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Indigenous knowledge systems-based drought coping strategies and mechanisms of the Ndau people of Chipinge district, Zimbabwe

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Drought is a common phenomenon that affects more people within the context of Africa than any other disaster. Likewise, drought is an extreme and common occurrence within the lowland areas of Chipinge district in Zimbabwe. Whilst responses to drought tend to focus on scientific investigations, of late, there has been growing awareness of the importance of adopting indigenous knowledge systems (IKS) as mitigation strategies. Through qualitative research utilising semi-structured interviews, focus group discussions (FGDs) and document analysis, this study sought to highlight the efficacy of indigenous knowledge as a sustainable and valuable resource that can be harnessed by indigenous communities for managing drought. A sample of 20 participants was recruited, seven participants through purposive sampling and 13 via snowball sampling. Data were analysed using thematic analysis. The study was underpinned by the community-based disaster risk management (CBDRM) framework. Research findings indicated reliance on IKS-based meteorological indicators for drought forecasting. Drought-coping strategies, inclusive of rainmaking ceremonies, the practice of *kuparira* (dry planting), intercropping, dry food preservation and the cultivation of drought-tolerant crops were identified.

Contribution: The study advocates for the integration of these IKS as tailored, sustainable strategies for drought management. Therefore, policymakers should formally integrate IKS into national drought management frameworks by establishing community-based platforms where local elders and experts can collaborate with meteorological services, and by adapting agricultural extension programs to promote proven indigenous strategies.

Keywords: coping strategies; disaster preparedness; drought; indigenous knowledge systems; lowland areas of Chipinge District; Ndau People; Zimbabwe.

Introduction

Drought is a major natural hazard with extensive socio-economic and environmental impacts, affecting agriculture, society and the economy (Dalezios et al. 2017; Ruwanza, Thondhlana & Falayi 2022). Whilst a common phenomenon, drought has many definitions, which stem from variations in its 'severity, location, duration and timing' (WMO & GWP 2016:1). According to Naumann et al. (2021), drought is defined as the period characterised by nonconforming soil moisture deficiency as a result of a lack of precipitation, increased temperatures and excess evapotranspiration. This subsequently results in negative impacts on both agricultural activities and the proper functioning of the ecosystem. Van Loon et al. (2016) offer a generic definition of drought, which is understood as a notable shortage of water in relation to normal conditions. According to Edossa, Woyessa and Welderufael (2014), drought is classified as both a natural hazard and a physical phenomenon. As such, it has the ability to stimulate severe socioeconomic and environmental effects, and these are more pronounced in resource-deprived and vulnerable communities. Therefore, this results in adverse effects on agricultural productivity, human and animal health, livelihood security, personal security, vegetation and water availability (Frischen et al. 2020; Shiferawa et al. 2014; WMO & GWP 2016). This consequently gives rise to food insecurity and poverty, and decreased access to education, especially for the girl child, who will be burdened with difficult and time-consuming household chores, such as searching for scarce firewood and having to walk for long in search of water (Shiferawa et al. 2014; WMO & GWP 2016). However, the adverse effects of drought are further dependent upon the 'socioeconomic contexts in which droughts occur, in terms of who or what are exposed to the droughts and the specific vulnerabilities of the exposed entities' (WMO & GWP 2016:1). Additionally, there are also indirect effects of drought which are manifested through environmental degradation, increased

shortage of food and compromised human welfare (Edossa et al. 2014). Shiferawa et al. (2014) also shared that within the context of Africa, drought has greatly affected agricultural activities with a severe impact on grazing lands and agricultural produce. Furthermore, the authors expressed that many smallholder farmers were left impoverished by spells of drought, and others ended up migrating from the rural to urban settings (Shiferawa et al. 2014). Ncube (2018) contends that drought is defined based on its repercussions on certain agricultural systems. It can therefore be defined as low rainfall, decrease in water availability, reduced grazing quality and quantity, dying vegetation and animals, as well as food shortages for both human and animal consumption (Ncube 2018). Drought is also regarded as an ecological catastrophe that has drawn the attention of environmentalists, hydrologists, meteorologists and agricultural scientists (Orimoloye et al. 2022). Research also indicates that climate change poses a great danger to planet Earth, and it is envisaged that this will give rise to more droughts (Ahmadalipour et al. 2019). Within the context of Zimbabwe, it has been noted that the country:

> [… *I*]s becoming more vulnerable to climatic changes and local climatologists predict various sectorial impacts that will affect the environment, agriculture and food security, health, water resources, economic activities, human migration and physical infrastructure. (Tanyanyiwa 2018:1)

In Zimbabwean local communities, the nexus between indigenous knowledge (IK) and disaster risk management has been neglected, potentially because of the ignorance and the subsequent marginalisation of indigenous knowledge systems (IKS). However, it has been evidenced that successful responses to disasters have been managed using the IK of local communities (Iloka 2016; Rahman et al. 2016; Sethi et al. 2011). According to Hlatywayo (2017):

> IKS refer to context-specific bodies of knowledge incorporating traditional values, belief systems and practices serving as practical knowledge developed under specific conditions for sustainable livelihoods of the local inhabitants of a specific geographical area. They are characterized by an unbroken continuance and are passed down from one generation to another. (p. 39)

Drawing from the Zimbabwean perspective, Muyambo, Bahta and Jordaan (2017) and Mutasa (2015) posit that there is a recent upsurge of literature that is profiling the adoption of IK by rural agricultural communities as coping strategies in response to the effects of climate change. It is in this wake that this study sought to investigate the IKS-based drought coping strategies of the Ndau people in the lowland areas of Chipinge district, Zimbabwe. In support of this broader objective, the study sought to:

- Identify Ndau indigenous prediction and indicators of drought.
- Explore Ndau coping strategies for drought mitigation.
- Propose policy recommendations for the formal integration of Ndau IKS into both local and national disaster risk reduction frameworks in Zimbabwe.

Therefore, this study presents Ndau-tailored indigenous solutions for coping with recurrent droughts in the lowland areas of Chipinge district. It addresses a gap in documented empirical knowledge regarding specific drought forecasting and mitigation strategies adopted by the Ndau people. Hence, this study presents a case study with recognisable and actionable strategies from a minority indigenous group in Zimbabwe, thereby contributing to the literature on IKS-based drought coping and mitigation strategies. These strategies can be assimilated into national policies on disaster risk management for local minority communities.

Background to the study

Research has noted that disaster risk reduction measures often downplay the IK of local communities when responding to calamities (Dube & Munsaka 2018). In this regard, IK is considered primordial and archaic. Development practitioners habitually disregard IK, citing its lack of documentation as well as claiming it lacks scientific validation (Dube & Munsaka 2018; Rai & Khawas 2019). However, Jones (2012) posits that local knowledge systems should not be dismissed as they serve as community intervention measures for the forecasting, mitigation and prevention of disasters. This entails that communities possess IK for disaster risk management that has existed and evolved over generations and has proven to be effective mitigation measures. Similarly, the United Nations International Strategy for Disaster Reduction (UNISDR) (2008) expresses that indigenous communities across the world have immemorially responded to disasters through the adoption of indigenous mitigation strategies passed down from one generation to another. UNISDR (2008) further contends that this has been in practice long before the advent of technology-based early warning systems. As such, Hiwasaki, Luna and Syamsidik (2014) contend that the IK prevalent in local communities can meaningfully mitigate against loss of human lives and valuable properties in the event of disaster. Thus, local communities make use of their local resources, which are harnessed as structural measures for disaster risk reduction (Dube & Munsaka 2018). Furthermore, IK for disaster risk management is regarded as more sustainable because it is entrenched in the religio-cultural traditions, ideologies and the language of given communities (Maferetlhane 2012). Accordingly, Makwara (2013) points out that the adoption of indigenous weather forecasting serves as a strategic mechanism that promotes sustainable development as it offers valuable information on both past and present weather conditions. Therefore, in order to effectively manage and respond to disasters, Kelman et al. (2012) suggest the need to respect and capitalise on the existing built-up IK of the local people. Not only does this serve as a disaster risk management strategy, but also it capacitates the local people to empower themselves through active participation in responding to disasters. Tanyanyiwa (2018) also cites the lack of access to radios and other media outlets that communicate weather forecasts for farmers in remote settings. Similarly, Sithole and Chundu (2020) also allude to the lack of both radios and

televisions for local farmers in rural settings to receive meteorological information. In this regard, the author believes IKS offers a valuable alternative.

It has also been noted that cultural beliefs differ across nations, regions, communities and social groups (Salite 2019). Hence, more in-depth, context-specific studies of the socio-psychological aspects of these beliefs are needed before implementing interventions to better support farmers in preparing for future drought risks. Zimbabwe features amongst the countries in Southern Africa severely affected by drought, and its impacts have resulted in water shortages, reduced yields, food insecurity and economic depressions (Frischen et al. 2020; Jiri, Mafongoya & Chivenge 2017). It is estimated that close to 70% of the country's populace directly depends on agricultural outputs (Government of Zimbabwe 2018). Further research indicates that an average of 17% of the country's gross domestic product (GDP) is realised from agriculture (World Bank Group 2025). Over 60% of Zimbabweans, and in particular, smallholder farmers, practice rainfed subsistence and semi-subsistence agriculture (Mafirakurewa, Mushunje & Zantsi 2023) and as such, the occurrence of drought has a direct effect on the socio-economic status of a larger percentage of the populace. As a result, smallholder farmers actively involved in rainfed agricultural practices are highly susceptible to drought because of their dependence on climate-sensitive resources (Muzari 2016). Lunduka et al. (2019) highlight that rural communities face significant challenges as a result of the effects of drought. These challenges are further exacerbated by crop diseases and pest infestations, which ultimately result in reduced yields and unpredictable incomes, leading to an increased risk of poverty (Lunduka et al. 2019). Drought has been recognised as a significant threat to agricultural livelihoods in Zimbabwe and is considered one of the major obstacles to achieving the Sustainable Development Goals (SDGs), and in particular SDG1 (no poverty), SDG2 (Zero Hunger) and SDG3 (Good Health and Wellbeing) (Frischen et al. 2020). It has been well noted that weak economic countries experience severe impacts of drought (Belle, Collins & Jordaan 2017), and Zimbabwe is no exception. Therefore, in order to mitigate the severe effects of drought, it is essential to adopt tailored adaptation strategies, including the revitalisation of IK for effective drought response.

Study site

The research was carried out in the lowland area of Chipinge district. Chipinge district is on the boundary with Chimanimani district to the north, Chiredzi to the south-west, Buhera to the north-west and Bikita to the west (Marashe 2014). The district is located in agro-ecological regions 1.4 and 5 in Eastern Zimbabwe (Zamchiya 2011). Chipinge district is characterised by both the highlands and the lowlands. The highlands are under the agro-ecological region 1 and are characterised by high rainfall and cool temperatures, whereas the lowlands fall under the agro-ecological regions 4 and 5, with little precipitation and high temperatures. Generally, the lowlands are a semi-arid region and receive low rainfall. When rainfall occurs, it is typically unpredictable and unevenly distributed, with the majority of precipitation falling during short, intense storms from the months of October to February. Research was carried out in Mariya and Zamuchiya villages, which are drought-prone areas with a semi-arid climatic zone and a bimodal rainfall pattern.

Statement of the problem

Within the lowland areas of Chipinge district in Zimbabwe, drought is a recurring and severe phenomenon. It disproportionately affects local smallholder subsistent farmers who depend on rainfed agriculture for their livelihoods. Although IKS have immemorially enabled local communities, including the Ndau, to forecast, cope with and mitigate the effects of drought, these embedded strategies remain largely marginalised, undocumented and excluded from formal disaster risk reduction policies. Existing drought responses accord precedence to Eurocentric models, despite the fact that many rural communities do not have access to modern meteorological services because of geographic isolation, poor and undeveloped infrastructure, and poverty. Additionally, there exists a lacuna of empirical research that documents specific drought-related IKS of minority indigenous groups in Zimbabwe, and the Ndau people in particular. Therefore, sustainable indigenous coping mechanisms remain underutilised, leaving poor and marginalised communities dependent on foreign interventions that are often incompatible with their socio-cultural and ecological contexts.

Theoretical framework

The theoretical underpinning for the study is the Community-Based Disaster Risk Management (CBDRM) framework. The CBDRM framework focuses on building people's capacity for coping with disaster risks, which consequently leads to the reduction of their vulnerability (Mclaughlin 2011). This, in turn, leads to the development of safer and resilient communities in the wake of the current climate change crisis. The CBDRM framework is regarded as an active practice whereby at-risk communities are positively involved in detecting, analysing, treating and monitoring and evaluating disaster risks as an attempt to lessen their susceptibilities (Mclaughlin 2011). This entails that the community members are active agents in the process of taking resolutions as well as implementing disaster risk management activities. The framework capacitates local community members with the ability to evaluate the presenting situation and to ascertain risk reduction measures and their implementation. Such risk reduction measures centre on alleviation as well as vigilance strategies that ought to be implemented when disaster strikes, as well as aftermath coping measures. Kafle and Murshed (2006) identified six successive phases of the CBDRM framework as: (1) selecting the community, (2) rapport building and understanding, (3) participatory disaster risk assessment, (4) CBDRM planning, (5) community-managed implementation and (6) monitoring and evaluation.

The CBDRM is positioned as an ideal framework for the study based on its consideration for the full and active involvement of community members in the formulation and implementation of risk reduction and mitigation measures. This entails that community members are involved in every stage of disaster risk management. Community members herein include the vulnerable social groups who are considered equally important in reducing local susceptibility to disasters (Mclaughlin 2011). The CBDRM framework posits that both opportunities and threats are better understood by the local community members, as they are the ones directly affected. This study focuses on the centrality of the role of the community, whereby the community is not regarded as the benefactor but the main actor in disaster risk management.

Research methods and design

This study employed a qualitative research approach to explore the lived experiences of indigenous people in drought-prone environments. Grounded in an inductive methodology, qualitative inquiry is designed to answer 'how' and 'why' questions by examining phenomena within their natural settings (Creswell 2013; Hennink, Hutter & Bailey 2011). This approach was essential for uncovering the religio-cultural factors that shape these experiences, as it allows for the interpretation of deeper meanings and complex social realities (Tuffour 2017). Consequently, the method is well-suited to explain the contextual complexities of drought impacts, local responses to crisis, and the innovative coping and mitigation strategies developed by the community. With respect to participant recruitment, the study employed a combination of purposive and snowball sampling to recruit a final sample of 20 participants, which comprised 10 females and 10 males. Purposive sampling was first used to identify key informants with direct experience of the phenomenon, thereby selecting participants who could provide in-depth and detailed perspectives (Creswell & Poth 2018). Snowball sampling was then utilised to access a broader network of participants through referrals, which is an effective strategy for reaching specific populations (Palinkas et al. 2015). This sample size was determined to be adequate to reach thematic saturation for the in-depth qualitative inquiry (Guest, Bunce & Johnson 2006). The purposive sampling produced seven participants (four males and three females), and the snowball sampling produced 13 participants (six males and seven females). The twofold approach adopted for participant recruitment ensured the research captured diverse and insightful perspectives central to understanding the lived experiences under study.

Data collection

Through a qualitative research design, data were collected using key informant interviews, focus group discussions (FGDs), and document analysis. The preference for key informants, such as traditional leaders, elders, and supported by local subsistence farmers, was essential because they possess deep, historically rooted knowledge of local environmental indicators and traditional drought management practices, which was the specific focus of the research. KIIs are qualitative in-depth interviews normally conducted with local people knowledgeable about the current events in the community (De Chesnay 2014). Key informant interviews aim to obtain insights from a broad spectrum of local people, such as community leaders, professionals and local residents, all of whom possess direct, first-hand knowledge of community issues (De Chesnay 2014). In the hierarchy of research methods, key informant interviews are regarded as generating more significant knowledge because of the expertise and authority of the interviewees and are believed to complement other research methods, such as FGDs (Lokot 2021).

Focus group discussions are commonly used as a qualitative method to gain a deeper understanding of social issues (Nyumba et al. 2018). The approach gathers data from a purposively selected group of persons, rather than from a statistically representative sample of the wider population. In FGDs, the researcher assumes the role of being a facilitator or moderator and is responsible for guiding the conversation between the participants rather than directly engaging in a one-on-one exchange (Nyumba et al. 2018). In this regard, the researcher adopted a peripheral role, thereby allowing the active interaction of participants amongst themselves. Focus group interviews were conducted through four groups of five participants. In addition, the study used document analysis to elicit more information and data from published peer-reviewed books, journal articles and reports. Information from these secondary sources provided the basis for formulating the background for the study as well as critically defining and classifying drought, taking into account its causes and effects. Such information was crucial in assessing possible drought coping mechanisms for the context under study.

Data analysis

The data were analysed using thematic analysis (TA). This followed the six-phase framework proposed by Braun and Clarke (2006), Clarke and Braun (2017). This process was preferred for its systematic approach to identifying, analysing and reporting themes in qualitative data, which was necessary for exploring the lived experiences and perspectives of research participants on drought mitigation. The data analysis process began with the familiarisation phase, which entailed actively reading and re-reading the interview transcripts in order to gain a deeper understanding of the content. This was followed by developing an initial set of codes (Clarke & Braun 2017), otherwise referred to as the first cycle of coding by Saldana (2015). In this phase, significant features of the data were systematically identified and coded, and the phase was aimed at reducing the data set and generating initial codes for further development and/or exclusion (Lochmiller 2021). The third phase involved collating the codes and grouping them to generate themes, whilst the fourth phase focused on reviewing and refining

the generated themes. In the fifth phase, themes were defined and named to clarify their core meaning and relevance to the research question. The final phase involved synthesising the analysis to construct a narrative drawn from the extracted data (Clarke & Braun 2017; Lochmiller 2021). Through the six-phase framework of TA, the data analysis for the study advanced beyond mere description to offer a meaningful interpretation of how the Ndau people of Chipinge perceive and respond to drought.

Research credibility

Validity of the research was enabled through the triangulation of data sources, which involved collecting data via multiple methods (semi-structured interviews, FGDs and document analysis). This allowed for the cross-verification of information as well as conferring a more comprehensive understanding of the phenomenon under study. The reliability of the study is reflected through the use of both purposive and snowball sampling procedures. This enabled the eliciting of rich information from key information, that is, traditional leaders and elders who possess historically deep-rooted knowledge, which adds significant weight to the study. This was also supported by a clear data analysis using the six-phase TA process by Clarke and Braun (2017). Overall, a clear methodological account of the research process ensured the study's reliability.

Results

The research established that the Ndau people make use of indigenous prediction and indicators of drought. These have been passed on from one generation to another. According to the Ndau indigenous belief systems, no single disaster happens without a causative agent. As such, when a disaster strikes, the Ndau community, drawing from their lived experiences, devise plausible strategies based on their socio-cultural interpretations that are adopted as disaster risk reduction strategies. This perception guides the community towards developing context-specific disaster risk reduction strategies based on local socio-cultural interpretations, thereby setting up a foundation for CBDRM. The research identified contemporary social ills and climate change as key triggers of drought. Ndau IKS revealed a variety of drought predictors, including astrological and atmospheric patterns; observations of vegetation, fauna (birds, insects and other animals); and cultural indicators such as the birth of male children. These findings highlight the fundamental relationship between social cohesion, cultural integrity and environmental resilience within the context of a CBDRM framework.

Discussion

Contemporary social ills as erosion of risk-informed cultural norms

Findings from the research participants, in particular, the older age group of between 50 and 70 years, indicated that current disasters, including drought, are a result of contemporary social ills. This perspective embodies the core principle of CBDRM, whereby it specifies that community-based governance and shared cultural norms are critical for the reduction of vulnerability. This particular age group expressed that indigenous communities and their ecosystems have been desecrated because of the disregard of local taboos; disharmony within the communities and sexual impurity (adultery and premarital sex); black magic or sorcery (in the form of *zvitokwani* (goblins) and *divisi* (indigenous crop yielding enhancer). The other social ills equally identified by the research participants were murder, abortions, divorce, bestiality, and wrong ascendance to the throne – leadership not recognised by the territorial ancestors. The erosion of indigenous belief systems was identified as the major trigger of such contemporary social ills. Drawing from the CBDRM perspective, these identified factors are not mere moral issues; they are regarded as direct causes of disaster vulnerability. This emanates from the understanding that such ills destroy the social fabric, thereby violating the principles believed to preserve harmony with the natural world. Participants posited that when a community's religio-cultural belief systems are violated, the ancestors turn their backs, and the community is left with no protection and is exposed to the risk of disasters. The cited social ills are believed to rob the land of its sacredness. Whilst the challenge of drought and other disasters can be triggered by other factors, Ndau indigenous belief systems also attribute such to the lack of ancestral protection.

Regarding the challenge of sexual desecration, one of the participants opined that:

> '*Takakura teibhuyirwa kuti kusangana pabonde musikazi kuroorana zvinoera. Tisingabhuyi hedu kuti zvinoduse unthu hwemusikana, taibhuyirwa kuti zvinotosvipidza ndau yemunogara. Hino zvineizvi nehwana hudoko vona ma2000 anesa aya, apachina usingachazii kuatwa, vana vadoko vazhinji, kunyanya ndombi, kunyari unono kumakanyi, vanozosara vooguma kuma 20 years varemba nekuatwa. Hino nyika ingasasvipidzwa ere pakadai. Sakei mvura yoonese kunaya. Adzimu avangaregi kufuratira, navo vanenge veitoti igumo renyi iriri.* [We grew up being told that sexual intercourse outside marriage is taboo. Not mentioning that it takes away the dignity of the girl, we were told it defiles the community. But now, with the popular 2000 age group, most of them are familiar with sex, especially the girls, even here in the rural settings, by the time they reach twenty years, they will have been well exposed to sexual exploits. Does this not defile the land? This is outright taboo, which is why we are experiencing challenges with the rainfall. No wonder the ancestors have turned their back on us, they will also be wondering what kind of disgrace is this.].' (RP13, female, 59 years [Author's own translation])

It was the conviction of this particular age group that once the ancestors turn their backs on the land, community members will be forced to rely on alternative drought prediction indicators, which usually is Western meteorology. Hence, the violation of religio-cultural systems leads to the withdrawal of ancestral protection, and this directly translates to a loss of cultural risk-reduction mechanisms. Additionally, when the taboos that govern resource management are destroyed and rituals are abandoned, the community's

indigenous early warning signs are disengaged. Research participants, however, argued that Western meteorological predictions are not always accurate, and this has often compounded the existing challenges of drought encountered by the communities. The belief that sexual immorality defiles the land, which results in disasters in the form of drought, is consistent with studies carried out by Boillat and Berkes (2013) and Jarawura (2014). These studies indicate blame is assigned to the younger generation, which is accused of inappropriate behaviour and adultery. In this regard, pre-marital and extramarital sexual relations are considered taboo; such acts are believed to anger the gods of the land, an abomination that triggers catastrophes, including drought and other ill omens. In the context of this study, the elderly research participants (age group 60–80 years) explained that the effects of contemporary social ills are communal mostly because it is culturally regarded as the responsibility of the elders to guide the young in the right moral values. As such, when societal norms are broken, the whole community is defiled, and the effects are communal as well as individual punishments. One of the elderly research participants shared that:

> '*Kudaya chingezi chisati chawanda, gore ngegore, madzimambo vainge nemukuba wekudira kuvadzimu kuchenesa ndau mvura isati yatanga kunaya. Wainge mukuba wokuti dangani pane vakasvipidza ndau, saka kwainge kuteketera kukumbira kuregererwa nekuchenesa ndau*. [Before modernity usurped our cultural traditions, on a yearly basis, the local chiefs would offer libation to the ancestors as a way to cleanse the land before the onset of the rainy season. This was a practice done in case the land was defiled, hence appeasing the ancestors as a form of penitence.].' (RP11, male, 73 years [author's own translation])

It was therefore the opinion of the research participants that fewer disasters were experienced before westernisation and the subsequent marginalisation of indigenous ways of life. Additionally, occasional cleansing rituals were performed to continuously appease the ancestors. However, such practices have also been usurped by Westernised religious belief systems that denounce ancestral veneration.

Climate change

Discussions from the research participants indicated the acknowledgement of climate change as a causative agent for increased drought spells in the lowlands. The research participants opined that increased environmental degradation and air pollution were the major triggers of disasters. One of the participants echoed that:

> 'There is a lot of environmental degradation resulting from projects that are carried out here in the rural settings. We have the green fuel that is processed close by and a lot of gases are emitted into the air. We also have a lot of people panning sand for sale. When the sand is harvested, gullies are created and this has a negative effect on the environment.' (RP2, male, 64 years)

Research participants also bemoaned that the constant changes in weather patterns because of climate change have made it difficult to continuously rely on IK predictors. Furthermore, participants shared that the continued drought spells have resulted in the migration of certain animal species, birds and insects, which have immemorially served as IK-based meteorological indicators. The dry spells have also affected the natural vegetation, and the local people are left with limited indicators for weather forecasting.

Ndau indigenous prediction and indicators of drought

The research findings highlight a critical challenge for CBDRM, which is the erosion of local cultural capital. Research participants lamented how the influence of westernisation has led to the neglect of sacred norms, once regarded as the backbone of the Ndau culture, resulting in unprecedented changes to once-efficient indigenous disaster prediction indicators. From a CBDRM perspective, this presents a weakening of the community's core capacity for local intervention and IK management. The participants identified varied changes affecting indigenous drought indicators, and these are inclusive of:

- Environmental shifts manifested through global warming and climate change, which consequently lead to variations in the local ecosystem;
- Loss of biodiversity in the form of the extinction of certain animal species whose behaviours were key indicators of disasters; and
- Socio-cultural changes expressed through the urbanisation of rural communities. This led to the disregard of rainmaking ceremonies and associated taboos and contemporary social ills. Nevertheless, there still exist notable indicators for weather forecasting and drought prediction. These include astrological and atmospheric indicators, vegetation and animal indicators.

Regardless of these challenges, a CBDRM approach reveals that a vital foundation for community-based early warning systems is in existence. Research participants shared that notable indicators for weather forecasting and drought prediction remain in use by the Ndau people. These include astrological and atmospheric indicators as well as observations of vegetation and animal behaviour.

Astrological and atmospheric indicators

The Ndau rely on the shape, appearance and position of astrological objects such as the moon, the stars and the sun. During the rainy season, beginning from late October, a big dark cloud surrounding the moon signifies heavy rains, and the absence of such indicates a lack of rain. Research participants shared that '*tikaona mwedzi watenderedzwa nedziya remvura zvinokombe kuti mvura iriyo*' (RP7, female, 48 years), loosely translated – when we notice the moon surrounded by a dark cloud, it signifies we will receive rain. A big dark circle surrounding the sun is also indicative of imminent rains for the farming season. The absence of these indicators on astrological objects signifies a dry year without rainfall, and according to the research participants, this prepares them for yet another difficult dry season ahead.

Alvera (2013) also points out that according to IKS, certain wind directions and speeds are associated with oncoming rains, whilst others with drought. Alvera (2013) further argues that the use of atmospheric temperatures is also a scientific concept that is used by meteorologists, hence validating the IKS-based astrological and atmospheric indicators.

Vegetation and fauna (animals, birds and insects) indicators

Research findings indicated that the effects of persistent droughts and patterns of climate change have altered the natural vegetation, thus eroding some of the weather forecasting indicators based on vegetation. However, participants shared that excessive seasonal fruiting was indicative of a dry season, and reduced leafage for a number of indigenous trees also signalled the possibility of a drought. A study by Chisadza et al. (2013) also indicated that judging the leafage and budding of flowers for certain trees reveals whether the rains will be early or late.

The Ndau also rely on the chirping of birds and the behaviour of animals to predict meteorological patterns. The cries of the *Procavia capensis* and the chirping of the *kowera* and *matendera* (ground hornbill) birds signify the coming of rains. Research findings indicated that it was easier to observe indicators of rain as opposed to those of drought. The absence of these indicators towards the farming season was indicative of drought. Insects were also identified as indicators of rain or its absence thereof. It was shared that '*mhamhasi zvekare kupenga kwadzinoita dzichiruma itsura mvura*' – loosely translated – the presence of the red ants and the way they bite signifies good rains) (RP3, female, 63 years). Hence, the absence of these common red ants indicates a dry season. A study carried out by Sithole and Chundu (2020) also indicates the cries of *Procavia capensis* and the *kowero* and *shezhu* birds as indicators of impending rainfall. A study carried out by the World Food Program (2022) also highlighted that animals, birds and insects are also used for climate forecasting in IKS. Archaya (2011) highlighted that the chirping and behaviour of certain species of animals, birds and insects is a result of what they sense in the atmosphere. Archaya (2011) further points out that thunderstorms create sound waves whose frequencies can be detected by these creatures, hence their reactions in responding to variations in the Earth's electromagnetic field that occur before extreme weather conditions. Further research also indicates that both animals and insects can detect ultrasound and micro-tremors, which are imperceptible to humans and are triggered just before extreme events occur (Alvera 2013).

Socio-biological signs as a drought indicator (increased birth of male children)

Research findings revealed another dimension that is deemed to be an indicator of impending drought by the Ndau people. During a FGD, a participant shared that – *kukabarwe vana vakomana zvakanyanya itsura nzara iyi nokuti zvinoratidza kuti varume vachabuda vachienda kundoshuzha* (literally translated – if a larger number of male children are born, it is an indicator of drought because it signals that the fathers or men will have to go out hunting or in search for food) (RP6, male, 59 years). This indicator was confirmed by other participants who highlighted that if baby girls outnumber baby boys, it will be a year of bounty. The intersectionality of baby boys outnumbering baby girls and drought remains unexplained; however, it constitutes the Ndau indigenous drought predictors.

Ndau coping strategies for drought mitigation

In order to redress the challenge of persistent drought in the lowland areas of Chipinge, local villages adopt specific mitigation measures that embody the core principles of the CBDRM framework. This framework postulates that effective disaster resilience is rooted in the agency, knowledge, and active participation of local communities. The strategies employed are not just reactive but represent a proactive, community-led control of risk management. Research findings identified culturally grounded rituals such as *doro remakoto* (a community-wide rainmaking ceremony) that foster social cohesion. Agro-ecological practices such as the strategic use of wetlands for cropping, the cultivation of drought-tolerant crops, intercropping and *kuparira* (dry planting) were identified as Ndau drought-coping strategies. Furthermore, livelihood diversification through migration to alternative fertile areas (*kumaeka*), the relocation of livestock, and dry food preservation were identified as strategies employed to reduce vulnerability. Even the reliance on humanitarian aid, whilst external, is managed through local social structures for distribution. Collectively, these measures underscore the CBDRM tenet that indigenous communities are not passive victims but active agents who develop and implement context-specific, sustainable strategies for drought risk reduction.

Doro remakoto – The Ndau rainmaking ceremony

In order to safeguard against drought, *doro remakoto*, the Ndau rainmaking ritual, is ideally scheduled every year in August in preparation for each year's rainy season. *Doro remakoto* also serves as an appeasement to their ancestors for the community's social ills. It is a communal ritual, presided over by the local headman. To promote community cohesion, each household contributes *mungoza* (finger millet or rapoko) and *mumera* (malt powder), which are the major ingredients of *doro remakoto*. The preparation and brewing of the traditional beer are done by selected post-menopausal women as a measure of purity. It is also believed that elderly women who are post-menopause are celibate, therefore ensuring the purity of the ritual. *Doro remakoto* is believed to evoke the territorial spirits to plead with Musikavanhu on behalf of the community, to release rain. It is further believed that the success of the *doro remakoto* ritual is witnessed through rainfall before the gathering for the event has dismissed.

Use of wetlands for cropping activities

The majority of homesteads in the Zamuchiya area, and in particular, the Nkosimananga village are semi-arid zones and are exposed to extreme hot weather conditions for the greater part of the year. Whilst most of the villagers are subsistence farmers, agricultural activities are carried out in the wetland areas. These wetlands have rich soils which are suitable for most grains and cereals. The soils are fertile, and villagers do not use any chemical fertilisers for their crops. These wetlands have been serving the villagers against the persistent drought that occurs in the lowland areas of Chipinge district.

Cultivation of drought-resistant crops

In order to mitigate against the effects of drought, local subsistence farmers tend to cultivate crops that adapt to arid or drought conditions. Early maturing crop varieties and indigenous small grains such as *mungoza* (rapoko), *mapfunde* (finger millet) and *rukweza* (sorghum) are mostly preferred. A special brand of *mapfunde* (finger millet) referred to as *mudhoriyana* or *chimupedzanzara* is mostly preferred because it is an early maturing breed which can be harvested as early as three months. Research participants indicated that the threat of bird infestations, which is usually a challenge where grains are planted, is also lessened as crops can be protected within the short span of growth and maturity. The other breed of finger millet is cultivated as a cash crop, and the yield is sold to breweries. Also common in the lowlands is cotton production, cultivated as a cash crop. Of recent, the community of Zamuchiya has resorted to the farming of *uninga* (*Sesamum indicum* or sesame seeds) in the neighbouring Mozambique as a cash crop. *Uninga*, an early maturing crop, was cultivated and harvested in rented land in nearby Mozambique and then sold back in Zimbabwe. This initiative cushioned a larger number of subsistence farmers in Zamuchiya and Mariya, who after the sale of *uninga*, were able to purchase basic foodstuffs and other necessities for their families. Similarly, a study conducted by Muyambo and Shava (2021) also highlighted the shift from the traditional cultivation of *uninga* as a women's domain to the socio-economic benefit for the Ndau community. According to Muyambo and Shava (2021), *uninga* was traditionally cultivated by women and harvested for the purpose of flavouring family meals. However, the demand for *uninga* in the market led to a shift from its cultural importance to an economic benefit (Muyambo & Shava 2021). Such a shift cushioned many local subsistence farmers in drought-persistent areas; they had liquid cash from the sale of *uninga* to fend for their families. The cultivation of drought-resistant crops is not just an agricultural technique but a practical solution for climate justice.

Intercropping or mixed cropping and Kuparira (dry planting)

This involves sowing two or three different varieties of crops together on the same piece of land – usual grain is the main crop and two other subsidiaries. Research participants cited the benefits of intercropping include increased crop yield, reduced pest infestation and the major advantage of the simultaneous harvest of a variety of crops. The preferred common subsidiary crops were cited as *nyemba* (cowpeas), *mutikiti* (pumpkin leaves), *nyevhe* (spider flower) and *makebe* (watermelons). Research participants also shared that during cultivation, plants like *mbowa* (pigweed) and *gushamunda* (jute) are also left as subsidiary crops. A key reason for cultivating these subsidiary crops is their storability, as a significant proportion of the yield can be reserved for future consumption, that is, *mutikiti, nyevhe, muyemba* (cowpeas leaves) and *gushamunda,* which are harvested and preserved as dried vegetables. *Kuparira* (dry planting) was cited as a common practice in the lowlands, and this is undertaken in the months of August and September. With this practice, dry-resistant crop seeds are planted, and according to the research participants, on the first onset of rains, germination takes place. This practice was mentioned as a strategy for safeguarding crops over prolonged periods of heat.

Relocation of livestock

The relocation of livestock to protect them from succumbing to the effects of drought was also cited as a common practice in the communities under study. Livestock are relocated to neighbouring Mozambique for pasturing. It was mentioned that there is always a need for constant treatment of the migrated livestock using particular indigenous plant medicines for safeguarding the livestock against different climatic patterns as well as disease outbreaks. In dire situations of drought and for those unable to relocate their livestock, animals are usually sold to avoid loss through death.

Dry food preservation

Food preservation is inevitable, especially for drought-prone areas. This practice ensures the availability of food supply, especially during times of famine. The common indigenous methods of food preservation include sun drying of indigenous leafy vegetables. These are blanched in salt water and naturally dried in the sun. Other foods preserved are fruits, which are dried and the smoking of meat. The meat is first marinated with coarse salt and is smoked using firewood.

Humanitarian aid

Because the lowland of Chipinge is classified as a drought-prone area, a number of non-governmental and faith-based organisations offer humanitarian aid to local villages. Organisations including the World Vision, the United Nations Central Emergency Response Fund (UNICEF) and the United States Agency for International Development (USAID) offer basic foodstuffs, including maize meal, cooking oil, rice, sugar and other basic necessities to disadvantaged villagers. However, it has been noted that the presence of humanitarian

aid from faith-based organisations and non-governmental organisations has crippled a number of local people, resulting in full reliance on external aid and social welfare.

Implications and recommendations

The lack of formal recognition and integration of indigenous communities' knowledge in dominant scientific investigations and policy responses often overlooks the tailored, place-based and effective strategies of minority groups. As such, this research strongly suggests a paradigm shift in national drought policy. The integration of these proven IKS should not be considered an alternative, but as vital for building resilient communities. The study recommends that policymakers move beyond a superficial acknowledgement and formally integrate IKS into national frameworks. This can be accomplished by establishing community-based platforms where Ndau elders and knowledge custodians can collaborate directly with meteorological services to co-produce early warnings. Furthermore, agricultural extension programs must be adapted to promote and validate proven indigenous strategies such as *kuparira* and the cultivation of drought-tolerant local crops. By bridging the gap between scientific and IK, Zimbabwe can develop more holistic, sustainable and culturally relevant drought management strategies that empower the very communities most vulnerable to its effects.

Conclusion

This study, grounded in the CBDRM framework, has demonstrated the profound efficacy and continuous relevance of Ndau IKS in forecasting and mitigating drought in the lowland area of Chipinge, Zimbabwe. The qualitative, inductive approach was critical for retrieving the multifaceted, context-specific knowledge held by the community, which is often overlooked in conventional, scientific drought management paradigms. Research findings indicated that for the Ndau people, drought is not just a climatic event, but a compound phenomenon interlinked with contemporary social ills and environmental changes. The findings revealed an intricate, multifaceted early warning system. The community's reliance on astrological and atmospheric indicators, observations of vegetation and fauna, and even socio-biological signs, such as the increased birth of male children, provide a holistic and accessible method for drought prediction for the Ndau people. More significantly, the study identified a diverse and resilient body of indigenous coping and adaptation strategies. These encompass the spiritual intervention of *doro remakoto* (the rainmaking ceremony) to practical, agro-ecological practices like *kuparira* (dry planting), intercropping, the strategic use of wetlands, dry food preservation, and livestock migration. These strategies are not relics of the past but are dynamic, sustainable, and tailored to the specific socio-ecological context of the Ndau people. This study highlighted the systematic neglect and under-documentation of the local communities' (including the Ndau people) IK systems in formal drought management policies and scientific frameworks.

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CRediT authorship contribution

Anniegrace M. Hlatywayo: Conceptualisation, Methodology, Formal analysis, Investigation, Writing – original draft, Visualisation, Project administration, Validation, Data curation, Resources, Writing – review & editing. The author confirms that this work is entirely their own, has reviewed the article, approved the final version for submission and publication, and takes full responsibility for the integrity of its findings.

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