literature review examines existing research on sustainable construction methods and the vulnerabilities

of rural structures to extreme weather events. The methodology section details the research design, data collection methods and analytical approaches employed in the study. The results section presents findings on the current state of rural building structures, the impact of tropical cyclones and the effectiveness of various construction practices in enhancing resilience. The discussion interprets these findings, highlighting their implications for sustainable rural construction. Finally, the conclusion and recommendations summarise key insights and propose actionable strategies for advancing sustainable construction practices in Zimbabwe's rural areas.

CONCEPTUAL FRAMEWORK: SUSTAINABLE CONSTRUCTION FOR CLIMATE RESILIENCE

This section explores the role of sustainable construction in enhancing the resilience of rural buildings to tropical cyclonic events. It examines key principles such as environmental sustainability, structural resilience, policy and regulatory frameworks and community engagement. Sustainable construction emerges as a critical solution, integrating environmentally friendly materials, disaster-resistant designs and adaptive policies to enhance the durability and sustainability of rural buildings.

Figure 1: *Tropical Cyclones and Sustainable construction for rural resilience.*

Sustainable construction is essential in adapting to the increasing frequency of tropical cyclonic events. It incorporates various principles that not only enhance resilience, but also minimise environmental impact throughout the

lifecycle of building structures (Shahin *et al.*, 2020). Tropical cyclonic events are characterised by rising frequency, intensity and duration, which worsen the vulnerability of rural building structures. Environmental factors such as wind loads, rainfall patterns and flood risks amplify these challenges. Together, these variables represent the external forces exerting pressure on rural infrastructure, necessitating adaptive and sustainable construction approaches.

Sustainable construction practices are vital for reducing environmental impacts, while ensuring that structures can withstand natural disasters. This will ensure that buildings are durable, materials are climate-resilient, adhere to design standards and implement locally adapted construction strategies. Policy and regulatory frameworks, including updated building codes and land-use planning, provide a critical foundation for enforcing resilience and sustainability measures (Ahmed and McDonnell, 2020). Additionally, community engagement, through awareness programmes and training, ensures that local populations are actively involved in building and maintaining resilient structures, fostering ownership and long-term compliance.

Achieving both structural resilience and environmental sustainability is essential in constructing buildings that can withstand the increasing threat of tropical cyclones. Structural resilience ensures that buildings endure extreme weather conditions with minimal damage, reducing the risk of displacement and economic loss (Chirisa, 2021; Austinet *et al.*, 2024). At the same time, environmental sustainability is promoted through resource-efficient practices that minimise ecological footprints. The selection of construction materials plays a crucial role in balancing these two aspects. The adoption of prefabricated components and modular construction techniques enhances quality control, shortens construction timelines and reduces material waste—making these approaches particularly valuable in disaster-prone regions.

Increased tropical cyclonic events and environmental factors drive the need for resilience, but their impact can be minimised through targeted interventions (Ahmed and McDonnell, 2020). Sustainable construction practices, backed by effective policies and active community participation, act as buffers, enabling rural structures to achieve the desired resilience,

sustainability and socioeconomic benefits (Chikodzi and Nhamo, 2021). This interconnected approach shows the importance of integrating environmental, social and regulatory dimensions in rural construction strategies to address the growing challenges posed by climate change.

The conceptual analysis highlights the necessity of sustainable construction as a strategic response to the increasing frequency and severity of tropical cyclonic events. A key insight is that resilience in rural infrastructure requires a multi-dimensional approach incorporating climate-adaptive building materials, stringent policy enforcement and active community involvement. Furthermore, the interconnectedness of environmental, social and regulatory factors underscores the importance of holistic construction strategies.

LITERATURE REVIEW

Climate change has significantly intensified the frequency and severity of tropical cyclones, posing major challenges for sustainable construction, disaster resilience and rural infrastructure (Fedele *et al.*, 2019). These extreme weather events expose the vulnerability of conventional rural housing structures and infrastructure, necessitating the adoption of climate-resilient construction practices. Key thematic areas in the literature include the impact of cyclones on housing and infrastructure, the role of resilient construction techniques, the influence of policies and regulatory frameworks, and the integration of sustainable building materials. Additionally, the role of community engagement, spatial planning and indigenous knowledge in fostering long-term resilience is discussed.

IMPACT OF TROPICAL CYCLONES ON RURAL INFRASTRUCTURE

Tropical cyclones have had devastating effects on rural settlements, particularly in developing countries where building materials and construction practices are often inadequate to withstand extreme weather events. The destruction of housing, sanitation facilities, water systems and transport infrastructure worsen vulnerabilities in affected communities (Austin *et al.*, 2024). Damage to rural infrastructure is not solely a result of the intensity of cyclones, but also of poor construction practices, weak regulatory enforcement and limited access to resilient building materials. The ability of communities to recover from such disasters depends on the robustness of their

infrastructure, access to financial and technical resources, and the effectiveness of disaster mitigation policies.

The increasing frequency and intensity of these extreme weather events have placed immense pressure on rural communities, particularly in cyclone-prone areas, where building structures are often inadequate. Traditional construction materials frequently fail to withstand strong winds and heavy rainfall, necessitating a shift toward more sustainable and resilient building practices. The challenge lies in balancing environmental sustainability with economic feasibility and cultural appropriateness, especially in regions where modern construction techniques are inaccessible or unaffordable.

Chatiza (2019) notes that inadequate settlement planning and deforestation exacerbate flood damage, resulting in extensive displacement and infrastructure loss. Poorly constructed homes, built with substandard materials and without proper foundations, suffered the most damage. In Zimbabwe, rural housing construction is largely unregulated, leaving many settlements vulnerable to climate-induced disasters (Chenga, 1986). Strengthening governance structures, improving spatial planning and integrating climate resilience into settlement policies are necessary steps to reduce future vulnerabilities.

RESILIENT CONSTRUCTION AND SUSTAINABLE BUILDING PRACTICES

Resilient infrastructure is central to mitigating the effects of cyclones. This encompasses not only durable housing, but also robust sanitation, energy and transport systems designed to withstand extreme weather (Elkharboutly and Wilkinson, 2022). Effective construction techniques, such as reinforced foundations, wind-resistant roofing and the use of durable local materials, significantly improve resilience. While conventional materials such as concrete and corrugated iron sheets are widely used, they may not always be the best solutions. In some cases, traditional construction techniques, which incorporate indigenous knowledge and local materials have proven more effective in mitigating cyclone damage.

Research on housing resilience in Vanuatu following Cyclone Pam, highlights the advantages of traditional structures, including their lightweight nature,

which reduces the risk of fatalities and the local availability of materials for quick repairs (Ahmed, 2022). However, other studies contradict this by showing that traditional houses suffered more severe damage compared to hybrid or modern structures (Handmer and Iveson, 2017). The key takeaway from these studies is that resilience is not determined solely by the materials used, but also by construction techniques. For example, houses lashed together with ropes instead of nails demonstrated greater wind resistance due to increased flexibility. This suggests that integrating traditional building methods with modern engineering principles could enhance structural resilience in cyclone-prone regions.

The Role of Policy and Regulation in Resilient Construction

Building codes and disaster mitigation policies play a critical role in fostering long-term resilience. In India, where cyclones frequently disrupt livelihoods, the government has implemented multi-hazard building guidelines to improve the resilience of coastal homes (Rao *et al.*, 2016). However, weak enforcement and financial constraints hinder widespread adoption, leaving many communities vulnerable to recurring disasters. Patel *et al.* (2020) highlight that poor reconstruction practices in cyclone-affected areas often lead to repeated destruction, emphasising the need for stringent regulatory oversight. Similarly, in Malawi, the construction sector remains heavily reliant on conventional techniques, with 90% of buildings still using burnt clay bricks despite environmental concerns (Malik *et al.*, 2024). The introduction of Sustainable Construction Materials Regulations in 2018 sought to curb deforestation by banning fired clay bricks in commercial projects, yet weak enforcement has limited its impact. Nogueira *et al.* (2022) argue that adopting alternative materials, such as precast concrete, recycled materials and green construction technologies, is essential for both resilience and sustainability.

The Role of Community Engagement and Local Knowledge in Building Resilience

Community awareness and engagement are fundamental in disaster planning and resilience building. Risk information sharing, coupled with the integration of scientific and indigenous knowledge, enhances communities' ability to prepare for and recover from cyclonic events. The concept of resilience extends beyond physical infrastructure to include social, economic and

environmental factors that influence a community's ability to withstand and recover from disasters. Diverse community capitals such as social, economic, political, built and environmental assets support hazard-resistant livelihoods, equitable resource distribution and proactive recovery strategies (Wang *et al.*, 2020; Choudhury *et al.*, 2021).

Community-based disaster risk management programmes have demonstrated success in empowering local populations to take an active role in preparedness. By fostering a culture of self-reliance and proactive mitigation, these programmes enable quicker recovery after disasters. In addition, local governments and non-governmental organisations (NGOs) play a crucial role in promoting sustainable construction practices by providing training, financial support and technical assistance. Such interventions ensure that rural communities adopt durable building techniques and disaster-resistant designs, reducing long-term vulnerability.

COMPARATIVE ANALYSIS OF HOUSING RESILIENCE IN CYCLONE-PRONE REGIONS

TRADITIONAL VS. MODERN HOUSING IN VANUATU

Vanuatu, situated in the southeastern Pacific, is highly susceptible to tropical cyclones, experiencing an average of 23 events per decade (Ahmed and McDonnell, 2020). The resilience of traditional versus modern housing has been a subject of debate, particularly in the aftermath of Cyclone Pam. Traditional houses, constructed from locally available materials, offer certain advantages, such as their lightweight nature, which poses less risk to human safety. However, damage assessments from Cyclone Pam indicated that a significant number of traditional homes were destroyed, whereas hybrid and modern structures, though partially damaged, were easier to repair using industrial materials like corrugated iron sheets (Handmer and Iveson, 2017). While some studies emphasise the vulnerabilities of traditional housing, others highlight the importance of construction techniques rather than just material choice. Ahmed (2022) observes that traditional houses lashed together with ropes rather than nailed, exhibited greater flexibility during strong winds, preventing complete collapse. However, the viability of traditional housing is

challenged by rapid socio-economic changes, which necessitate the adoption of hybrid construction approaches that retain indigenous knowledge while incorporating durable materials.

Cyclone-Resistant Construction in India

India experiences frequent cyclones due to its geographic and climatic conditions, placing millions of people at risk. Approximately two-thirds of India's population relies on agriculture, making them particularly vulnerable to cyclonic events and their associated impacts, such as food and water shortages, homelessness and economic instability (Rao *et al.*, 2016). Poor building practices have contributed significantly to cyclone-induced damages (Patel *et al.*, 2020). In response, the Indian government has developed comprehensive rehabilitation plans that incorporate multi-hazard perspectives into housing reconstruction. Guidelines for cyclone-prone coastal regions emphasise resilient building designs, improved land-use planning and the enforcement of stricter building codes. However, challenges persist, particularly in informal settlements where financial constraints and lack of technical expertise hinder the implementation of these measures. Coastal environmental degradation, exacerbated by population growth and industrial expansion, further increases the risks of storm surges and flooding (Mohapatra *et al.*, 2022). Strengthening disaster-resistant construction practices and enforcing spatial planning regulations are essential for mitigating these risks.

Malawi's Construction Industry and Sustainability Challenges

The construction sector in Malawi is a critical driver of socioeconomic development, contributing 3.6% to GDP in 2022, with a target of 10% by 2025 (Malik *et al.*, 2024). However, the industry faces significant challenges, including limited access to modern technologies, financial constraints and an over-reliance on traditional construction methods. The predominant use of burnt clay bricks, though cost-effective, has led to widespread deforestation and environmental degradation. In response, the Malawian government introduced the Sustainable Construction Materials Regulations in 2018, banning the use of fired clay bricks in commercial and public projects. However, enforcement remains weak due to a lack of viable alternatives and insufficient regulatory oversight.

LESSONS FROM CYCLONE IDAI: SPATIAL PLANNING AND SETTLEMENT DEVELOPMENT

In Zimbabwe, rural housing construction is largely unregulated, with developments often lacking clear siting and construction guidelines (Chenga, 1986). Weak institutional support and informal land allocation processes contribute to settlement patterns that increase disaster vulnerability. For instance, before Cyclone Idai, many communities had settled in flood-prone areas, exacerbating the impact of the disaster (Chatiza, 2019). Poor construction practices, including the use of substandard materials and inadequate structural reinforcement, further heightened risks.

A case study of Cyclone Idai in Mozambique highlights the critical role of spatial planning in disaster resilience. Chatiza (2019) notes that inadequate settlement planning and deforestation exacerbated flood damage, resulting in extensive displacement and infrastructure loss. Poorly constructed homes, built with substandard materials and without proper foundations, suffered the most damage. Thus emphasising the importance of regulated land-use planning, disaster risk assessments and the enforcement of construction standards.

THE ROLE OF STRUCTURAL DESIGN IN DISASTER RESILIENCE

Structural design is a critical factor in determining the resilience of buildings against cyclonic events. Studies on construction failures reveal that poorly designed buildings, rather than material choice alone, contribute to widespread destruction during disasters. For instance, following Cyclone Idai, all corrugated iron sheet houses in Mozambique were destroyed, whereas a properly designed adobe house remained intact, demonstrating the significance of construction techniques (Kurda and Garton, 2020).

Minke's (2025) research on adobe structures in seismic regions, reinforces the importance of adhering to fundamental construction principles to enhance disaster resilience, a concept equally relevant in cyclone-prone areas. According to Sturridge *et al.* (2022), features such as reinforced corners, strong structural connections and simple building layouts are crucial for improving the performance of structures under stress. Similarly, cyclone-resistant housing relies on several key design principles. These include the

careful selection of safe building locations away from high-risk zones, the use of regular and aerodynamic layouts that minimise wind resistance and the incorporation of sloped roofs to reduce wind uplift. Additionally, ensuring robust structural connections between walls, roofs and foundations is essential to maintain the integrity of the building during extreme weather events. When these design strategies are combined with local construction knowledge and enhanced through modern engineering techniques, they can significantly strengthen the resilience of rural housing in regions vulnerable to cyclonic activity.

The literature on sustainable construction in cyclone-prone regions emphasises the importance of integrating resilient building techniques, effective policies, community engagement and spatial planning. While some studies highlight the advantages of traditional housing in disaster resilience, others stress the superiority of modern materials and engineering solutions. The key consensus is that resilience is determined not just by materials but by construction techniques, regulatory frameworks and community involvement. There appears a gap in strengthening the enforcement of building codes, promoting the adoption of sustainable materials and investing in community-based disaster preparedness programmes. Additionally, integrating indigenous knowledge with modern engineering practices presents a viable pathway for enhancing housing resilience.

RESEARCH METHODOLOGY

This study adopts a qualitative research approach, relying primarily on secondary data sources, including published literature, policy documents and case studies, to analyse sustainable construction practices under the increasing threat of tropical cyclones. Academic journals, technical reports and industry publications were reviewed to extract insights on regulatory frameworks, financial mechanisms, material innovations and policy developments.

To enhance methodological transparency, the selection of sources followed specific criteria: relevance to sustainable construction in disaster-prone or tropical cyclone-affected areas, publication by reputable institutions or peer-reviewed outlets and coverage of empirical findings. Sources were analysed through thematic content analysis, identifying recurring patterns, gaps and

contextual factors across different settings. This allows for the triangulation of findings to minimise bias and improve the robustness of conclusions. Case studies were employed as a complementary strategy to explore the performance of sustainable building materials and construction techniques in cyclone-prone regions. These case studies were selected based on their diversity in geographic setting, building approaches and documented outcomes in the aftermath of cyclonic events. They provided grounded, context-rich examples of how specific designs and practices influenced resilience. Although case studies are inherently context-specific and may not be widely generalisable, they are used here to illuminate key principles and recurring strategies that could inform broader recommendations.

FINDINGS

This section presents the findings on the impacts of climate change—particularly tropical cyclones—on rural communities in Zimbabwe, with a focus on the role of sustainable construction in enhancing resilience. Drawing on policy frameworks, community experiences, case studies from Manicaland Province and field-based observations, the analysis explores the vulnerabilities of traditional rural housing, examines shifts in construction practices and identifies critical barriers and opportunities for building back better. Both institutional (top-down) responses and grassroots (bottom-up) efforts are considered in the broader context of climate adaptation and sustainable development.

IMPACTS OF CLIMATE CHANGE ON RURAL COMMUNITIES

Zimbabwe's rural areas are increasingly exposed to the adverse effects of climate change. Rising temperatures averaging 0.4°C and erratic rainfall, have contributed to more frequent droughts, floods and intense cyclones. Major events such as Cyclone Eline (2000), Cyclone Idai (2019) and Cyclone Freddy (2023,) have caused extensive damage, resulting in the displacement of thousands, loss of lives and destruction of critical infrastructure (IFRC, 2019). The vulnerability of rural communities is compounded by widespread poverty and food insecurity, which affect over six million people. In many cases, traditional houses, typically constructed from mud, poles and thatch, have collapsed under storm conditions, highlighting their structural fragility. The

inability of affected households to invest in climate-resilient housing further intensifies exposure to disaster risks (Chatiza, 2019; Nyahunda *et al.*, 2024).

TRADITIONAL AND MODERN CONSTRUCTION PRACTICES

Traditional building methods in rural Zimbabwe are rooted in cultural practices and affordability. Locally available materials like adobe, pole-and-dagga and thatch are widely used, but they often lack durability, structural reinforcement and scientific validation. These limitations are especially apparent during floods and cyclones, where poorly constructed homes frequently collapse. Modern materials such as cement blocks, steel trusses and corrugated roofing—offer greater resistance to climatic shocks but remain inaccessible to most rural households due to cost and limited availability. Only around 27% of the country's housing stock incorporates these more resilient materials. Moreover, enforcement of building codes in rural areas is weak and self-built structures often fail to meet safety standards.

To bridge the gap between affordability and resilience, hybrid construction models are gaining traction. Innovations such as stabilised soil blocks, rammed earth and cement-wire mesh composites present viable alternatives. These methods integrate local materials with engineering enhancements, offering greater resistance to wind and water at a lower cost. Performance-based building codes, improved early warning systems and climate-resilient design standards, are beginning to shape disaster risk reduction strategies. However, adoption remains limited due to low technical capacity, minimal investment and inadequate community engagement in rural areas (Chirisa, 2021).

Several structural and socio-economic barriers continue to hinder the advancement of climate-resilient construction in rural areas. One of the most significant challenges is poverty, which limits the affordability of quality construction materials and access to skilled labour, thereby constraining the ability of communities to build or upgrade to resilient structures. Cultural resistance also poses a challenge, as many rural communities prefer familiar traditional construction techniques, even when these methods have proven vulnerable to climate-related disasters. Compounding these issues is the weak enforcement of building regulations, particularly in rural and peri-urban

regions, where oversight is often minimal or absent. The over-reliance on donor-led reconstruction efforts can undermine sustainability, as these initiatives sometimes lack long-term planning and fail to promote local ownership. Moreover, limited grassroots engagement in planning and implementation processes often results in the exclusion of valuable community knowledge and practices.

Policy and Institutional Frameworks

Zimbabwe has made notable policy commitments through frameworks, like the Zimbabwe Resilience Building Fund, aligning with global goals such as the UN Sustainable Development Goal (SDG) 9, which focuses on resilient infrastructure and SDG 11, which emphasises sustainable cities and communities. These frameworks promote several key objectives, including upgrading rural housing from traditional dagga-and-pole technology (DPT) to more resilient construction options, mainstreaming disaster risk reduction into rural development and fostering public-private partnerships in rural housing delivery. Additionally, there is a push to expand building inspection and compliance mechanisms beyond urban areas to ensure broader adherence to resilience standards (Chikodzi and Nhamo, 2021). Despite these positive policy directions, the implementation remains fragmented, with significant gaps in institutional coordination, community involvement and the allocation of adequate resources. These challenges hinder the full realisation of these policy goals and underscore the need for a more integrated and well-resourced approach to ensure that rural areas benefit from these frameworks.

Case Studies: Local Impacts and Recovery Efforts

Chipinge and Chimanimani (Manicaland Province)

Cyclone Idai caused catastrophic damage in these districts, leading to flooding, landslides and widespread infrastructure failure. Over 33 000 people lost access to clean water and schools, homes and bridges were destroyed (Waini *et al.*, 2023). Emergency response efforts included relocation and rebuilding initiatives; however, weak planning systems and limited capacity have slowed recovery.

NDIADZO VILLAGE RECOVERY INITIATIVE

In Ndiadzo, where homes built with poor-quality farm bricks were destroyed, the government implemented a reconstruction programme using improved cement-based materials. The new designs included reinforced foundations, storm-resistant features and deforestation mitigation strategies (Bhatasara *et al.*, 2023). While this initiative demonstrated the potential of policy-backed rebuilding, challenges remain regarding its replicability due to funding constraints and cultural resistance.

COMMUNITY-BASED AND NGO-LED RESPONSES

Beyond government interventions, communities and NGOs have increasingly taken the lead in implementing small-scale, locally driven solutions aimed at enhancing climate resilience in rural construction. Among these initiatives are the formation of rebuilding groups and community-led construction brigades, which empower residents to collectively rebuild homes using safer techniques. Disaster preparedness training tailored specifically to rural contexts has also been introduced, equipping communities with the knowledge to respond effectively to cyclonic threats. NGOs have played a critical role by offering capacity-building programmes that teach low-cost, climate-resilient building methods, thereby bridging knowledge gaps and promoting self-sufficiency. Furthermore, there has been a revival of traditional environmental stewardship practices, including community afforestation projects and water harvesting techniques, which not only reinforce climate resilience, but also strengthen communal ties and ecological sustainability.

Despite their promise, these initiatives are often underfunded and poorly documented, limiting their scalability. Greater recognition of indigenous knowledge, local agency and participatory governance is essential to strengthen these efforts.

The findings reveal that climate change, particularly in the form of tropical cyclones, poses a serious threat to rural communities in Zimbabwe, exposing the fragility of traditional housing and infrastructure. While policy frameworks and innovations exist to promote resilient construction, practical implementation is hindered by economic, institutional and cultural challenges.

Sustainable construction must balance affordability, cultural appropriateness and structural safety. Hybrid technologies and community engagement offer promising pathways, but require sustained investment, training and decentralised support systems. The case studies of Chipinge and Ndiadzo Village illustrate both the risks of poor housing and the transformative potential of coordinated, inclusive rebuilding efforts.

Ultimately, building resilience through sustainable construction is not only a technical challenge, it is also a social and developmental imperative. A shift toward integrated, locally grounded strategies is essential to enable Zimbabwe's rural communities to withstand and recover from future climate shocks.

DISCUSSION

Literature on sustainable construction in cyclone-prone rural regions reveals a complex interplay between theory and practice, with growing consensus around the integration of resilient construction techniques that fuse modern engineering with traditional building methods (Kurda and Garton, 2020; Elkharboutly and Wilkinson, 2022; Mohapatra *et al.*, 2022). Theoretical perspectives have long highlighted the value of lightweight, locally sourced materials, which are often more accessible and environmentally suitable. However, empirical evidence from events such as Cyclone Pam in Vanuatu, demonstrates that without structural reinforcement, these traditional buildings are often inadequate in withstanding severe cyclonic impacts. This has led to an evolving understanding that sustainability in rural construction must go beyond material choice to include robust construction techniques, reinforced frameworks and flexible, locally adaptable design models. A notable divergence also emerges between the idealised appreciation of traditional housing and the empirical realities observed during cyclonic disasters. In practice, traditional structures have suffered disproportionately high levels of damage compared to hybrid or reinforced modern buildings (Nyahunda *et al.*, 2024). For example, in post-disaster assessments in Vanuatu, many traditionally built homes were destroyed despite their assumed ecological and climatic suitability. This points to structural deficiencies, such as inadequate anchoring or substandard roofing methods, which are rarely addressed in theory. Bridging this gap requires a critical reassessment of local building

codes, integrating cyclone-resilient specifications that draw from both indigenous knowledge and scientific engineering standards.

Recent studies from regions including India, Malawi and Zimbabwe support, note a shift toward more context-sensitive, integrative models of rural construction. For instance, in Odisha, India, post-cyclone rebuilding initiatives have introduced cyclone shelters which double as schools, combining traditional stilt-based designs with reinforced concrete elements to enhance durability. In Malawi, community-driven housing programmes have piloted the use of stabilised soil blocks with embedded disaster risk training, showing success in both cost-effectiveness and community ownership. These case studies highlight the importance of designing construction solutions that are locally relevant, scalable and resilient to long-term climatic pressures. However, the implementation of such integrative strategies is not without challenges. Resource constraints, low technical capacity among local builders and limited enforcement of building codes often impede progress. Moreover, resistance to change, especially when traditional methods are tied to cultural identity, can stall the adoption of safer alternatives. Addressing these barriers requires inclusive community participation, ongoing education and capacity-building. Local artisans and community leaders should be empowered through training programmes that demonstrate how traditional aesthetics can be preserved within stronger, hybrid designs.

While policy reforms are essential, over-reliance on top-down regulatory changes may be ineffective without parallel grassroots engagement and practical, immediate interventions. Local governments and NGOs should prioritise hands-on initiatives, such as subsidised cyclone-proof roofing kits, mobile construction training clinics and participatory hazard mapping. These actions provide visible, short-term benefits, while aligning with broader national adaptation strategies. Instead of displacing traditional construction entirely, sustainable approaches should promote hybridisation—using modern reinforcements to strengthen vernacular forms. This not only enhances physical resilience, but also preserves cultural continuity, which is vital for community acceptance and long-term adoption. Sustainable construction in cyclone-prone rural regions must balance scientific innovation with cultural sensitivity, robust policy with practical action and long-term goals with present-day realities. Empowering communities, adapting global best

practices to local contexts and addressing structural vulnerabilities through both policy and practice are essential for building cyclone-resilient rural settlements in Zimbabwe and beyond.

CONCLUSION AND RECOMMENDATIONS

The study highlights the urgent need to transition rural construction practices in Zimbabwe toward more sustainable and resilient models, particularly in response to the increasing severity of tropical cyclonic events. While traditional building practices offer valuable cultural insights and context-specific adaptability, they often fall short of withstanding extreme weather without strategic enhancements. The intersection of empirical evidence and theoretical frameworks underscores that resilience is not only a matter of material selection, but also hinges on quality design, skilled construction and compliance with rigorous building standards. Thus, harmonising indigenous knowledge with contemporary engineering practices is essential to develop robust, durable and contextually appropriate solutions. To translate these findings into practice, the following targeted recommendations are proposed:

- Develop and implement localised cyclone-resilient building frameworks. Governments, in collaboration with local authorities and NGOs, should formulate region-specific construction guidelines that integrate traditional knowledge with modern safety standards. These should include: technical manuals for builders, prototypes of hybrid housing structures and subsidised training programmes for local artisans and builders. There is need to empower community-led construction and decision-making. Community engagement must go beyond consultation to genuine leadership and ownership in planning, building and maintenance. Actions should include establishing village-level resilience committees to lead housing decisions.
- Facilitating community-based construction cooperatives to scale up local participation and job creation.
- Incorporating women and youth in construction training and leadership roles.
- Promotion of balanced use of modern and traditional construction methods**.**

While modern methods of construction offer efficiency and durability, they must be adapted to local conditions and values. Recommendations include:

- Supporting pilot projects which blend stabilised soil blocks, bamboo and modern reinforcements.
- Preserving architectural heritage through retrofitting traditional homes rather than replacing them entirely.
- Ensuring that modern methods are affordable and replicable for rural households.

Linking Construction Strategies to Broader Socio-Economic Development Goals is imperative. Given that 76% of Zimbabwe's rural population lives in poverty, construction strategies must address intersecting issues of livelihoods, food security and employment. Governments and development partners should:

- align construction projects with local economic development plans, such as hiring locally and sourcing materials regionally.
- integrate green infrastructure including rainwater harvesting, solar energy to enhance both resilience and sustainability.

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