



Southern African Journal of Communication and Information Science

Special Issue: Climate Change

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Zibusiso Mabonisa and Justin Salani

To cite this article: Mabonisa, Z. C. and Salani, J. 2026. Application of Indigenous Knowledge System in climate-induced disaster risk reduction: A case of smallholder farmers in Matobo district. *Southern African Journal of Communication and Information Science*. 4(1): 18-35

Published Online: 21 August 2026

SAJCIS

2026, Vol. 4, No. 1, 18-35.

Application of Indigenous Knowledge System in climate-induced disaster risk reduction: A case of smallholder farmers in Matobo district

Zibusiso Condry Mabonisa

Lupane State University, Zimbabwe

zicomabonisa@gmail.com

Justin Salani

National University of Science and Technology, Zimbabwe

salani.j@yahoo.com

Abstract

Climate-related disasters have been increasing in intensity and frequency globally, largely due to anthropogenic climate change. The extreme climate events such as tropical cyclones, floods, and droughts have posed unprecedented socio-economic challenges, disproportionately affecting vulnerable rural smallholder farming communities that rely primarily on climate-sensitive natural resources. Effective interventions in disaster risk reduction, therefore, require local solutions, rooted in indigenous knowledge to ensure effective mitigation, and adaptation and strengthen resilience. This study, therefore explores the application of Indigenous Knowledge System (IKS) in climate-induced disaster risk reduction among smallholder farmers in Matobo district. The paper determines the extent to which smallholder farmers apply indigenous knowledge systems for risk reduction and strengthening resilience to climate-induced disasters, and identifies the challenges associated with indigenous practices in disaster prediction and response by smallholder farmers. Informed by a decolonial theoretical heuristic, the paper adopts a qualitative approach, a case study design, with purposively selected smallholder farmers in Matobo district as the sample. In-depth interviews are used to collect data from the participants, and a thematic approach is used in data analysis. The study found that smallholder farmers in Matobo use cosmological, ecological and cultural methods in disaster prediction and mitigation, leveraging knowledge from the margins for vulnerability reduction and resilience building. The efficacy of these strategies validates a decolonial approach to disaster risk reduction that localises and indigenises community-based approaches and stakeholder interventions. The study infers that IKSs are applicable and reliable in disaster risk reduction, and recommends that they should be integrated and applied in national policies and adaptation plans. Interventions should also leverage the complementarity of IKS and techno-scientific approaches in disaster risk reduction and resilience building.

Keywords: Indigenous Knowledge Systems; Climate Change; Disaster risk reduction; Decoloniality; Smallholder farming.

Introduction

Anthropogenic climate change has exacerbated global disproportionate impacts of hydrometeorological disasters, primarily affecting vulnerable communities in Africa. Climate change-induced disasters such as floods, tropical cyclones and heatwaves are increasing in intensity and frequency (Zhang et al., 2024; Fonjong et al., 2024), causing significant challenges especially for rural farming communities in Zimbabwe and Africa at large (Dzvimbo et al., 2022; Chitswa, 2024). These disasters have impacted food insecurity and worsened poverty, while also causing violent conflicts. Droughts are the most damaging of the catastrophes, destroying crops and contributing to violent conflicts in Africa (Shimada, 2022). According to Ngcamu (2023), climate change adversely impacts vulnerable populations, yet adaptation mechanisms are not sufficiently implemented in most rural farming communities in Africa. It is apparent that the increasing unpredictability of climate patterns as a result of climatological modifications exacerbates food insecurity (Bedasa and Deksisia, 2024), economic instability, and displacement, further marginalising vulnerable communities. The subsequent challenges are particularly severe for the underprivileged, aged, and physically challenged, and women who face gender inequalities and socio-economic limitations are particularly susceptible (Onyeaka et al., 2024). As smallholder farmers are among the most vulnerable, proactive and timely interventions are critical in addressing the challenges faced. There is a growing recognition of the importance of incorporating local, context-specific solutions rooted in Indigenous Knowledge Systems (IKS) (Mwalwimba et al., 2024), to effectively reduce the impact of climate-related natural disasters. Interventions that prioritise local, context-specific solutions, and integrate IKS to enhance mitigation, adaptation, and resilience are particularly important (Mercer et al., 2020). Filho et al. (2023) found that although recognised as a crucial asset for adaptation, existing national adaptation plans in Africa exhibit significant deficiencies in adequately incorporating IKS into policy frameworks to mitigate risk.

Indigenous knowledge accumulated over generations through lived experiences and cultural practices, offers valuable insights into climate adaptation and disaster risk reduction, particularly for communities that have historically co-existed with their environments. Makondo et al., (2018) and Dorji et al (2024) spectacle the centrality of IKS in disaster risk reduction, but they do not acknowledge its potential application as epistemic disobedience. It is also evident that global and national efforts have largely relied on modern scientific and technological approaches to Disaster Risk Reduction (DRR), that have often overlooked the lived experiences, cultural contexts, and indigenous knowledges that are deeply rooted in African communities. Extant literature emphasises the integration of science-based initiatives employing spatial techniques, such as geographic information systems, disaster exposure mapping, and socio-economic risk and vulnerability mapping (Dlamini et al., 2024; Koike et al., 2018). This overreliance on (Western) science further marginalises indigenous technical knowledge, perpetuates epistemicide and sustains colonial legacies in knowledge production (Adams, 2024; Ogunbure, 2013; Seehawer, 2018). Where IKSs are embedded and integrated with Western scientific approaches, only what conforms to the Western scientific approaches is extracted, as indigenous knowledge has been seen as anecdotal. Through a decolonial lens, this study, therefore is poised to examine the application of IKS in disaster risk reduction in smallholder farming communities, focusing on how IKS and

scientific approaches can complement each other. The study therefore seeks to answer the following questions:

- How and to what extent do smallholder farmers in Matobo district apply indigenous knowledge systems in disaster risk reduction?
- What are the challenges associated with the use of indigenous practices in disaster risk reduction among smallholder farmers in Matobo district?

By exploring how smallholder farmers in Matobo district apply indigenous knowledge and practices to predict, mitigate, and adapt to climate-induced disasters, the study provides valuable insights into locally grounded solutions that are often overlooked in mainstream, Western-centric approaches.

Overview of Matobo

Matobo district is situated in Matabeleland South province, in the semi-arid southwest region of Zimbabwe. The district is characterised by an iconic granite topography, kopjes and balancing rocks that attract millions of tourists. Beyond the tourism destination of its landscape, it holds a deep spiritual and cultural significance for its residents and many Indigenous Religion believers by hosting sites such as the Njelele rain-making shrine. The district is mainly populated by isiNdebele-speaking people whose socio-economic livelihoods are deeply grounded in rural smallholder farming. The geoclimatic categorisation of Matobo district is region five (5) under the Zimbabwe Natural Farming Regions. This region is characterised by erratic, low annual rainfall and high average temperatures. This climate is not favourable for rain-fed crop cultivation; however, the region is conducive for animal ranching. It is from this background and the cultural relevance of domestic animals like cattle among Matabeleland people that the community's reliance on livestock ranching and the application of generational, indigenous ecological knowledge as a mechanism for surviving climate shocks are accentuated.

Impact of climate change-induced disasters on smallholder farming

Climate-induced disasters are calamitous events caused by changes in weather patterns that result in the loss of life, environmental damage, and economic losses (Muzerengi et al., 2023). These disasters have escalated food insecurity in Africa because most of the countries are vulnerable and are very far from reaching adaptation and mitigation stages (Dzvimbo et al., 2022). Zimbabwe's susceptibility to climate change in agriculture is classified in its natural farming regions 1 to 5, where the categorisation is based on the average rainfall, soil type, vegetation, temperature, and altitude of each region (Shoko Kori et al., 2024). Matobo District falls under natural farming region 5, which receives the least rainfall; however, it is good for cattle ranching (Ndlovu et al., 2020). Due to climate change impacts on agriculture, Zimbabwe has seen a huge decrease in productivity from once an excess to only 15 to 20% of the country's GDP, while other countries such as Malawi and Mozambique have 31% and 27% contributions to the GDP, respectively. Overall, agriculture still plays an important role in the Southern African economy and is a very vital source of achieving food security (Nhemachena et al., 2018). Smallholder farmers in Southern African countries like Zimbabwe, Zambia, and Malawi are vulnerable to dependency due to the land tenure challenges,

their farm occupation agreements do not guarantee them access to financial assistance from credit facilities like bank loans (Mwalwimba et al., 2024).

Smallholder farmers are confronted with poor infrastructure, lack of adequate inputs, and insecure land tenure; however, agriculture thrives on good climatic conditions; therefore, climate-induced disasters have exposed smallholder farmers to the negative impacts of climate change (Kudejira, 2014). Cyclones like Cyclone Eline in 2000 and Cyclone Dineo in 2017 resulted in agricultural infrastructure destruction; dams, bridges, dip-tanks, electric pylons, and roads were destroyed, hence harming smallholder farmers' nutrition gardens, transportation of agricultural inputs, as well as buying and selling of the agricultural products (Ndlovu et al., 2020). Climate change impacts on agriculture necessitate the continuous outward migration of the active population, robbing smallholder farmers of their potential human and social assets (Ndlovu et al., 2020). Smallholder farmers mainly rely on rain-fed agriculture, making them susceptible to climate-induced disasters that result in spatial and unpredictable rain patterns (Kugara et al., 2022). Climate change impacts rainfall patterns, amount, and duration (Dzvimbo et al., 2022). Climate-induced disasters like droughts result in the drying of water bodies, which are alternatives to irrigation schemes for smallholder farmers (Muzerengi et al., 2023). In Mwenezi, Zimbabwe, after a very poor rainfall season, farmers had to deal with pests and diseases on their crops and animals, which are exacerbated by droughts and further affect the yields (Muzerengi et al., 2023).

Frost and prolonged winter seasons also delay planting of crops and impact the livestock production system as livestock succumb to low temperatures (Ndlovu et al., 2020). Erratic and often unpredictable rainfall has resulted in crop failures for smallholder farmers (Muzerengi et al., 2023). Climate change has interfered with farmers' known calendars, making it difficult for farmers to plan their planting dates and, in the end, resulting in reduced crop hectareage due to delays in non-crop planting (Ndlovu et al., 2020). There is a shift from the traditional season, which usually starts in October, and it now starts at the end of November or early December, while the duration of the wet season is now unpredictable but much shorter than usual (Dzvimbo et al., 2022). The 2021/22 prolonged dry spells caused crop failure in the legumes, which are known to be drought-resistant plants (Muzerengi et al., 2023). The unpredictable rainfall patterns have resulted in the diminishing of pastures and the death of livestock. Due to climate change-induced disasters like droughts, smallholder farmers can no longer depend on farming water-loving crops, such as maize, adhere to traditional planting days, keep large herds of cattle, or practice semi-pastoralism (Ndlovu et al., 2020).

IKS and Disaster Risk Reduction

The application of indigenous knowledge systems has the potential to enhance disaster risk reduction in vulnerable communities. Dorji et al. (2024) acknowledged that local people can utilise indigenous knowledge to predict catastrophic climatic events, prepare for them, and endure their impacts through various adaptation tactics. Radeny et al. (2019) also agree that numerous African communities depend on indigenous and local knowledge for their agricultural practices, employing local biophysical indicators, such as the behaviour of certain animal species, insect activities, the flowering of specific plants, astrological signs, and the timing of seasonal changes to organise their farming efforts. Indigenous and Local Knowledge (ILK) offers numerous benefits in addressing

climate change. It enables communities to leverage their understanding of local ecosystems and weather patterns, alongside traditional practices, to formulate effective adaptation strategies. These strategies encompass the development of crop varieties, cropping calendars, livestock breeds, and drought- and disease-resistant varieties, as well as land management techniques that have adapted to local climatic conditions (Masango and Mbarika, 2022; Redvers et al., 2023). Walter et al. (2025) identified significant challenges that hinder the efficient utilisation of ILK for climate change adaptation in Africa. The destruction of indigenous cultures and languages, frequently attributed to globalisation, urbanisation, and the impact of Western education, jeopardises the transfer of indigenous knowledge across generations.

Indigenous Local Knowledge is frequently transmitted across generations, primarily through oral means, thereby maintaining continuity of practices that have demonstrated efficacy in the management of local ecosystems (Christie et al., 2023). Kugara et al. (2022) identify four main arguments about the value of IKS in climate-induced disaster risk reduction. The first is on the knowledge possessed by the indigenous people on mitigation and adaptation to these shocks; the second argument is on the activeness of the people in applying those IKSs discovered by various researchers and, the third argument being that the Disaster Risk Reduction projects implementations can enhance knowledge contained in IKS, while the other argument being that the non-formality of IKS dissemination is a powerful education tool than formal education. A study by Mwalwimba et al. (2024) reveals that the people of Chikwawa in Malawi monitor the behaviour of animals to predict and prepare for climate-induced disasters. Such as floods and droughts. Animals like hippopotamuses, crocodiles, and frogs will flock from the Shire River to the nearby villages to indicate the floods that are coming. However, deforestation affects the behaviour of these animals as the bushes used to accommodate them are destroyed. Smallholder farmers prefer IKS to scientific climate information because scientific information tends to generalise things; if it happens to reach them, otherwise they may have little access to it. Whereas IKS is always available and it warns them of a specific disaster that will occur in their village, not generalised (Mwalwimba et al., 2024).

Zimbabwe's National Climate Policy acknowledges the critical role played by IKS in climate change mitigation and adaptation objectives; it acknowledges the importance of maximising people's potential, knowledge base, culture, and skills that are all buttressed by IKS (Nyahunda, 2024). However, there is a gap in the implementation of IKS-based interventions. The findings by Filho et al (2022) reveal that, although recognised as an important asset for climate adaptation, existing national adaptation policies across Africa exhibit significant shortcomings in adequately incorporating Indigenous and Local Knowledge systems into legal frameworks aimed at mitigating vulnerability. In Tsholotsho, Zimbabwe, the area is prone to floods; people observe the continuous crying and unsettledness of a rain-making bird and the presence of dark clouds to predict heavy rainfall that has the potential to result in floods. To mitigate the disaster, they employ measures, such as land zoning, relocating livestock shelters to higher grounds, as well as using available resources like wooden poles to create temporary bridges on flooded rivers for children going to school (Dube and Munsaka, 2018). Integration of IKS in climate change policies helps in

stimulating an easy understanding of climate change to the marginalised communities that bank on IKS (Nyahunda, 2024),

Theoretical framework

This study is grounded in decolonial theory, which challenges the dominance of Western-centric epistemologies and advocates for the recognition and valorisation of knowledge from the margins, including African Indigenous Knowledge (AIK). This theory applies to this study given that Western construction of climate change and natural disasters as universal and techno-scientific issues fails to capture the complex, relational, and culturally embedded ways in which African communities experience and understand the climate. Decoloniality seeks to dismantle the enduring legacies of colonialism in knowledge production, power structures, and societal practices, emphasising the importance of diverse ways of knowing and being that have historically been suppressed or devalued (Mignolo, 2011; Quijano, 2000). This colonial legacy is also evident in the overreliance on Western science in disaster risk reduction and response in the Zimbabwean context. A decolonial framework provides a critical lens to interrogate the exclusion of indigenous knowledge in mainstream approaches and to centre the voices and practices of smallholder farmers in Matobo district. This approach makes disaster risk reduction strategies resonate, ensuring their widespread adoption in communities. This is often important given that climate change is an abstract and often complex phenomenon that requires tailored, context-specific interventions.

Decolonial theory critiques the epistemic violence perpetuated by the privileging of Western scientific knowledge, which often disregards the lived realities, cultural contexts, and indigenous epistemologies of African communities (Ndlovu-Gatsheni, 2013; Seehawer, 2018). This epistemic violence, referred to as epistemicide, erases indigenous ways of knowing and reinforces colonial hierarchies of knowledge (Santos, 2014). Through a decolonial heuristic, this study resists such epistemicide and positions indigenous knowledge as a legitimate and invaluable resource for addressing contemporary challenges, including climate change and disaster risk reduction. The decolonial framework also emphasises the importance of relationality and interconnectedness, which are central to many indigenous worldviews. Indigenous Knowledge Systems often embody holistic understandings of the environment, emphasising the interdependence between humans, nature, and spirituality. Furthermore, decoloniality calls for the democratisation of knowledge production, advocating for participatory and inclusive research practices that empower marginalised communities (Crothers, 2013). In line with this, the study employs a qualitative, case-study design that prioritises the voices and experiences of smallholder farmers in Matobo district. Through in-depth interviews and thematic analysis, the research seeks to co-create knowledge with the participants, ensuring that their indigenous practices and perspectives are central to the findings and recommendations

Methodology

The study adopted a qualitative research approach, guided by a case study design, to explore the application of indigenous knowledge systems in climate-induced disaster risk reduction among smallholder farmers in Matobo district. The qualitative approach is appropriate for this study given

that it allows for an in-depth understanding of the lived experiences, practices, and perspectives of the participants, aligning with the decolonial theoretical framework that prioritises the voices of marginalised communities (Crothers, 2013; Smith, 2012). The case study design enables a focused examination of the unique experiences of smallholder farmers in Matobo district, providing rich, context-specific insights into how indigenous knowledge is utilised for disaster risk reduction and resilience building. A purposive sampling technique was employed to select participants who possess rich knowledge of indigenous practices and have actively applied them in disaster risk reduction. This sampling technique ensured that the participants were information-rich cases, capable of providing detailed insights into the research questions (Creswell and Poth, 2018). The sample consisted of 25 participants, including 20 community elders and 5 Agriculture Extension (AGRITEX) officers, and this was sufficient to yield reliable data given that a sample involving 9-17 interviews and 4–8 focus group discussions reaches saturation (Hennink and Kaiser, 2022).

Data were collected through in-depth interviews with AGRITEX officers and focus group discussions with community elders. Four focus groups involving five community elders who are often custodians of indigenous knowledge systems were conducted. The interviews and discussions were recorded verbatim and conducted in isiNdebele, a local indigenous language. The data were analysed using thematic analysis, following Braun and Clarke's (2006) six-step framework. The audio recordings were transcribed and translated into English, then coded to find repeating patterns and themes. The coding approach was both inductive and deductive, allowing themes to arise from the data while adhering to the research objectives and theoretical framework. Key themes included the nature of indigenous techniques adopted, their effectiveness, problems encountered, and the potential for integration with modern strategies. The analysis was carried out manually to ensure a thorough engagement with the data and the integrity of the participants' voices. The researchers ensured anonymity and confidentiality, and all ethical practices were adhered to throughout the study.

Findings

Findings in this study confirmed that climate change is exacerbating smallholder farmers' vulnerability to disasters and that effective intervention in disaster risk reduction requires a tailored, indigenised and localised approach that leverages knowledge from the margins. The key themes and codes that emerged during the data analysis are summarised in Table 1.1 below.

Table 1: Themes, subthemes, codes and example statements

Main Theme	Subtheme	Codes	Example statement

Climate change impacts and disaster experiences	Climate patterns and disaster frequency have changed	Unpredictable weather patterns, erratic rainfall, extreme temperatures, seasonal shifts, increased frequency of disasters	"Our climate patterns in Gulathi Matobo have over the years become unpredictable and confusing to the community at large"
	Climate-related disasters negatively impact communities	Crop failure, livestock loss, water scarcity, food insecurity, disease outbreaks.	"Droughts are now frequent, affecting our crops as most of us depend on rain-fed agriculture."
Use of traditional practices in prediction and adaptation	Indigenous methods for disaster prediction	Animal behaviour, plant indicators, celestial observations, cultural rituals.	" <i>Inkanku</i> (Rain making Bird) has its unique calling that it does, it alerts us of both droughts and floods." "We perform rain-making ceremonies starting with <i>Itenela</i> (Bush Cleaning)."
	Indigenous practices for disaster mitigation	Water harvesting, crop diversification, agroforestry, traditional ceremonies	
IKS faces challenges and limitations	Reliability of indigenous methods	Lack of documentation, cultural erosion, generational disconnect	"These practices reduce the impacts but do not end the disasters."
	Barriers to effective application of IKS	Scientific methods, cultural barriers, political interference, technological advancements.	"A shift from traditional practices due to technological advancements."
Need for integration of indigenous and modern practices	Combining indigenous and modern strategies	Use of improved crop varieties, irrigation technologies, weather forecasts.	"We now plant drought-resistant crops like sorghum and millet, but we also use modern irrigation methods."
	Support for integration	Training, funding, community engagement, policy support	"Extension officers provide training on how to integrate traditional water harvesting with modern irrigation techniques."

Changes in climate and weather patterns and the prevalence of disasters

Findings in this study reveal that there have been observable changes in local climate patterns, characterised by erratic rainfall, extreme temperatures, and shifting seasons, exacerbating the risk of climate-induced disasters. These changes have led to increased frequency and severity of

climate-related disasters, such as droughts, floods, and heat waves. *“Extreme weather became more frequent and severe. This past decade has been marked by devastating extreme events, including heat waves, record decline in rainfall and flooding,”* a participant noted. This has had a profound impact on livelihoods and food security, especially among farmers who rely solely on rainfed farming systems. Drought, shifts in farming seasons, midseason dry spells, and early-season cessation of rainfall have had the most impact on agricultural activities, affecting both crop and livestock production. Participant 1 said, *“...Long dry season, winter extending to September and October, while May and June, even July, have hot temperatures. Very little rainfall for consecutive years, which is not normal; we used to have drought once after many years.”* The high variability and unpredictability of the onset of the rain season has an impact on smallholder farmers’ ability to effectively plan their operations and prepare for natural disasters, particularly using indigenous knowledge. The findings also suggest that the rainfall received is becoming more intense, short-lived, and violent, indicating a deviation from the traditional rainfall patterns.

A rise in temperatures and increased frequency and severity of heat waves also emerged as significant climate-related challenges. Data gathered revealed that average temperatures have been rising, with summers becoming hotter and winters becoming warmer. Heatwaves are now more common and prolonged, further straining water resources and negatively impacting crop and animal productivity. Even during the winter months, sunlight intensity and warmth persist at higher levels than in the past, altering traditional seasonal cycles. *“There’s an increase in temperature received with winters even being warm, and sunlight received also even during winter remains high,”* another participant noted. This shift has led to a noticeable change in local climate patterns, with the seasons seemingly collapsing into long, dry winters and short, intense rainy seasons. This shift has profound implications for ecosystems, agriculture, and human livelihoods. Participant 7 noted, *“There has been reduced rainfall and high temperatures; there is a change in seasons from a traditional four seasons to two seasons which are characterised by long winter and very short rain season.”* The changing climatic patterns have also worsened the impact of the El Niño phenomenon, according to the findings in this study. These climatic patterns have intensified farming risks, making it difficult for smallholder farmers; hence, a need for increased investment in disaster preparedness, mitigation and adaptation. This unpredictable shift in seasonal cycles does more than disrupt farming; it threatens to destabilise the very ecological baselines that ground indigenous knowledge, making the reclamation and adaptive validation of these localised indicators a critical survival strategy.

Shifts in climate patterns have also been associated with meteorological disasters such as tropical cyclones and floods. These disasters have exacerbated farming risks, impacting planning and investment in farming and other livelihood projects. Cyclones have become more frequent and severe, affecting large parts of the country and causing widespread destruction to infrastructure, crops, and homes. These cyclones are often accompanied by heavy rains and flooding, which compound the challenges faced by communities already struggling with water scarcity and food insecurity. Additionally, severe storms and thunderous rains have become more common, often occurring over short periods and causing significant damage. *“...storms and thunderous rains of high intensity over short periods punctuated by host days even when rainy season has started.”* These observations confirm a shift in climate patterns, increased variability and seasonal

unreliability, exacerbating water, nutritional and food insecurity in smallholder farming communities. There is a need for intervention to build resilience to these disasters.

The impact of these disasters was profound, evidenced by frequent crop failures, loss of livestock, which provides drought power, the spread of animal diseases, and worsening farmers' plight. A participant noted that, *"prolonged dry season affects livestock as they end up dying of hunger; most of the farmers here use cattle and donkeys to cultivate, so if there is a long dry season it means that they will not be fit to be used in farming when the rains come; this also delays the planting of crops."* The extreme climate events are leading to recurring crop failures and the drying up of critical water sources such as dams, which are essential for both irrigation and livestock. As water levels recede, livestock are drawn to the remaining muddy pools, where they often become trapped. A participant noted, *"Livestock end up dying on these dams when they are stuck in the mud because when they dry, there will be very big muddy water that will attract them and they end up stuck."* Additionally, the scarcity of water and pasture forces livestock to share resources with wild animals, increasing the risk of diseases, such as foot-and-mouth and anthrax. This exacerbates public health risks, highlighting the urgent need for adaptive strategies to mitigate these compounding effects. It also emerged that these disasters have led to soil degradation, loss of fertility and the spread of wildfires. The impact of these hazards has also cascaded into negative environmental spill-overs, such as illegal mining as the primary source of livelihoods is disrupted. These challenges signal a need for more tailored responses that are based on local indigenous solutions for local communities. However, challenges still exist, which inhibit effective coping mechanisms.

Application of indigenous knowledge systems in disaster risk reduction

Data gathered confirmed the widespread use of indigenous knowledge, traditions and practices in disaster mitigation, adaptation and resilience among smallholder farmers. It was apparent that rural farming communities command rich indigenous knowledge developed through interaction with the environment. Although these indigenous methods cannot be validated in Western scientific terms, they have proved valuable in supporting rural farmers' disaster preparation, response and in strengthening resilience. The findings indicate that indigenous technical knowledge is applied in areas such as disaster prediction, mitigation, response, and adaptation. The indigenous practices were found to be effective, although there are certain limitations.

Indigenous methods for disaster prediction

Disaster prediction is critical to ensure effective planning and impact reduction. Through indigenous knowledge, smallholder farmers predict and develop mechanisms for response and risk reduction grounded in indigenous understandings of the environment. The participants consistently emphasised the use of ecological indicators and animal behaviour as indigenous methods for predicting disasters. The migration patterns of birds, the behaviour of livestock, and the presence of specific species such as the *Inkanku* (rain-making bird) and *Amangabuzane* (black and white storks) are closely monitored to forecast rainfall and drought conditions. *"For floods, there is a bird called Inkanku (Rain-making Bird) it has its unique calling that it does, it alerts us of both droughts and floods. For droughts, its calling is very weak; it can spend the whole day*

without calling, but when heavy rains are coming, it calls now and then.” Monitoring the behaviour of the bird informs us of impending disasters, which enables the community to effectively prepare and reduce the damage that can be caused. This is equivalent to satellite-based monitoring systems that inform early warning systems for public alertness. Another bird called *Inkonjane*’s behaviour also informs the community of the impending disaster. When the birds fly at high speed as if chasing each other, flying very low to the ground, informing people that there will be heavy rains.

Other community-level disaster prediction and monitoring systems that are based on indigenous knowledge include observation of the behaviour of birds, for instance, birds building nests on lower branches indicating drought or flying in circular formations signalling heavy rains. The information guides farmers on proactive response strategies in the event a disaster happens. A participant noted, *“Birds also build their nest to indicate the amount of rainfall; when they are built on very low tree branches, there will be droughts.”* They also study the movements of stars and appearances on the sun, moon and the sky. A clear sky without any haze indicates drought, while haze on the sun and moon indicates a good rain season. Additionally, the timing of plant flowering, fruiting, and leafing, as well as cloud formations and wind patterns, are used to predict weather changes. Participant 9 noted, *“Cloud types, with heavy clouds indicating significant rainfall and light clouds indicating minimal rainfall, offer further insights.”* These practices demonstrate a sophisticated understanding of ecological dynamics and the ability to interpret subtle environmental cues, which are often corroborated by modern meteorological observations. These observations are deeply rooted in generational knowledge and are passed on through oral tradition. These indigenous methods of forecasting are particularly important for smallholder farmers in marginalised communities as they have limited access to technology-based methods.

Indigenous practices in disaster mitigation and response

Disaster risk reduction also requires effective mitigation and timely response to reduce severe impacts that can lead to loss of lives and damage to infrastructure. In terms of disaster mitigation, the findings reveal a range of indigenous strategies employed by communities. Agricultural practices such as *Gatshopo/Pfumudza* (conservation farming), contour ploughing, and mixed cropping are widely used to conserve soil moisture, reduce erosion, and enhance crop resilience. *“Gatshopo/ Pfumudza conserves water and nutrients; first, a low amount of rainwater collects in holes and provides enough moisture to cause seed germination,”* a participant noted. These methods are particularly effective in drought-prone areas, as they maximise water retention and nutrient availability. Conservation agriculture ensures minimum soil disturbance, which is also essential in climate change mitigation and soil conservation. Moisture conservation reduces crop failure caused by severe midseason dry spells or early-season cessation of rainfall. This guarantees farmers’ yields, thereby mitigating the risk of food and nutritional insecurity.

Water harvesting and management techniques, such as digging trenches, constructing small dams, and building terraces, are also employed to capture and store rainwater. These practices provide a reliable water source during dry periods while reducing the risk of flooding by managing surface runoff. Livestock management strategies, including rotational grazing and stockpiling of fodder, ensure the survival of livestock during droughts, with indigenous breeds such as the hard Mashona

cattle being preferred for their drought resistance. A participant noted, *“Digging of trenches in our fields helps in storing water; we also cut grass and amahlanga (plant residues) and keep them for our livestock to feed them during dry season.”* In addition, cultural and ritual practices, such as *Itenela* for bush cleaning, which is done by men and *Amayile*, ritual appeasement dances done by women, play a significant role in drought risk mitigation. Visiting sacred mountains to perform rainmaking rituals is also another drought mitigation strategy, as this practice is associated with a good rainy season. A participant noted, *“We also go to our sacred mountain Njelele to perform rituals there that will be guided by our Hosana (Rain making Queen), The Hosanas are also there at village level where each village can do their rain making ceremony by preparing traditional beer and going to the village sacred place for rain making ceremony, they will dance the whole day there beating drums as the dance is being led by the Hosana.”* While these practices are spiritual in nature, they also foster social cohesion and collective action in the face of climate challenges. Relying on these holistic, spiritually integrated practices that completely diverge from Western scientific models, smallholder farmers are executing a form of epistemic disobedience. They are actively asserting the legitimacy of ancestral, relational ways of knowing to protect their ecosystems, refusing to let their cultural traditions be erased by Eurocentric disaster mitigation paradigms.

Drought mitigation strategies also include community-based food storage, where smallholder farmers collectively grow drought-resistant crops and store yields in communal barns for redistribution, ensuring food security during droughts. This strategy ensures a consistent supply of food, thus strengthening resilience to drought. *“We have started growing crops as a community in Gulathi and keeping them in barns for later usage. We also recycle water as much as we can.”* In addition, practices such as intercropping, crop rotation, and the use of organic manure to improve soil fertility and water retention have been adopted to enhance agricultural productivity. These strategies are also supported by ritual practices that demonstrate the interconnectedness of nature and spirituality, making local strategies essential in disaster risk reduction. Rituals like bush cleaning and the burning of lightning-struck trees are believed to appease ancestral spirits and restore ecological balance, reflecting a holistic approach to disaster mitigation.

Challenges and limitations of IKS

Data gathered confirmed that there are limitations and challenges associated with the use of IKS in disaster risk reduction and factors that hinder their effective application in communities. It emerged that a generational divide exists that hinders the adoption of IKS, where the younger generations rely on techno-scientific methods, viewing IKS as inferior to Western science. This also stems from the reliance on documented information; thus, orally passed indigenous knowledge is overlooked. A participant noted, *“the fact that this knowledge is undocumented makes it difficult to be effective to our generation, which is used to documented knowledge.”* Additionally, IKS often has a localised focus, limiting its applicability to regional or national disasters, and its reliance on cultural beliefs may not be transferable across different contexts. Data gathered has also shown that environmental changes, such as heatwaves and prolonged dry seasons, are altering the behaviour of ecological indicators, undermining the reliability of traditional prediction methods. Cultural and religious conflicts further complicate the application

of IKS, as clashes between traditional practices such as rainmaking ceremonies and contemporary beliefs create resistance within communities. A participant noted, *“There is a clash between traditional beliefs like the taboos and Christian beliefs where Christians are violating the taboos like ukuthwasa kwenyanga (resting days in respect of the new moon) ukuzilela izulu eline ngolaka (resting in respect of a thunderstorm)”*. In addition, limited funding, lack of integration with modern methods, and insufficient community engagement in decision-making processes also pose significant barriers. These challenges highlight the need for documenting and formalising IKS, fostering intergenerational dialogue, and integrating indigenous practices with modern technologies to enhance their relevance and effectiveness in disaster risk reduction.

Discussion

Climate change has exacerbated the impact of hydrometeorological disasters, causing unprecedented challenges, especially for rural farming communities. Findings in this study confirmed that local climatic patterns have shifted, with increasingly unpredictable seasonal variations in weather patterns. The rainy season is also becoming shorter, marked by early season cessation and prolonged mid-season dry spells, and the impact of climate-induced disasters drought, floods, cyclones and heatwaves is increasingly becoming evident. This evidence supports findings from a study by Ndlovu et al. (2020), which revealed that the shift in farming seasons has led to the disruption of farming calendars. Extreme events have disrupted traditional farming practices, reduced agricultural productivity, and intensified food and water insecurity, worsening the vulnerability of smallholder farmers who rely predominantly on rainfed agriculture. These findings are consistent with extant literature, which highlights the increasing unpredictability of rainfall patterns, prolonged dry spells, and the intensification of extreme weather events as key drivers of agricultural vulnerability in Southern Africa (Dzvimbo et al., 2022; Muzerengi et al., 2023).

The study also highlights the cascading effects of climate-induced disasters on livelihoods and ecosystems. Frequent crop failures, loss of livestock, and the drying up of critical water sources have also exacerbated environmental degradation, including soil erosion, loss of fertility, and the spread of wildfires. These challenges are compounded by the encroachment of illegal mining activities, which emerge as alternative livelihoods when farming becomes untenable. This aligns with the literature’s discussion of the socio-economic spill-overs of climate change, including the disruption of primary livelihoods and the rise of environmentally destructive practices (Ndlovu et al., 2020). The impacts of these disasters therefore require effective localised interventions that are tailored to the specific needs of the communities. This calls for the indigenisation of forecasting and response strategies.

This study reveals that IKSs are being used widely by smallholder farmers for disaster prediction, mitigation, and adaptation. The application of IKS in disaster risk reduction reflects a sophisticated understanding of ecological dynamics and the ability to interpret subtle environmental cues, such as bird behaviour, plant flowering, and cloud formations, to predict weather changes and impending disasters. These practices, deeply rooted in generational knowledge and passed down

through oral traditions, provide marginalised communities with accessible and context-specific tools for disaster preparedness that have often been overlooked in disaster risk reduction and response. The utility and applicability of this indigenous knowledge supports calls by proponents of decolonial thought who seek to dismantle the enduring legacies of colonialism in knowledge production, power structures, and societal practices, emphasising the importance of diverse ways of knowing and being that have historically been suppressed or devalued (Mignolo, 2011; Quijano, 2000), such as African indigenous knowledge of the environment. The reliance on ecological indicators, such as the behaviour of the *Inkanku* (rain-making bird) and *Inkonjane* (swallows), mirrors extant literature's emphasis on the value of IKS in predicting catastrophic climatic events (Kugara et al., 2022; Mwalwimba et al., 2024). These indigenous methods of forecasting are particularly crucial for smallholder farmers who have limited access to technology-based early warning systems, demonstrating the significance of integrating IKS into broader disaster risk reduction strategies.

In addition, the findings in this study validate the efficacy of indigenous practices in disaster mitigation and response. Agricultural techniques such as conservation agriculture (Gatshopo/Pfumudza), contour ploughing, and intercropping have proven effective in conserving soil moisture, reducing erosion, and enhancing crop resilience. These practices are in alignment with findings from previous studies, which highlighted IKS-based land management techniques that maximize water retention and nutrient availability, particularly in drought-prone areas (Masango and Mbarika, 2022). Water harvesting and management techniques, such as digging trenches and constructing small dams, further demonstrate the ingenuity of indigenous practices in addressing water scarcity and reducing the risk of flooding. Moreover, livestock management strategies, including rotational grazing and the use of indigenous breeds like the Mashona cattle, demonstrate the utility of IKS in ensuring the survival of livestock during droughts. These findings reinforce findings from previous studies that demonstrate that IKS offers practical, context-specific solutions for enhancing resilience to climate change (Redvers et al., 2023).

Cultural and ritual practices, such as *Itenela* (bush cleaning), *Amayile* (ritual appeasement dances), and rainmaking ceremonies at sacred mountains like Njelele, play a significant role in drought risk mitigation. The effectiveness of this strategy, which does not conform with Western science, demonstrates the utility of epistemic disobedience in disaster risk reduction. Decolonial theory critiques the epistemic violence perpetuated by the privileging of Western scientific knowledge, which often disregards the lived realities, cultural contexts, and indigenous epistemologies of African communities (Ndlovu-Gatsheni, 2013; Seehawer, 2018). Thus, the application and utility of culture-related practices resonate with decolonial thoughts, which valorise the indigenisation of disaster risk reduction strategies. While these practices are spiritual in nature, they foster social cohesion and collective action, reflecting the holistic approach to disaster mitigation embodied in indigenous worldviews. This interconnectedness of nature, spirituality, and community action is a central tenet of decolonial theory, which critiques the privileging of Western scientific knowledge and advocates for the recognition of indigenous epistemologies (Mignolo, 2011; Ndlovu-Gatsheni, 2013). The findings underscore the importance of relationality and interconnectedness in indigenous worldviews, which view humans, nature, and spirituality as interdependent. This holistic understanding of the environment is often absent in mainstream, techno-scientific

approaches to disaster risk reduction, highlighting the need for a decolonial framework that centres indigenous knowledge and practices.

Despite the effectiveness of IKS, there are challenges and limitations that hinder its full potential. The erosion of indigenous cultures and languages, attributed to globalisation, urbanisation, and the influence of Western education, threatens the transmission of IKS across generations. This aligns with the decolonial thought that problematises coloniality of power and epistemic violence perpetuated by the marginalisation of indigenous knowledge (Quijano, 2000) through scientific institutions and education systems, amongst others. Additionally, while Zimbabwe's National Climate Policy acknowledges the importance of IKS, there are significant gaps in its implementation. This agrees with Filho et al. (2022), who observed that existing legal frameworks often fail to incorporate indigenous practices adequately. This persistent implementation gap highlights the enduring structural legacy of the coloniality of power. Within state bureaucracies, indigenous practices are still routinely dismissed as anecdotal or unscientific, perpetuating a soft form of epistemicide where institutional frameworks continue to privilege Western techno-scientific approaches over tested knowledge from the margins. These challenges highlight the need for policy reforms that prioritise the integration of IKS into national adaptation strategies and ensure its recognition as a legitimate and invaluable resource for addressing climate change. The complementarity of modern science and technologies and indigenous knowledge, involving the use of solar-powered irrigation systems and traditional moisture conservation techniques as well as reliance on satellite-based weather forecasts and indigenous methods for disaster risk reduction, is critical in strengthening smallholder farmers' resilience to climate change-induced natural disasters.

Conclusion

The study infers that IKS is applicable and effective in disaster risk reduction, through indigenised disaster prediction, mitigation, and response strategies that are rooted in cultural practices and intricately connected with nature. Climate and weather patterns are changing, exacerbating the impacts of hydrometeorological disasters such as floods, heatwaves, droughts and tropical cyclones on already vulnerable rural smallholder farming communities, affecting food security, livelihoods, and ecosystems. The efficacy of IKS-based approaches in reducing the impacts of these disasters validates a decolonial approach to disaster risk reduction and response. However, the challenges and limitations associated with IKS, such as the erasure of indigenous knowledge and practices, require a synergistic approach that leverages the complementarity of IKS and modern techno-scientific approaches in reducing the negative impacts of hydrometeorological disasters.

Recommendations

Based on the findings, this study recommends a complete shift toward localised and integrated disaster management policies. Firstly, national adaptation plans and disaster risk reduction

frameworks must formally integrate and legitimise IKS, systematically moving away from an exclusive reliance on Western techno-scientific models. This policy integration should be operationalised as a complementary strategy where localised moisture conservation practices such as Gatshopo/Pfumudza and ecological indicators run parallel with modern satellite-based forecasting and solar-powered irrigation technologies. To ensure the survival of these practices, climate interventions must prioritise community-based approaches that actively foster intergenerational dialogue, counteracting cultural erosion by passing orally transmitted knowledge down to younger generations. Furthermore, a collaborative ecosystem involving state actors, agricultural extension officers, NGOs, and traditional leaders should be established to co-finance, document, and sustain these community-led initiatives. Finally, future academic research in Southern Africa should consciously adopt decolonial frameworks that centre indigenous voices, ensuring that knowledge production in disaster mitigation is co-created with, rather than exploitatively extracted from, marginalised rural communities.

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