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An Exploration of Meteorological Indigenous Knowledge Systems in Salima District, Malawi

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ABSTRACT The paper explores the indigenous knowledge systems (IKS), which people of Salima District of Malawi use to predict meteorological phenomena. This follows evidence of the failure of modern early warning systems in the face of adverse weather conditions. Exploratory Concurrent Mixed Methods were used to collect data from 55 respondents who comprised traditional community leaders, community elders and the youths. The estimated weather prediction probabilities constituted the quantitative component of the study. The meteorological IKS was classified into five major interpretive categories namely, flora, fauna, clouds, wind, and the planetary system. The study concluded that rich meteorological IKS in Salima District are widely known and shared. Most of the predictors show high predictive power averaging seventy percent, hence the communities' reliance on them. The study concludes that if properly incorporated into the mainstream meteorological prediction systems, IKS have the potential to improve communities' disaster preparedness in the face of changing climatic conditions.

INTRODUCTION

Natural disasters and food insecurity in Malawi are no longer unforeseen vulnerabilities. Climate change effects continue to increase socio-economic shocks among the citizens. There are floods or dry spell or both almost yearly. For instance, the January 2015 rainfall was the highest on record for Malawi and constitutes a one in 500-year event, and caused significant flooding. The most adversely affected area was the "Southern Region, exacerbating an already precarious socio-economic situation for rural households in the area. It is estimated that the floods affected 1,101,364 people, displaced 230,000 and killed 106 people. As a result, on January 13, 2015, the President declared a state of disaster for the following 15 districts, namely, Nsanje, Chikwawa, Phalombe, Zomba, Blantyre, Chiradzulu, Thyolo, Mulanje, Balaka, Machinga, Mangochi, Ntcheu, Salima, Rumphi and Karonga" (Malawi iGovernment 2015: 1).

One then wonders whether the national meteorological unit was not adequately equipped to detect early warnings of the January 2015 floods on time to invoke mitigation measures. Equally so, was there a prediction failure by the indigenous weather prediction system for the community to have been caught by the floods unprepared? As scholars like Mashoko et al. (2012) and Zuma-Netshiukhwi et al. (2013) found out earlier, African communities long had their own scientific methods for weather forecasting and climate prediction and this immensely contributed to successful farming, environmental conservation and disaster prevention. The authors add that communities had clear indicators for rainfall forecasting and early warnings for disasters. So, what happened to all this rich body of indigenous meteorological knowledge systems? A possible answer could lie in the modernity movement, which was packaged, disseminated and communicated in a way that eroded the space for African indigenous knowledge systems. The systematic displacement of the socio-cultural and economic heritage of the African people have been extensively discussed in Mapara (2009), Matunhu (2011), Kaya and Seleti (2013), Emeagwali and Shizha (2016) and Sithole and Bondai (2020), and it is clear that the authors concur that the time has come to revisit Africa indigenous knowledge. The revisit is with a view to creating deliberate spaces and modernising it through appropriate policies towards

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foregrounding transformative and sustainable development on the continent.

The marginalisation and the potential for knowledge integration motivated the current study, which sought to explore the integration of meteorological indigenous and conventional Euro-centric knowledge systems in Salima District. This motivation was meant to determine if the two broad categories of the knowledge systems could have a space in the conventional meteorology system in Malawi. The study also sought to determine the extent of usefulness of the local knowledge in preparing communities in the face of weather-related disasters. The motivation was couched in the disaster civil protection phenomenon with a view that perhaps the explored meteorological IKS in Salima could strengthen the government's capacity to deal with physical, human and environmental damage caused by extreme weather phenomenon.

Notwithstanding dominance over centuries of conventional methods in predicting weather patterns, there is abundant agrometeorological evidence in Africa and Asia that farmers have developed and relied on their Indigenous Knowledge (IK) systems to adapt to variable rainfall (Garay-Barayazarra and Puri 2011; Mashoko et al. 2012; Okonya and Kroschel 2013; Zuma-Netshiukhwi et al. 2013; Rautela and Karki 2015). For instance, "historically, and still today in India, farmers have used indigenous knowledge to understand weather and climate patterns in order to make informed decisions about crop and irrigation cycles This knowledge is adapted to local conditions and needs and has been gained through many decades of experience passed on from previous generations" (Rengalakshmi 2007: 7).

The scholarship on this subject matter shows that IK systems worked for centuries in communities. There is consensus among the scholars (Mashoko et al. 2012; Kaya and Seleti 2013; Soropa et al. 2015) that key success factors for IKS are that they relate to local lifestyles, institutional patterns, socio-cultural cosmology, ecology and historical rootedness of communities. In light of this, it seems prudent to explore the potential to integrate conventional and IK systems of weather forecasting towards building internal community development capacities and resilience.

The importance of IK becomes clearer when looked at through the Theory of Knowledge Integration (TKI), which gained prominence in the early 1990s especially in the education and development sectors (Clark and Linn 2013; Lang 2004; Knutsson 2006). It acknowledges the synergetic value of embracing various sources and types of knowledge to comprehensively understand phenomena or to solve problems. Historically, the theory has been developed against the backdrop that the ideological, philosophical and epistemological 'crusade' by the West that its knowledge is superior and sufficient for the world's development needs or problems is increasingly being questioned especially in the Global South (Davis 2005; Mafongoya and Ajayi 2017) and in some indigenous communities in Canada (Settee 2007), Australia (Foley 2003) and the United States of America (Barnhardt and Kawagley 2005; Tedlock 2014). One scholar put it emphatically that Western knowledge driven development "devastated" the once colonised communities because of the arrogant disregard of the local people's knowledge systems (Settee 2007: 27).

It would appear that any efforts to exclusively propel one type of knowledge is in itself an act of undermining human dignity because no people are without their own indigenous knowledge systems (Breidlid 2009; Masuku 2016). Specifically, this is a breach of social justice and a suffocation of community sovereignty. Without a doubt, the knowledge superiority, which has been driven by the West, is admittedly against the natural law and science in that geographical regions of the world were uniquely created, which resulted in the diverse landscape, social norms and practices, culture and resource endowment. In fact, the knowledge systems required for the sustenance of life in specific communities would naturally be distinctive in alignment with the physical, social and cultural characteristics that are obtained in a given locality (Settee 2007).

Therefore, it can be seen that the unique knowledge systems found in specific localities, be it in the West or in the South, are not *holistically* sufficient for fostering sustainable and resilient development in particular communities but their integration makes sense. In Africa, the phenomenon of integration is aptly reinforced by the proverbial statement, which states that *it takes a whole village to raise a child*. Unfortunately, this cardinal philosophy of life in Africa is marginally rooted in the production and application of its own indigenous knowledge systems post-colonialism. The Knowledge Integration Theory could be the continent's social evolution strategy to revisit and integrate indigenous knowledge systems with the imported and adopted and adapted Western knowledge systems for enhanced transformative and sustainable development. Figure 1 is the authors' conceptual framework that depicts the contextual factors of a community's IKS, ideal integration of knowledge systems and the theorised resultant effect of transformative and sustainable development in a society.

The assumptions of the conceptual framework above with regards to knowledge integration are that:

i. IKS is a direct function of a community's socio-cultural and environmental characteristics.
ii. One type of knowledge system is in itself insufficient to contribute to transformative and sustainable development.
iii. Knowledge that remains unrefined is highly likely to be less useful in society.
iv. Integrated knowledge in society results in transformative and sustainable development in a society.

Objectives of the Research

The main research objective was to explore indigenous knowledge systems, which communities in Salima District use to understand and predict weather and climatic conditions/patterns. The specific objectives were to:

a) Identify categories of meteorological IKS in the communities.
b) Establish the meteorological meanings of the behaviours of each element of the categories identified.
c) Determine prediction probability estimates for each element in every meteorological category identified.

METHODOLOGY

A mixed methods research approach was used, utilising both qualitative and quantitative

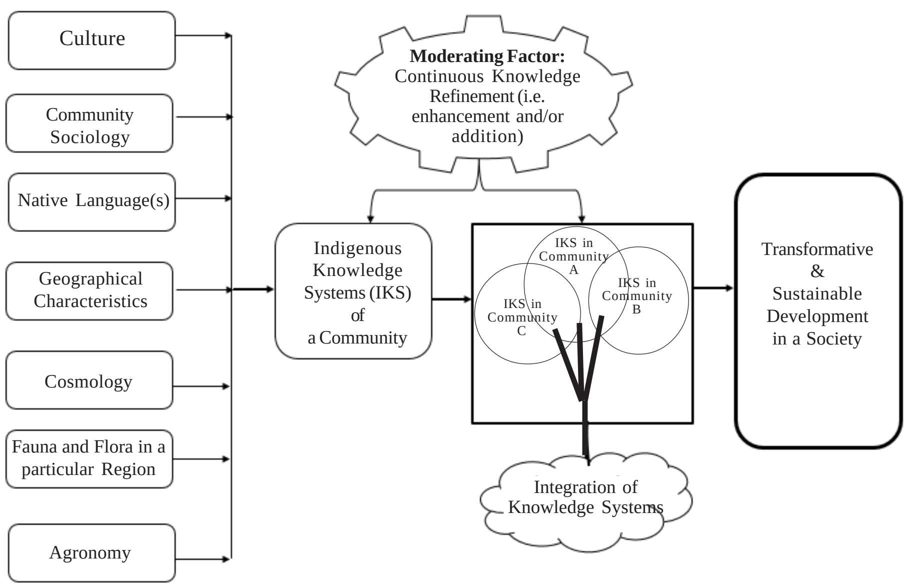

Fig. 1. Conceptual framework of knowledge integration
Source: Authors

data to address the objectives of the study. Specifically, an adapted version of Creswell's (2014) Exploratory Sequential Mixed Methods (ESMM) design was employed to guide the overall exploration of the meteorological IKS in Salima District. In its original form, ESMM design starts with a qualitative data collection followed by a quantitative phase in a distinct way with respective analyses. In fact, the qualitative findings are used to construct the quantitative data collection instrument. In this study, the authors did not separate the phases but collected both quantitative and qualitative datasets at the same time from each study participant using the same data collection tool. The qualitative questions to explore the meteorological IKS were asked first in a one-to-one interview fashion and after the discussion was exhausted, the study participant was then asked to estimate the probability prediction on the specific aspect(s) shared. Thus, the estimated weather prediction probabilities constituted the quantitative component of the study. Since there was no sequential process separated by phases and there was no separate instrument for qualitative and quantitative data sets, the researchers labelled the mixed methods design as Exploratory Concurrent Mixed Methods (ECMM).

A one-on-one semi-structured questionnaire was used to collect data from 55 research participants who comprised the community traditional leaders (CTL), community elders (CEL) and the youth (CYL). The actual number of the research participants, their age groups, gender and corroboration pattern are outlined in Table 1.

As a way to uphold research ethics, pseudonyms were used for identification of research participants as follows. The 15 traditional leaders were CTL01, CTL02, CTL03…CTL15, the 30 community elders were CEL01, CEL02, CEL03…CEL30, and the youth and the middle aged were CYM01, CYM02, CYM03…CYM10. The pseudonyms were used in the selected verbatim notes integrated in the presentation and discussion of results section.

RESULTS AND DISCUSSION

In line with the Exploratory Concurrent Mixed Methods (ECMM) approach applied in the study, the qualitative datasets were analysed through classification of similar meanings of characteristics of each element of the IKS research categories that emerged. The five major categories identified were flora (trees, bushes or shrubs), fauna (animals on land and in the water), clouds, wind (direction and intensity), and planetary system (sun, moon, stars). This categorisation is similar to an earlier study conducted in South-Western Free State of South Africa summarised in the quotation below:

…means of engagement with the natural environment, are skills not well understood by most scientists, but useful to the farmers. They range from the constellation of stars, animal behaviour, cloud cover and type, blossoming of certain indigenous trees, appearance and disappearance of reptiles, to migration of bird species and many others (Zuma-Netshiukhwi et al. 2013: 383)

Where applicable, the botanical names for the various plants, animals and birds are given in parentheses against the vernacular names. It was difficult to find matching botanical names for some of the species that are not known globally.

Table 1: Breakdown of research participants

Category of research participants	*Age range*	*Total number*	*Sex*		*Number of research participants who did not corroborate on one or more meanings*	*Percent corroboration on meanings*
			Male	*Female*		
Traditional leaders	51-70	15	12	3	1	93.3
Community elders	51-70	30	15	15	3	90.0
The youth and the middle aged	25-50	10	5	5	6	40.0
Average percent corroboration						74.3

An ethno-meteorological research by Elia et al. (2014) in Muluga and Chibelela villages of Tanzania arrived at a similar categorisation of natural indicators of reading meteorological patterns in the community. Following the identification and categorisation of meteorological IKS themes that emerged, average probability estimates (in percentages) provided on the prediction of rainfall under each element were computed. This formed the descriptive quantitative analysis for the study and it was necessary to complement the qualitative meanings provided. Most importantly, the quantitative analysis brought about some level of quantification of the lived experiences-based views expressed by the study participants. The meanings with high corroboration in each category were selected for inclusion in the paper. The following are the findings under each of the five categories identified in the study.

Flora: Indigenous Trees, Bushes and Shrubs

Bearing an average probability estimate of seventy percent, the *Nsangu (Fidebia adiba)* tree signifies normal rainfall when it has plenty of leaves, whilst plenty of leaves on the *Mtondo* tree signify high rainfall. When the *Kadale* tree loses its leaves, it heralds a normal rainy season in the outlook. The results are consistent with the findings of a similar study conducted by Green et al. (2010) in Northern Australia among the Aborigines and Torres Strait Islanders, which revealed that the changes that occur on trees or shrubs such as colouring and shedding off leaves indicate meteorological changes in the atmosphere. Comparable behaviour of trees and meteorological interpretation was found in Mukueni District, Kenya (Speranza et al. 2010) from the agro-pastoralists studied and from the communities of Rungwe and Kilolo in south-western Highland of Tanzania in the study by Chang'a et al. (2010). In a seasonal weather forecasting study in two Tanzanian villages of Maluga and Chibelela, Elia et al. (2014), made similar conclusions that the natural behaviours of trees are used to predict weather patterns in the communities to allow for farming decisions.

A study by Makwara (2013) of indigenous knowledge systems in agriculture in Zaka District of Zimbabwe, came to the same conclusion that farmers tend to associate heavy production of tree leaves with a good rainy season. Also, similar studies conducted in Zimbabwe earlier on meteorological IKS on weather forecasting by Mashoko et al. (2012) in Chimanimani District and Soropa et al. (2015) in Chiredzi, Murehwa and Tsholotsho districts corroborate the findings in this study. A most recent study by Sithole and Chundu (2020) in Chimanimani District of Zimbabwe reached comparable results on this ethno-meteorological discourse where the native people use natural indicators to predict rainfall. The probable explanation for this similarity of meteorological IKS findings illustrated here could be that world over ethno-meteorology preceded the modern meteorological science. Moreover, the two countries happen to share common climatic conditions, which supports *miombo* woodlands, hence the common trees, bushes and shrub species.

With an average probability estimate of eighty percent, when the mango *(Mangifera Indica)* tree and the *Malambe (Adonsonia)* tree bear plenty of fruits, it is an indication of high rainfall anticipated in the coming season. However, this is contrary to findings by Makwara (2013) that high fruit production in Zaka heralds a poor season. This was also contrary to the findings of Sithole and Chundu (2020) where high fruit production by the *muzhanje (Uapaca kirkiana)* tree signals a bad season. The reason for this seeming contradiction lies in whether the fruit trees concerned are domestic or indigenous wild ones. A close examination shows that Makwara (2013) and Sithole and Chundu (2020) referred to indigenous wild fruit trees while the mango tree and the *Malambe* mentioned in this paper are domestic fruit trees. From these facts, it can be concluded that there is an inverse meteorological meaning of high fruit production of domestic and indigenous wild fruit trees. Furthermore, it appears that the indigenous wild fruit trees have a compensatory behaviour to produce abundant fruits given the imminent food shortage highly likely to occur due to bad rainy season. For the domestic fruit trees, high fruit production seems to be a natural instinct that fruits will survive since there will be sufficient rains in the season. This interpretation resonates with one of the community elders consulted in this study who emphasised that:

When a mango tree bears plenty of fruits, we have always known from time immemorial that we are up to a good rainy season and there is no reason why the community should experience hunger (CEL27).

From the foregoing analysis and the quotation given above, this can only be nature's intelligence embedded in the environmental factors, which the human race should not resist but embrace for its own survival especially in this era of erratic and violent climatic changes. It can also be seen that in the communities studied, rainfall patterns are directly associated with the level of food sufficiency in the community, an aspect found in other parts of the world by Murali and Afifi (2014), Rademacher-Schulz et al. (2014), Roncoli et al. (2011) and Warner and Afifi (2014). This partly explains why the set of meteorological IKS emerged in the study still lives despite the fact that it is not documented as it passed through generations.

Fauna: Indigenous Animals Including Birds and Butterflies

The armyworm known in the vernacular (*Chichewa*) as *Tchembere zandonda (Spodoptera frugiperda)*, when in unusually high population, is a sign of pending hunger/famine because of drought or below normal rainfall. This has a one hundred percent average probability of correctly predicting weather. Similarly, a high population of mice *(Mus Musculus)* signals a pending famine, hence an attempt by the mice to stock enough food ahead of the famine. This natural behaviour of mice was aptly summarised by one of the traditional leaders who illuminated that:

High population of mice in a given year is a sure sign of widespread food insecurity in the community. As a survival strategy, the mice heap sufficient food in their habitats, underground, that will last the entire period of scarce food in the environment (CTL06).

One of the youth participants buttressed the above quotation and stressed, "the behaviour of mice to stockpile food is without exception, noticeable just before the famine strikes the community" (CYM02). It is with little doubt that in the community studied, the mice's behaviour of gathering food is a natural early warning of both pending drought and food shortage.

When *Koyela* birds make musical sounds, it means high rainfall and a good farming season as well as an indicator for an overall good ecological environment for all living organisms expected in the outlook. Another bird that signals pending normal rainfall is the *Kalewulewu* bird especially when it hovers around a specific area in the community. Both birds have an average of seventy percent chance of correctly predicting the rainfall pattern in a given season. Different behaviours of birds are usually associated with good rainy season and the timing of the same with different communities using different bird species to come to the same conclusions. The interpretation of birds' natural behaviour to understand meteorological changes concur with Reside et al. (2010) and Elia et al. (2014) who studied a variety of bird species in the Australian tropical savannahs and Tanzania, respectively. In the case of Rungwe and Chilolo communities in Tanzania, the Dudumizi bird was singled out as one of the best indicators for rainfall (Chang'a et al. 2010). Recently, the ethno-meteorological study of Chimanimani community in Zimbabwe reads the behaviour of the *Kowero and Shezhu* birds (Sithole and Chundu 2020) whereas the Zaka community (also in Zimbabwe) believes the appearance of black and white stork *(shohori/shuramvura)*, *denderas*, swallows *(nyenganyenga)* all signal the imminence of a good rainy season (Makwara 2013).

When the animal known as *Gondwa* is seen moving slowly down from the treetop, it means the rains are near. It was reported that as soon as it touches the ground, the rains are known to start immediately though with a relatively low prediction rate of sixty percent. When the entrance of an anthill, locally known as *Chulu (Isoptera)* faces or is positioned towards a specific direction generally known in the community, the back of the anthill symbolises the direction where the rains will come from. Another organism in this category is the frog (*Anura*), which when it produces constant whistling or croak sounds, it means the rains are going to be continuous, lasting for long and possibly causing floods in areas of poor drainage. This was emphatically expressed by one of the study participants who said, "*When you hear a low-pitched sound for a prolonged time [in seconds], then you know that mvula mosalekeza [continuous* *rains] are imminent*" (CEL07). According to the data obtained in this study, the frog has an average of eighty percent predictive power whilst the anthill has a seventy percent probability. This is consistent with the study conducted in Makueni District, Kenya among the agro-pastoralists where it was found that if frogs fail to make a noise, it signifies drought in the season (Speranza et al. 2010).

Clouds Formation

The presence of fog known as *Nkhungu/ Chifunga* on some mountains means normal rainfall is certain in that season with a probability of eighty percent. The presence of lightning or *Ziphaliwalia* in the vernacular signifies high rainfall with strong winds with a ninety percent predictive power. The rains are usually destructive to people, property and the environment. The slow movement of the *Makongwa* clouds symbolises normal rainfall with an average probability estimate of seventy percent.

Wind Direction and Intensity

Wind direction and intensity can also contribute to the prediction of pending weather conditions. For instance, the *Mwera* winds that originates from the south within Salima District signals normal rainfall with a probability of seventy percent. Also, if a whirlwind/*Kavuluvulu* originates from the east coast of Salima District, this is predictive of rainfall within a few hours with a relatively low probability of fifty percent. If *mzambwe/chikolo* winds originate from the south-west, it signals the end of a mid-season drought/ dry spell.

When winds begin to blow from the south-westerly direction following a prolonged period of a dry season, we say mvula (rain) is life. (CEL21)

The above quotation reveals that such a natural phenomenon brings hope to people, as they expect rains to come soon after to embark on their rains dependent livelihood activities. In a study by Moyo (2010) on indigenous knowledge systems and development in Northern Malawi, it was concluded that farming is a key activity where communities apply their IKS. This suggests that IKSs are vital means or enablers to people's livelihood options in their communities. Another aspect in this category is the *Kapote* winds, which are violent and very destructive whenever they occur. The occurrence of *Kapote* in a community symbolises little to no rainfall but has a low predictive power of fifty percent. The use of wind direction to predict the imminence of rainfall, its amount and continuity in a season was one of the conclusions in the Muluga and Chibelela villages of Tanzania study (Elia et al. 2014). The authors stated that the community members in the two villages explained that strong winds in October or November from east to west signify the beginning of the rains and a good year and west to east, this indicates less rainfall in the season (p.22).

Planetary System (Sun, Moon and Stars)

The presence of shining stars known as *nyenyezi* from the east signifies normal rainfall or death of an important person in the community. The dual signal can be confusing at times, as it is not easy to tell which of the two possible outcomes is being predicted. The direction in which the rainbow/*Utawaleza* appears determines whether there will be drought in the community. When the moon is surrounded by a water marked ring (*Mwezi uli madzi)*, it means the community should expect normal rainfall. This category of predicators of rainfall patterns generally has low predictive strength averaging fifty percent, save for the shining star at sixty percent. This is also consistent with findings of Elia et al. (2014) in the Tanzanian Muluga and Chibelela villages study and most recently, Sithole and Chundu (2020) in the study of the Chimanimani district of Manicaland in Zimbabwe. Other studies that show similar results on how the planetary or astronomical system is used to predict rainfall are that conducted in Mukueni District, Kenya (Speranza et al. 2010), Burkinaa Faso (Roncoli et al. 2011) and Rungwe and Chilolo Districts, Tanzania (Chang'a et al. 2010). In all these studies, the local people use the colour and position of the moon to predict rainfall and the resultant information is used primarily to plan for farming activities. The apparent similarity may suggest that as long as the natural element used in the ethno-science is the same, there is high likelihood that the behaviours referred to and interpretation would be the same regardless of the geo socio-cultural differences of the people.

Apparently, the cosmological indicators were the most common indicators between Salima and Chimanimani communities in Malawi and Zimbabwe respectively. Animals and plants tend to vary across communities and cultures, which is a reflection of the peculiarities of some of the species in the specific locations.

CONCLUSION

The results have revealed that rich indigenous knowledge on ways to predict weather patterns in Salima District of Malawi exists and are widely known and shared. Barring a few outliers, most predictors found to be significant in the area studied are common in the Southern Africa region due to shared cultural heritage. Most of the predictors have an effective power averaging seventy percent, hence the communities' reliance on them. Where the indigenous knowledge systems have been ignored in favour of modern meteorological systems, communities have suffered as was recently witnessed with the destructive Cyclone Idai, which caught most communities in the Southern African region unprepared. This rich knowledge had proved handy over the centuries in terms of the communities' capacities to predict weather conditions. This enabled communities to better prepare for mitigation measures against the predicted catastrophes and to better prepare for the farming seasons and other rain dependent livelihood activities. In fact, studies have suggested that precision of prediction increases when ethnometeorology and modern meteorology are combined (Kolawole et al. 2014; Mutasa 2015). The study findings presented in this paper are quite instructive in that they make clear the fact that it is more beneficial to integrate local knowledge systems with external ones in a society to achieve transformative and sustainable development. It is also noted that meteorological IKSs are intricately dependent on the preservation of the natural environment.

The results presented in this paper also reveal that to the extent the indicators are specific to certain species and in the absence of substitutability, it is important that issues of environmental conservation are dealt with simultaneously. In fact, the preservation of these traditional indigenous heritages was in itself an embedded mechanism to preserve plant and animal species in the communities. Notably, most of the indicators used always carry a sacred status in the communities of reference. By inference, this is what has contributed to the communities' ability to concurrently preserve their IKS and the environment, notwithstanding the colonial and neo-colonial-induced and sustained factors that have consistently weakened the walls of IKS in Africa. Thus, preservation of indigenous knowledge has a dual benefit, which is, enhancing weather predictability, whilst at the same time helping with environmental conservation.

RECOMMENDATIONS

Whilst modern scientific ways of predicting weather patterns are plausible, they should not have to come at the expense of indigenous knowledge but rather to complement it. This notion is theoretically illustrated in Figure 1 with the argument that exclusive use of one type of knowledge is less useful for a society than when the knowledge systems are deliberately integrated. A close look at the two weather prediction systems reveals similarities in their interpretation of some aspects of weather indicators such as clouds and wind systems. Modern weather prediction results, if not communicated timely, are not of any help in respect of rural and remote communities' state of preparedness. For most of Africa, connectivity in the realm of digital communication remains a challenge, and hence the need to complement whatever comes from the meteorological offices with what has been known to work at the community level over the centuries of human existence. Thus, there is scope for governments, especially in Africa, to integrate indigenous weather forecasting systems into the mainstream, recognising it as complementary to modern scientific systems. This could also be taught right from primary school through to tertiary education levels, possibly under heritage studies and geography as a way of preserving, modernising and utilising the knowledge, which is fast getting extinct.

LIMITATIONS

The localised nature of indigenous knowledge makes replicability of study findings a challenge as predictors relate mostly to local resource endowments. There is also scope for further study to interrogate the extent to which the climate change phenomenon has compromised the predictive power of these indigenous predictors of weather patterns. For instance, with shifting seasons, can the timing of the predictions be affected or the predictors have equally adjusted to the realities of global warming?

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