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The use of indigenous knowledge in weather and climate prediction in Mahenge and Ismani wards, Tanzania

Kijazi A. L.[1], Chang'a L. B.[1*], Liwenga E. T. [2], Kanemba A.[1] and Nindi S. J.[3,4]

[1]Tanzania Meteorological Agency (TMA), Tanzania.
[2]Institute of Resource Assessment (IRA), University of Dar es Salaam, Tanzania.
[3]Centre for Sustainable Rural Development, Sokoine University of Agriculture, Tanzania.
[4]Tanzania Wildlife Research Institute (TAWIRI), Tanzania.

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This paper discusses the role of indigenous knowledge (IK) in weather and climate prediction in Mahenge and Ismani wards focusing on Safari Road and Mahenge Mjini villages in Mahenge; and Uhominyi and Ismani Tarafani villages in Ismani. The perception of local communities about climate change is assessed. Local environmental and astronomical indicators used by local communities in weather and climate prediction are identified and documented. A team of five IK experts in both Mahenge and Ismani was identified and assigned the task of making continuous observations of the IK indicators and producing seasonal rainfall forecast for the purpose of testing the accuracy and reliability of IK. Key informant interviews and Focus Group Discussions (FGDs) approaches were used in data collection regarding existing IK in weather forecast. A total of 120 respondents were interviewed in study Mahenge and Ismani wards respectively. A Statistical Package for Social Science (SPSS) was used for data analysis. More than 83% of the respondents were found to be aware of climate change. Plant phenology, particularly that of mango trees was found to be the most used indicator in both wards. An assessment of the forecasted and observed 2011/2012 seasonal rainfall indicates comparable results.

Key words: Adaptation, climate variability and change, indigenous knowledge and weather prediction.

INTRODUCTION

The observed increase in climate variability and the projected climate change, characterized by increased frequency and severity of extreme climatic events pose a serious threat to the livelihood of most people in Tanzania. The adverse impacts of climate variability and climate change on various socio-economic sectors, environment and livelihoods are already vivid and have the potential to undermine and even undo progress so far attained in the development of the socio-economic well being of Tanzanian (Nindi and Mhando, 2011). Climate change impacts can be significantly reduced by having sound adaptation strategies based on increased accuracy in weather and climate predictions. This will enable most rural communities to make informed, timely

*Corresponding author. E-mail: changa60@hotmail.com.

and effective decision on their farming activities leading to increased productivity.

In Africa, agricultural food production is widely rain-fed; weather prediction, particularly rainfall and information sharing is critical for community adaptation to climate variability and climate change. Emery (2000) singles rainfall as a key determinant of climate change, yet rainfall forecasting is a notoriously difficult area. The increased attention in rainfall prediction in recent years is bringing together the conventional scientific community and the indigenous community scientists to share their knowledge systems. This paper discussed the relevance of indigenous knowledge in weather prediction and enhancing local communities' climate change adaptation.

Historically and to date, local communities in different parts of the world have continued to rely on IK to conserve the environment and deal with natural disasters. This is partly due to lack of accessibility and difficulty in interpreting conventional weather forecast. Communities, particularly those in droughts and floods prone areas have generated a vast body of indigenous knowledge on disaster prevention and mitigation through early warning and preparedness (Rongoli et al., 2002; Anandaraja et al., 2008; Svotwa et al., 2007). The importance of integrating both the scientific and indigenous climate forecasts information for farm level decision is gaining momentum as also documented in Mozambique and Kenya by Lucio (1999) and Ngugi (1999), respectively.

In Zimbabwe, for instance, local communities have been coping with droughts by integrating scientific and indigenous climate forecasting techniques (Shumba, 1999). Indigenous knowledge about natural hazards enables in many cases communities at risk, to capitalize on this knowledge to protect themselves from natural disasters. This knowledge is still intact among indigenous communities in many parts of Africa and other regions of the world. However, it is not well documented and it stands in danger of being lost as its custodians are passing away.

Using IK in weather and climate prediction, local communities in different parts of Tanzania have been coping and adapting to increased climate variability normally manifested in the form of increased frequency and magnitude of various exigencies including droughts and floods, and outbreak of pests and diseases. Prediction of impending hazards has been an integral part of their adaptation strategies. Various environmental and astronomical indicators including plant phenology, behaviour and movement of birds, animal and insects are widely used in many parts of Tanzania to predict rainfall (Chang'a et al., 2010, Kihupi et al., 2002; Mhita, 2006).

In spite of all the usefulness of IK in weather and climate prediction, the art is under threat of disappearing due to lack of systematic documentation of the knowledge and lack of coordinated research to investigate the accuracy and reliability of IK forecasts.

This paper assesses the perception of local communities on climate change, identifying and documenting local environmental and astronomical indicators used by local communities in rainfall prediction. The paper also determines the accuracy and reliability of indigenous knowledge forecasting system.

STUDY METHODS

Description of the study area

The study area covers Mahenge and Ismani wards in Morogoro and Iringa regions, respectively. Four villages namely Mahenge Mjini and Safari Road in Mahenge ward and Uhominyi and Ismani Tarafani in Ismani ward were involved in this study. Climatologically, Ismani is mostly low land characterized by semi-arid climate with unimodal rainfall pattern. The rainfall season in Ismani is from November to April of following year with a maximum mean monthly rainfall of 138 mm occurring during the month of January. Mean annual rainfall for Ismani is 598 mm. Mean monthly minimum temperature ranges from 12^0C in July to 16.5^0C in December, while mean monthly maximum temperature ranges from 24.3^0C in July to 28.8^0C in November. Mahenge is mostly mountainous with an elevation ranging from 400 to 1,500 meter above sea level and is characterized by relatively wet and cool climate. The area is characterized by unimodal rainfall pattern with a maximum mean monthly rainfall of about 450 mm occurring during the month of March. Mean annual rainfall for Mahenge is about 2193 mm. The rainfall seasons normally starts in October and ends at the beginning of May. Mean monthly minimum temperature for Mahenge ranges from 14.4^0C in July to 18.9^0C in January, while mean monthly maximum temperature ranges from 22.3^0C in July to 27.7^0C in November. June to September is normally a dry season for both Mahenge and Ismani. The Mahenge Mountains are recognized as an important water catchment and natural resource site for the surrounding areas. Majority of the people in both Ismani and Mahenge wards accrue their livelihoods from rain-fed farming and livestock keeping.

Identification, analysis and documentation of the traditional indicators used for seasonal rainfall forecast in Southwestern highlands were conducted adopting similar approach to that by Kihupi et.al. (2002). A total of four villages (Safari Road and Mahenge Mjini villages in Mahenge and Uhominyi and Ismani Tarafani villages in Ismani) were sampled. The selection of study villages was based on the accessibility to the respective villages and availability of extension officers. Household survey involved a total of 120 respondents; 30 respondents per village were randomly selected based on age factor, where all people older than 35 years were eligible to participate in the interviews. The communities that were selected in this study included farmers, pastoralists and agro-pastoralists. A structured questionnaire was used to collect data from households. The collected data were analyzed and synthesized using Statistical Package for Social Science (SPSS) l computer programme.

Participatory Rural Appraisal (PRA) methods namely key informant interviews and Focus Group Discussions (FGDs) were also used in data collection. A semi-structured questionnaire was administered to different group of elders focusing on climate change awareness and perception, seasonal rainfall prediction, knowledge on traditional indicators and past climatic events with focus on extremes. A total of four Focus group discussions were conducted; one FGD per village. FGDs in weighing and balancing the information collected through interviews with a view to produce generalizations that represent the traditional knowledge existing within the community. FGDs involved up to eight people focusing

Table 1. Awareness of local communities on climate change in percentages.

Ward villages		Awareness on climate change		Total count
		Yes	No	
Mahenge	Mahenge Mjini	93.3(28)	6.7(2)	100(30)
	Safari Road	90.0(27)	10.0(3)	100(30)
Isimani	Isimani Tarafani	86.7(26)	13.3(4)	100.0(30)
	Uhominyi	63.3(19)	36.7(11)	100.0(30)
Total		83.3(100)	16.7(20)	100.0(120)

Numbers in parentheses are actual counts of respondents.

Table 2. Perception of people on rainfall trends (percentages).

Ward villages		How is rainfall changing			Total count
		Increasing	Decreasing	Fluctuating	
Mahenge	Mahenge Mjini	20(6)	56.7(17)	23.3(7)	100(30)
	Safari Road	16.7(5)	56.7(17)	26.7(8)	100(30)
Isimani	Isimani Tarafani	3.3(1)	90.0(27)	6.7(2)	100.0(30)
	Uhominyi	10.0(19)	83.3(11)	6.7(2)	100.0(30)
Total		12.5(15)	71.7(86)	15.8(19)	100.0(120)

Numbers in parentheses are actual counts of respondents.

on perceptions on climate change and various techniques used within the community in weather forecasting were explored. According to Saunders et al. (2007), a typical focus group discussion involves four to twelve participants depending on interviewer skill and subject matter. Content analysis was used to analyze information from key informants interviews and FGDs and this enabled one to ascertain values and altitude of respondents.

RESULTS AND DISCUSSIONS

Perception about climate change

The assessment of climate change awareness indicated that more than 83% of the respondents were aware of climate change and mentioned frequent droughts and disappearance of some species as among the evidence of climate change (Table 1).

In the assessment of the perception of people in rainfall trends, majority of the respondents (72%) indicated a notable decrease in rainfall (Table 2). However, in Mahenge ward, which is characterized by mountainous and relatively wet and cool climate, only 56% of the respondents indicated to have noted a decrease in rainfall. This may mean that the decreasing rainfall trend in Mahenge is localized and is not significant. However, in semi-arid Ismani ward, majority of the respondents (>83%) indicated to have noted a decrease in rainfall, which may indicate that the decreasing rainfall trends in Ismani ward is widespread and significant.

The assessment of the perception of people on temperature trends indicates contrasting results between the two wards. While majority (90%) of the respondents in Mahenge ward indicated an increase in temperature, most of the respondents (>70%) in Ismani ward noted a decrease in temperature (Table 3) and attributed it to deforestation.

Local environmental and astronomical indicators used in rainfall prediction

In both Mahenge and Ismani wards, plant phenology was found to be the most used indicator in predicting rainfall events. Other indicators mentioned include behaviors and movement of birds, insects and animals. The plants that were found to be mostly used include mango trees (Mangifera indica) and Mikuyu (Ficus ssp). On meteorological indicators, wind patterns, direction and variation were also found to be used in monitoring rainfall. Tables 4 to 6 provide details of other local climatic indicators.

Despite such useful prediction by IK on climate events, the system is facing various challenges. One of the

Table 3. Perception of people on temperature trends (percentages).

Ward villages		How is temperature changing				Total count
		Increasing	Decreasing	Fluctuating	No change	
Mahenge	Mahenge Mjini	93.3(28)	3.3(1)	.0(0)	3.3(1)	100(30)
	Safari Road	86.7(26)	10.0(3)	3.3(1)	.0(0)	100(30)
Isimani	Isimani Tarafani	16.7(5)	76.7(23)	6.7(2)	.0(0)	100.0(30)
	Uhominyi	30.0(9)	63.3(19)	6.7(2)	.0(0)	100.0(30)
Total		56.7(68)	38.3(46)	4.2(5)	.8(1)	100.0(120)

Numbers in parentheses are actual counts of respondents.

Table 4. Documented indicators and their application in rainfall forecast.

Indicators	Local/Swahili name	English name	Scientific name	The sign used to relate to rain
Insects	*Mchwa*	Termite	*Ancistrotermes spp*	Appearance of many termites indicate near rainfall onset
	Viwavi	Army worms	*Spodoptera exempta*	Appearance of army worms on trees during the month of October signifies abundant rainfall in the upcoming season.
	Senene	Grass-green grasshopper	*Hesperotettix speciosus*	Occurrence of more grasshoppers in a particular year indicates less rainfall and hunger.
	Nge	Scorpion	*Arachnida ssp*	When black/dark scorpion are seen in the months of September and October indicates the possibility of a good rain season
Birds and animals	*Yangeyange*	(Cattle Egret)	*Bubulcus ibis*	Occurrence of Yangiyangi birds in October and November indicates imminent rainfall onset and a good rainfall season.
	Dudumizi	Coucal	*Centropus ssp*	Singing of the Dudumizi especially early in the morning hours in October and November is the sign of imminent rainfall onset and a good rainfall season.
	Finyanyamba	Swallow tailed Bee-eater	*Merops Hirundineus*	When swallow flock are seen flying all over in the atmosphere it indicates heavy rain to come at that particular time. When they appear on November it indicates imminent rainfall onset.
	Kakakuona	Pangolin	*Scaly anteaters*	One of the best indicators used in rainfall prediction

challenges facing the Indigenous Knowledge forecasting system is the disappearance of some of the indicators from their area. Birds such as Mbungu (Vultures) and trees such as *Misombe* (fruit trees) and birds that were used as rainfall indicators by local communities in Ismani ward have disappeared. Deforestation and climate changes were linked to the disappearance of these local attributes.

The accuracy and reliability of indigenous knowledge forecasting system

First experimental forecast done by local IK experts for the 2011/2012 rainfall season in both Mahenge and Ismani yielded good results as it corresponded with observed results. The forecast by the local IK expert team in both Mahenge and Ismani predicted the

Table 5. Plants phenology documented indicators and their application in rainfall forecast.

Indicators	Local name	English name	Scientific name	The sign used to relate to rain
Plants phenology	*Minusi*			When their leaves sprout indicates the approach of rain season
	Mikwee			
	Mwembe	Mango tree	*Mangifera indica*	A significant flowering of mango trees indicate a potential drought season

Table 6. Astronomical and meteorological indicators.

Indicators	Signs	Descriptions in relation to rainfall
Wind	North – west wind direction on November/or December	Heavy rainfall is going to fall. Also it indicates due onset of rainy season
	Change in wind direction and temperature	Signifies imminent rainfall
	Strong Wind during the month of July through October	Indicates less rainfall in the upcoming season.
Moon	Dark moon in July accompanied by cold, ICE and snows fall	It signifies good rainy season.
	Disposition of the new moon (slanted position)	Indicates more diseases and erratic rainfall
Five stars	Vilimila	Indicates that rainfall season is approaching
Temperature	Heart/hot in low land areas on August	It means there will be more rainfall in the coming rainy season
	Strong Wind	Strong wind during the month of July through October indicates less rainfall in the upcoming season.
	High Temperature on October and November	Signifies near rainfall onset and the prospect of a good rainfall season.
	Cold weather on July	Indicates possibility of hail stone

2011/2012 rainfall season to feature above normal rainfall. Observational evidence indicates that so far the observed rainfall in both Mahenge and Ismani was well above normal. However, more experimental forecasts need to be done to determine the level of accuracy of IK forecast.

CONCLUSION AND RECOMMENDATIONS

Majority of people in both Mahenge and Ismani were found to be aware of climate change and attributed it to changes in rainfall and temperature patterns. Local indicators that are used by local communities in seasonal rainfall prediction over Mahenge and Ismani have been documented. It has been found that plant phenology is the mostly used indicators in rainfall prediction in both Mahenge and Ismani. The appearance of Kakakuona (Pangolin) and the behaviour of Dudumizi (Caucal) birds were singled out as among the best indicators used in rainfall prediction. Both local Indigenous Knowledge specialists in Mahenge and Ismani have successfully predicted the 2011/2012 seasonal rainfall using Indigenous Knowledge. It is recommended that the documented indicators should be monitored for at least ten years and that the study should be expanded to cover more wards and villages around the two regions.

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