ZIBELINE INTERNATIONAL™ PUBLISHING

ISSN: 2633-4062 (Print)
ISSN: 2633-4070 (Online)
CODEN: ECCCB9

Ecofeminism and Climate Change (EFCC)

DOI: http://doi.org/10.26480/efcc.01.2026.01.07

RESEARCH ARTICLE

THE ROLE OF TRADITIONAL KNOWLEDGE IN CLIMATE CHANGE FORECASTING AMONG SMALL-HOLDER FARMERS IN SAMUEL VILLAGE, KASENENGWA, DISTRICT, ZAMBIA

Ackim Phiri[a]*, Ashish Khanal[b]

[a] Department of Zambia Forestry College, P/Bag 1, Kitwe, Copperbelt Province, Zambia
[b] Global Research Institute and Training Center (GRIT), Kathmandu, Nepal
**Corresponding Author Email: ackimphiri2020@yahoo.com*

ARTICLE DETAILS

Article History:

Received 10 October 2025
Revised 15 November 2025
Accepted 21 December 2025
Available online 05 February 2026

ABSTRACT

Lack of reliable localized weather forecasting systems to predict weather patterns is a big challenge to smallholder farmers in Samuel village of Kasenengwa. This hinders effective crop production planning among smallholder farmers. The challenge has increased due to climate variability being experienced in the Saharan region. The increase in temperatures, droughts, and spread of diseases affect crop production. Modern technology provides valuable insights, but its forecasts are often not localized. Also, the challenges of adequate infrastructure, which is expensive to acquire and maintain, have affected the adoption of modern technology. The study focused on smallholder farmers in Samuel village. A total of 100 respondents were selected for the study with the average age being 45 years old, were 65% were female and 35% male. Data was collected using structured questionnaires, interviews, and focus group discussions in April 2023. The collected data was analyzed using Statistical Package for Social Science (SPSS) to understand the relationships. The study revealed various natural and cultural indicators used to predict weather patterns. These include natural-based indicators like plants, insects, and birds. Commonly used plants included ***Uapaca kirkiana,*** and ***Parinari curatelifolia,*** whose flowering and fruiting ability is key in weather forecasting. This method of forecasting climate change is negatively being impacted due to increasing population causing deforestation, hence affecting prediction accuracy. Smallholder farmers are willing to support government efforts in forest conservation. Therefore, the government must promote extension services to the community and strengthen monitoring mechanisms to reduce high deforestation levels in the area.

KEYWORDS

Climate change, Indigenous Knowledge Systems, Weather forecasting, small-holder farmers, Kasenengwa.

1. INTRODUCTION

Globally, Indigenous Knowledge (IK) is a critical factor in economic growth and sustainable development and is as important as scientific knowledge (Magni, 2017). However, it is observed that when it comes to the African narrative, IK research still seems to fall short, even with the great recognition and interest it is attracting. IK has always been underprivileged and marginalized, treated as an unsubstantiated type of knowledge that cannot provide any scientific solutions (IPCC, 2018). There is increasing evidence of human responses to the climate change impacts in Africa. However, understanding the effectiveness of these responses for adaptation to climate change across the diversity of African contexts is still limited.

The terms indigenous, traditional, or local knowledge refer to knowledge accumulated over generations and guides human societies in their innumerable interactions with their surrounding environment. According to the study, indigenous ecological information refers to a body of knowledge and practice in adaptation practices, passed on from one generation to another culturally (Berkes, 2012). Indigenous Knowledge Systems (IKS) is a body of knowledge of the indigenous people of a particular geographical area that have survived for a very long period of time (Mapara, 2009).

According to the study, Africa's climate is warmer than it was 100 years ago, and changing climate will place additional stresses on water resources, whether or not future rainfall is significantly altered (Hulme et al., 2005). Climate change could reduce total agricultural production in many developing countries by up to 50% in the next few decades, particularly in South Asia and sub-Saharan Africa (Hoffmann, 2011). Rainfed agricultural production is the common way of producing food crops across Africa. For example, 89% of cereals in sub-Saharan Africa are rain-fed (Orlove et al., 2010). Rainfall is highly variable in Africa. It is important to have a reliable forecast to enable farmers, of whom the majority are small-scale, to plan types of crops that produce a good yield under the forecast conditions. Climate prediction should be prioritized to promote timely and effective responses to climate shocks. Farmers across the globe, and particularly in Africa, use weather and climate information from indigenous and meteorological sources when making risk-based decisions (Mapfumo et al., 2015).

The knowledge regarding the performance of weather parameters is important for smallholder farmers, particularly those dependent on rain-fed agriculture, especially in the absence of modern weather forecasting facilities. In Zambia, rain-fed agriculture has long been the mainstay of most rural smallholder farmers' livelihoods. Various communities utilize the behavior of animals, such as birds and insects, and the flowering of plants to predict rainfall and drought. In the Mwanga District of Tanzania, the budding of trees and the appearance of certain butterflies signal impending rain (Lusiru, 2023). Similarly, the Borana community in Kenya

Quick Response Code	Access this article online	
	Website: www.efcc.com.my	DOI: 10.26480/efcc.01.2026.01.07

Cite The Article: Ackim Phiri, Ashish Khanal (2026). The Role of Traditional Knowledge in Climate Change Forecasting Among Small-Holder Farmers in Samuel Village, Kasenengwa, District, Zambia. Ecofeminism and Climate Change, 7(1): 01-07.

observes animal behavior and plant flowering as early warning signs for weather changes (Kagunyu et al., 2016). Likewise, the Borana herders employ astrological readings to forecast weather, which requires specialized knowledge (Ayal, 2017). Another study documented 16 bioindicators for weather forecasting, including insect, bird, and mammal behavior, plant characteristics, and patterns of clouds, lightning, wind, moon, sun, and stars, reflecting both natural and cultural knowledge among the tribal peoples of Mizoram (Chinlampianga, 2011). Natural and cultural indicators for forecasting weather patterns include floods or excessive rains, strong winds in October, extended cold seasons, and the abundance or scarcity of certain fruits, as observed by farmers in Southern Zambia and North Western Zimbabwe (Mugabe, et al., 2010).

Despite the significant reliance on IKS for weather forecasting by smallholder farmers in Africa, there is limited understanding of the specific natural and cultural indicators used by rural farming communities in Samuel Village. Earlier studies have focused on IKS in agriculture without exploring the localized, community-specific forecasting methods that combine ecological and cultural dimensions. This study seeks to address these gaps by exploring the unique natural and cultural indicators of weather forecasting employed by smallholder farmers in this region.

2. Methodology

This study used a descriptive research design. This process involved observing and describing phenomena as they naturally occur. It was meant to provide a comprehensive overview of a situation, behavior, or group without influencing it.

2.1 Study Area Location and Description

The study was conducted in Samuel village in Kasenengwa District, which lies in the eastern province of Zambia (Figure 1). The area is found in the agro-ecological region II, which receives about 800 – 1000mm of annual rainfall.

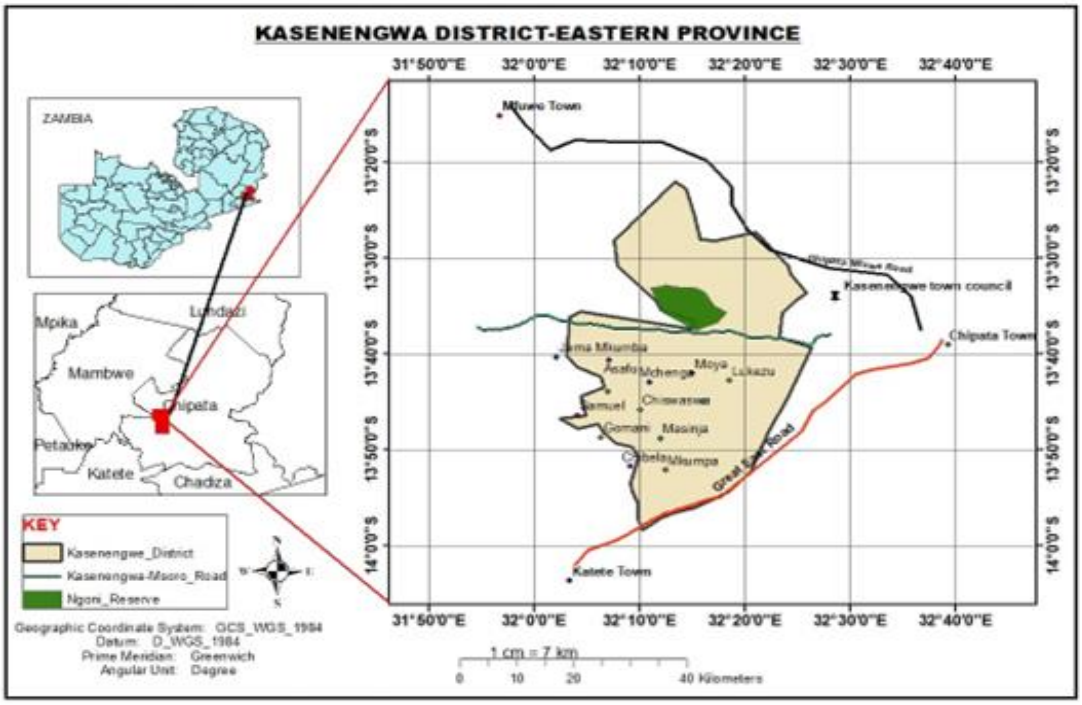

Figure 1: Map showing study area location

The area being in the agroecological region II, receives around 800mm to 1000mm of rainfall. Further, the area also experiences droughts and floods which affect the people in the area through economic loss. Agriculture is the major economic activity being practiced in Kasenengwa district. Hence, most smallholder farmers in this area depend on subsistence crop production of small grains such as maize, groundnuts, and beans grown in the area. Despite the desire of the local farmers to grow and produce more crops, the village has fewer people who are very old to help manage indigenous knowledge, particularly in weather forecasting, which is key to effective agricultural production.

2.2 Population and sampling

The respondents were 20 years old and above. However, special consideration was given to those older, mostly above 50. The targeted number of respondents was 100. Of the total, 55 percent were between 20 and 49 years old, and 45 percent were 50 years and above. The formula was used to come up with the actual number of respondents to interview (Yamane, 1973).

$n= N/1+N(e^2)$

Where:

n = Sample size

N = Population size

e = Level of precision or margin of error

2.3 Statistical Methods

Data collection was done through administering questionnaires and interviews. Samuel village was purposively selected for this study due to the uniqueness of the research (size of the village, number of old people) and the fact that the forest area is still intact. Key informant interviews were conducted, where key informants were selected based on their expertise, social standing, and length of stay in the village. The village head was part of the key informants. Focus group discussions (FGD) were used to get qualitative, in-depth information. It consisted of between 5 to 10 people aged 40 to more than 60 years. Further, Microsoft Excel and Statistical Package for the Social Sciences (SPSS) were used to analyze the data collected in the study area to address the set objectives.

3. Results And Discussion

3.1 Cultural-Based Indicators

There are various cultural and spiritual practices, such as divination, visions, or dreams, are performed by respected elders of the community (Table 1). For example, they use a rainfall-predicting pot, where they will get a clay pot and fill it up with water and herbs placed on three traditional cooking stones. Using a special reed, an expert blows into the concoction in the pot while other elders read and interpret the color changes. When the black colour shows, it means that abnormal rainfall was expected. This would mean that too much or too little rainfall would be received. Then, when white colour appears it means that normal rains were expected. The use of cultural indicators is connected to spiritual discernment of a given area. Aligning with the current study, Cabañuelas, an Indigenous practice, combines observational techniques and spiritual elements to forecast rainfall. It involves interpreting signs from nature and engaging with various agents. It is part of a broader complex of practices, including offerings and coca leaf readings (Legoas, 2022).

Table 1: Cultural-based indicators for predicting weather patterns

Indicators/practice	Experience/Observation	Interpretation
Clay pot full of water and herbs placed on three traditional cooking stones. Using a special reed, an expert blows into the concoction in the pot while other elders read and interpret the color changes.	Black- colour White – colour	Abnormal rainfall is expected (too much or too little). Normal rains are expected.
Visions	Short but violent downpours, usually early morning or at sunset accompanied by heavy wind, sharp thunder, and lightning. Also, damage to animals, crops, and dwellings	This means unfavorable rainy seasons and predicts poor harvests.
Dreams	The clan's seers might also receive dream messages or visions from ancestors or divinities regarding rainfall and crop performance.	Results will vary depending on the nature of the dream experienced.
Divinations	The seer can formulate predictions from the behavior of sacrificed animals, how long it lasts before falling, which direction it falls, and where the blood spills.	Rain falling after a ritual is a sign that the gods have accepted the offering and granted the accompanying petition.
Sacrifices/offerings	Different sacrifices are also offered to the gods of rain when it delays. Sheep and goats are taken for sacrifice in sacred places like mountains. Also white chickens can also be offered as an appeasement to the gods.	The colour of the smoke and its direction helps to know the amount of rainfall expected (black colour means rain, and white colour means drought). After making an offering through a sacred place or shrine and they pass through the following day; if the offering has disappeared it means the gods have accepted by the sacrifice and vice versa.

The religious landscape is characterized by a relatively peaceful, somewhat overlapping coexistence of customary beliefs and monotheistic religions. For most of Samuel's population, spiritual life revolves around the lineage of ancestors and earth spirits mediating the relationship between humans and the divine. Spirits may inhabit specific places or fetishes, such as hills, rocks, and graves, and are believed to intervene in human affairs, sometimes as judgment for moral transgressions. Senior men are responsible for performing sacrifices honoring their family's ancestors. Overall, spiritual authority rests with an earth-priest. He is the eldest member of the clan that originally settled in the area and has ritual authority over the land (Barth, 1995). These are very influential because it is believed that their ancestors established the village of Samuel so that they retain spiritual jurisdiction over it. However, some residents who attribute problems affecting the village, including drought, to their failure to perform sacrifices to the ancestors adequately are contesting the legitimacy of the present earth priest.

The use of cultural indicators is connected to the spiritual discernment of a given area (Sillitoe, 1998). Therefore, its usage in weather pattern forecasting entails receiving messages from traditional or spiritual leaders, who could be spirit mediums, prophets, or rain-makers, about the seasonal weather outlook. The rainmakers are also commonly called spiritualists, and they also helped in giving information to the village on weather predictions in the area (Roudier, et al., 2014). Rainmaking is an inherited practice passed on to the family's most trusted and loved son. Shared knowledge and spiritual knowledge are neither clearly defined nor mutually exclusive categories. Some elders have reputations for expertise in reading stars based on keen scrutiny and spiritual insight. Since the residents of Samuel village had lost confidence in the ability of the seers to predict rainfall, farmers are open to and keenly interested in alternative sources of rainfall information. These findings disagree with who did not support introducing scientific information or regard it as threatening the integrity of local cultural traditions (Barth 1995 ; Sillitoe 1998).

Observation-based knowledge production is consistent with cultural learning styles where children learn from watching adults rather than through verbal instruction or asking questions. In the village, seniority is a mark of authority because those who have lived for many years have heard and seen a great deal. Key informants interviewed enumerated many historical events they had seen, such as famines, successions, colonial intervention, forced labor, and droughts, as a way of shoring up the authority of their words. The spiritual leaders draw the information to predict the rains from divinations made in the sacred places of the area. This agrees with studies which indicated that elderly male farmers formulate hypotheses about seasonal rainfall by observing natural phenomena, such as the appearance of certain birds, the mating of certain animals, and the flowering of certain plants, while cultural and ritual specialists draw predictions from divination, visions or dreams (Roncoli et al., 2002). Cultural and spiritual practices such as divination, visions, or dreams are performed by elders of the community. Shared knowledge and spiritual knowledge are neither clearly defined nor mutually exclusive categories, as observed by (Roncoli et al., 2002). Some elders have reputations for expertise in reading stars based on keen scrutiny and spiritual insight. One sees signs in the landscape and in dreams, in the outcome of sacrifices, or the casting of cowries.

3.2 Natural Based Indicators

Environmental indicators are based on experience and can be learned by anyone who listens to elders. However, work spaces and vantage points of daily life shape one's ability to observe and interpret these signs. Generally, elderly male farmers are considered to know more than younger men or women farmers, but knowledge varies greatly among elders. In addition, women may note different phenomena than men, and herders may seek information different from that of farmers. Various indicators were used to predict weather patterns in the area. Some of them were the animals, birds, and insects indicated as natural-based indicators in (Table 2).

Table 2: Natural based indicators for predicting weather patterns

Indicators	Description	Significance
Crickets (gryllus spp) Armoured cricket (Acanthoplos discoidalis - Bzimbi)	Presence in large numbers Chirping the whole day and night Produces loud noise	Indication of drought conditions An indication of high temperatures and rains are expected in a week or two

Table 2 (cont): Natural based indicators for predicting weather patterns		
Mosquitoes (Plasmodium spp. Udzudzu)	Biting activity increases	Indicates that the temperatures are high. Rains are expected to fall with a day or two
Toads (Xenopus laevis)	Croaking a lot	Rains are expected within a day or two
Spiders	Spiders moving around in large numbers Spiders closing their webs	Indicates the beginning of the rainy season Rains are near
Butterflies (Charaxespollux)	Presence of butterflies.	The rainy season has begun A large number of butterflies means there will be lots of worms
Termites (Isoptera sp.)	Increased activity, cutting grass plants (collecting food) during a dry spell	Rains can fall within a week or less
Weaver birds (Ploceus intermedius)	Building of nests high on the trees Nests are low on trees along the riverbed	Indicate Rains will be normal/ above normal Indication of a drought
Elephants (loxodotna Africana - Njovu)	Migrating to higher ground	Above normal rains expected, with the possibility of flooding
Grasshopper (Chidiza)	Abundances and hatching of grasshoppers in mid-season	Indicates a good rainy season
Millipedes (Bongolo)	millipedes producing sounds in the soil	Indicate the onset of rains
Adansonia digitata (Mbuyu)	Leafy sprouting and fruiting An abundance of mauyu fruit	Determine the onset of the rains/ Indicates that there won't be enough rain
Strychnos innocua Flacourtia indica (Nthuza)	An abundance of fruit	Indicates a bad rainfall season
Dyspros mespiliformis (Chenja)	An abundance of chenje fruits Late foliaging of trees	Indicates drought conditions. Indicates low rains that season/ drought conditions.
All trees	Time of foliaging Generally, when tree start growing new leaves	It means the rains are near. Early sprouting of new leaves means the rains will come early that particular year, and late foliage indicates late rains, which usually translate to a short bad rainfall season.
Moon (Mwezi)	halo around the moon at night	indicates a good rainy season and that it may rain in a few days
Moon and stars	A hallo around the moon and the stars and the sun	This is an indication that the rainy season is about to start. New and old moons Indicate That Wet conditions are expected (during the rainy season). A full moon during the rainy season indicates dry conditions.
Wind (Mphepo)	Winds blowing from the east/ north east direction) When the wind blows consistently from that direction Continual blowing of the wind from the southern direction until late November) Dark clouds accompanied by very strong winds	Rains fall within a week An indication of below-normal rains A storm is imminent, and lots of rains expected
Rainbow (Utawaleza)	Appearance of rainbow during a rain event	An indication that the rain will stop
Temperatures (Kuphya or warm temperature) Temperatures (kuzizila cold temperature)	Very high temperatures, causing breathlessness and sweating, even at night, and sparks/ mirages during the day. Temperatures Very cold winters	Rains can fall within hours up to day or two Indicates below normal rains

In natural-based indicators, it was found that interpreting environmental indicators relied on the experience of individual farmers. However, it could be learned by anyone who listens to elders, although workspaces and vantage points of daily life shape one's ability to observe and interpret these signs. There is a variation in expertise among the elderly farmers, it was also revealed that elderly male farmers were considered to have more

information that both women and the young men. However, the use of indicators was different depending on the individuals' knowledge. The results indicated that about 72% of the respondents mentioned using a combination of indicators for better prediction.

3.2.1 Accuracy levels by education

The accuracy by education was also noted and it indicated that primary education had 11 percent, secondary education had 22 percent, while tertiary education had the biggest with 64 percent and the smallest was for those who had no any form of formal education with 3 percent. This meant that skill also played an important role in the prediction of the weather pattern (Figure 2).

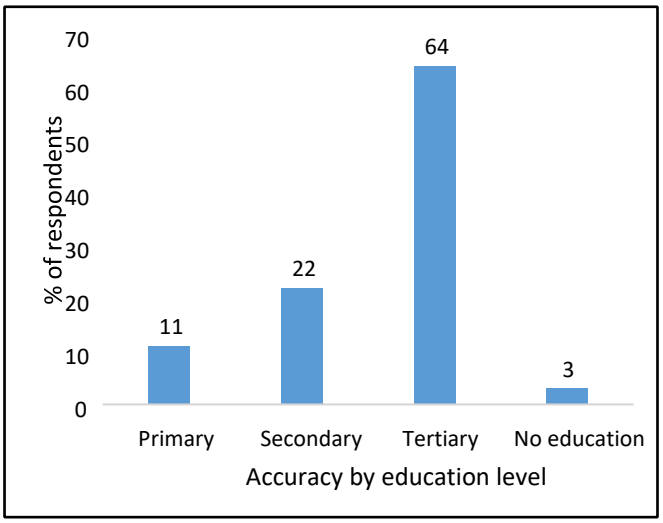

Figure 2: Education level of respondents

3.2.2 Predictions according to weather events

The results of the predictions were also collected by observing various weather events. These noted observations were on rainfall 30 percent, drought had 41 percent, diseases had 9 percent, 16 percent was for extreme events and 4 percent for others which included such things as outbreak of fall army worms (Figure 3). Pests and diseases outbreak was a serious challenge at the time the study was implemented.

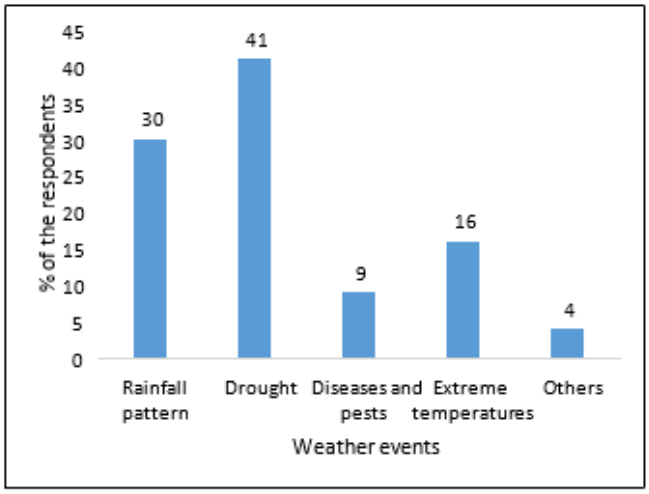

Figure 3: Weather events used in predictions

The respondents in the area also mentioned using plant phenology to predict weather patterns. Under this one, they looked at the behavior of that plant and tied it to the weather pattern. This ranged from flowering, blossoming of their new leaves, and fruit production levels. Indigenous communities, such as those in the Delta State of Nigeria, rely on phenological events like the emergence of fresh leaves to predict rainfall, compensating for the lack of formal meteorological data (Fitchett and Ebhuoma,, 2018). In Tripura, India, the flowering of night-flowering jasmine (Nyctanthes arbor-tristis) is a reliable indicator for forecasting heavy rainfall, demonstrating the accuracy of local knowledge in weather prediction (Acharya, 2011). The last indicator that was used in the prediction of the weather was astronomical or meteorological observations. These included the moon, the sun, stars, temperature, wind direction, and speed. All these have different meanings and interpretations in Samuel village. These findings are in agreement with the findings which argued that observations are made on special plants, insects, birds, and the environment to conclude future weather conditions (Balehegn et al., 2019). They further mentioned that using these forecasts, they can recommend community actions based on the probability of each weather forecast, with the most probable always considered first for making decisions. This further confirmed the results of this study on forecasts being important in providing farmers with guidelines for seasonal planning in terms of timing for planting, and choice of crops.

Accuracy by gender indicated that around 65% of the predictions were done by women and only 45% by men. Further, accuracy by age revealed that the most accurate information came from the age 61 years old and above with 66%, followed by those who were between 51 -60 years old with 22%, and lastly, those whose ages ranged between 20 to 40 years old with 11%. Also, accuracy by education level indicated that the higher the level of education someone had, the more accurate their predictions were. Additionally, about 64% of the respondents had a tertiary level of education and were able to make better predictions. 22% had reached secondary school, 9 % had reached primary level, and those who had no formal education were 5%. Out of all the predictions made in the last farming season, 2023-2024 farming season, about 74% of the predictions were accurate, and 36% were not. One of the challenges experienced in using this information is the increasing population that has led to a high demand for agricultural land. This has led to the loss of forest areas that are key to weather forecasting. Also, some animals have left the area, making predictions by wild animals almost impossible. Climate variability is also affecting the growth of plants, hence affecting the effective interpretation of the weather.

4. Conclusion

Natural and cultural indicators are crucial in weather forecasting among smallholder farmers in Samuel village. Both plant-based indicators and social based indicators were identified as critical in this study. The plant-based indicators found included the interpretation of tree leaf blossoms, their flowering and fruiting especially for plants like *Uapaca kirkian, Flacourtia indica* and *Parinari curatelifolia.* The cultural practices, such as divination, visions, dreams, and sacrifices, were found to be deeply intertwined with the community's spiritual and social structures. However, the reliability of these traditional systems is increasingly threatened by climate change and anthropogenic activities, such as deforestation, agriculture expansion, and charcoal burning, which undermine the availability of tree species key in the interpretation of weather. These anthropogenic activities hinder the success of forecasting as more people cut down trees. The loss of these species, especially the wild fruiting trees affects forecasting accuracy. Despite all these challenges the smallholder farmers are willing to support government efforts in forest conservation.

Recommendation

Preserving the natural resources and cultural traditions that underpin these forecasting methods is essential to safeguarding their accuracy and relevance. This requires proactive policies on forest protection, sustainable land management, and cultural preservation. Also, the promotion of community forestry, being practiced in some parts of the country. This will promote collective effort in the protection of the forest resources, land management and cultural preservation, by involving the local people in making decisions, on how to manage protected areas. Thus, enhancing tree planting programmes in schools, streets and various degraded areas may greatly help to manage our forest areas successfully.

Acknowledgement

The authors would like to thank Mrs. Florence Phiri for the support given during this study.

Conflict Of Interest

The authors declare that there is no conflict of interest.

References

Acharya, S. 2011. Prediction of rainfall variation through flowering phenology of night-flowering jasmine (Nyctanthes arbor-tristis L.; Verbenaceae) in Tripura. https://nopr.niscpr.res.in/handle/123456789/11070.

Ayal, D. Y. 2017. Revisiting Indigenous Biotic and Abiotic Weather Forecasting for Possible Integration with Scientific Weather Prediction: A Case from the Borana People of South Ethiopia. .

InTech. doi: 10.5772/intechopen.69887.

Balehegn, M., Baleney, S., Fu, C., and Liang, W. 2019. Indigenous weather and climate forecasting knowledge among Afar pastoralists of north eastern Ethopia; Role in adaptation to weather and climate variability . Pastoralism .

Barth, F. 1995. Other knowledge and other ways of knowing. Journal of anthropological research.

Berkes, F. 2012. Sacred Ecology: Traditional ecological knowledge and resource management (Third edition). New York, Routledge.

Chinlampianga, M. 2011. Traditional knowledge, weather prediction and bioindicators: A case study in Mizoram, Northeastern India. . https://nopr.niscpr.res.in/handle/123456789/11083.

Fitchett, J. M., and Ebhuoma,, E. 2018. Phenological cues intrinsic in indigenous knowledge systems for forecasting seasonal climate in the Delta State of Nigeria. International journal of biometeorology, 62, Pp. 1115-1119. https://doi.org/10.1007/s00484-017-1.

Hoffmann, U. 2011. Some reflections on climate change, green growth illusions and development space. Geneva, United Nations Conference on Trade and Development.

Hulme, M., Doherty, R., Ngala, T., and New, M. 2005. Global Warming and African Climate Change. Climate Change and Africa.

IPCC. 2018. Global warming: Special report on impacts of global warming. Water Field T(ed) in press.

Kagunyu, A., Wandibba,, S., and Wanjohi, , J. G. 2016. The use of indigenous climate forecasting methods by the pastoralists of Northern Kenya. Pastoralism, 6, Pp. 1-6. https://doi.org/10.1186/s13570-016-0054-0.

Legoas, P. J. 2022. Performing Symmetry in Andean Weather Forecasting: The Practice of Cabañuelas, Beyond Divination and Suffering. Journal of the American Academy of Religion, 90(4), Pp. 987-1009. https://www.doi.org/10.1093/jaarel/lfad030.

Lusiru, S. 2023. With these I know it will or it will not rain: Indigenous indicators of rainfall in Mwanga district, Tanzania. International Journal of Agriculture, Environment and Bioresearch, 8(1). https://www.doi.org/10.35410/ijaeb.2023.5808.

Magni, G. 2017. Indigenous knowledge and implications for the sustainable development agenda. European Journal of Education .

Mapara, J. 2009. Indigenous knowledge systems in Zimbabwe. Juxtaposing Post Colonial Theory.

Mapfumo, P., Mtambanengwe, F., and Chikowo, R. 2015. Building an indigenous knowledge to strengthen the capacity of smallholder farming communities to adapt to climate change and varaibility in Southern Africa. Development.

Mugabe, F. T., Mubaya, , C. P., Nanja, , D., Gondwe, , P., Munodawafa, , A., Mutwangwa,, E., and Murewi, C. 2010. Use of Indigenous

Knowledge Systems and Scientific Methods for Climate Forecasting in Southern Zambia and North Western Zimbabwe. Zimbabwe Journa of technological sciences, 1(1), https://doi.org/10.4314/zjts.v1i1.65216, Pp. 19-30.

Orlove, B., Roncoli, C., Kabugo, M., and Majugu, A. 2010. Indigenous climate knowledge in southern Uganda: The multiple components of a dynamic regional system integrating indigenous knowlwdge systems into climate change interpretations. Perspectives relevant to Zimbabwe, Greener J. Edu.

Roncoli, C., Ingram, K., and Kirshen. 2002. Reading the rains: Local knowledge and rainfall forecasting in Burkina Faso. Society and Natural resources .

Roudier, P., Muller, B., D'Aquino, P., Roncoli, C., Soumare, M. A., Batte, L., and Sultan, B. 2014. The role of climate forecast in smallholder agriculture: Lessons from participatory research in two communities in Senegal. Climate Risk Management .

Sillitoe, P. 1998. What, Know, Natives? Local knowledge in development, Social Anthropology. Anthropologie Sociale.

Yamane, I. 1973. Statistics: An introductory Analysis 3rd Edition. Harper and Row, New York.