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Research Article

Dissemination of agricultural weather forecasts under weather and climate variability: a case of the smallholder farmers in Moshi rural District, Tanzania

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Since its formation in 1978, the Tanzania Meteorological Agency (TMA) has continued to provide agricultural weather forecasts among other climate products. However, the uptake and use of these weather forecasts by target end users under changing environment is uncertain. In this paper, production and dissemination pathways of agricultural weather forecasts in Tanzania with a focus to Moshi Rural District are presented. A combination of participatory research approaches and household surveys were used to explore perceptions of local communities on dissemination, application and reliability of agricultural weather forecasts. While the study shows that 96% of farmers depend on climate and weather information for on-farm decision making, only 40% of farming communities rely on TMA weather forecasts. The rest of farmers rely on indigenous knowledge-based weather forecasts. The TMA seasonal weather forecasts lack local/area specific focus. The forecasts relates to area-wide patterns, amounts, distribution, onset and offset of rains, its associated impacts and advisories on possible actions to be taken by users in risk areas. TMA forecasts are unpopular because of too high degree of local unreliability in terms of spatial and temporal distribution and use of technical language. Challenges of packaging and dissemination of seasonal agricultural weather forecasts to smallholder farmers by TMA were identified, and some suggestion on the way forward made.

Key words: Weather forecast, communication pathways, Tanzania

INTRODUCTION

Rain-fed agriculture is the stronghold of the Tanzanian economy contributing about 29.0% of GDP in the year 2015, 100% of food for good rain years, 30.9% of export earnings and employs about 65.5% of the total labour force (URT, 2016). Smallholder farmers dominate the agriculture sector in Tanzania with average farm sizes of between 0.9 to 3.0 hectares per household. This amounts to a total of 5.1 million hectares annually (URT, 2015). 85% of this area is used for food crops. Food production contributes about 70% of rural household income through sale of agricultural products (URT, 2012). Despite this remarkable contribution of agriculture to the national economy and the livelihoods of its people, growth of the sector has declined from 3.4% in 2014 to 2.3 in 2015 (URT, 2016).

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However, uncertainties associated with increasingly unpredictable seasonal weather conditions thought to be related to increasing climate variability, are a major constraint faced by smallholder farmers. Scientists involved in the production of weather information and those concerned with the agricultural sector's overall development, similarly are unsure about what advice should be given to farmers (Tall *et al*, 2013). Some are advocating as one option the generation and dissemination of reliable seasonal weather forecasts that would allow smallholders to pursue strategies based on better understanding of predicted changes in climate. Ensuring food security for the most vulnerable members of rural community users is considered by the government an imperative (CCAA, 2010a).

Agro-meteorological services include the development and dissemination of climate forecasts to support a range of agricultural production activities (CCAA, 2010 a). However, climate forecasts do not carry the same degree of risk and uncertainty. They are of various types, and are based on different time periods and expiry dates, ranging from one day forecasts to several months, with the degree of uncertainty increasing as forecasts project further and further into the future (Lutgen and Tarbuck, 2010). A seasonal forecast is one type of such climate forecasts. It focuses on average temperature and precipitation for periods of up to several months (CCAA, 2010b).

Agro-meteorological and related information is generated by highly specialized national meteorological and hydrological services using models and historical empirical data, mostly under guidelines set by the World Meteorological Organization, supplemented by other regional and international climate centres (Chagonda *et al*, 2010). Although seasonal climate forecasts (SCFs)have become increasingly available in many parts of Africa including Tanzania over recent decades (Roncoli *et al.,* 2009, Chang'a, *et al.,* 2010), most Africancountries have not experienced significant benefits from using this information to reduce climate variability risks (Chagonda *et al.,* 2010; Chang'a., 2012; Risiro *et al.*, 2012). One of the key challenges of climate and weather information use has been access to user friendly forecasts by farmers' and pastoralists. Their ability to respond and make meaningfully use of meteorological and climate information has been low due to too high degree of unreliability and local inaccuracy (Roncoli *et al.,* 2009).

The Tanzania Meteorological Agency (TMA) established by an Act of Parliament (Act.No.6 of 1978) in 1978 is responsible for all meteorological activities in the country. The agency offers a wide range of services: weather forecasting (public, marine and aeronautical); various meteorological, technical services, research and applied services. The agency also provides long range (LR) and short range (SR) weather forecasts and seasonal climate outlooks for various sectors such health, energy, agriculture, livestock, natural resources and tourism, water, disaster management, etc. Seasonal climate outlooks are provided four times a year (March-April-May (MAM), October-November-December (OND), January-February-March (JFM) and June-July-August (JJA). In addition, the TMA provides quarterly climatological statistics for the planning sector, energy, agriculture, researchers etc.; daily, quarterly and seasonal climate information and weather summaries for various stakeholders; as well as monthly agro-meteorological bulletins. The TMA also produces decadal (10 day) and monthly weather bulletins. The decadal weatherreviews (DWR) provides a 10 day summary of the synoptic situation, rainfall, agro-meteorological and hydro-meteorological impacts, and a weather outlook for next decade (10 days). The reviews also provide a rainfall map and relevant graphs; they are only produced during crop growing seasons (World Agro-meteorological Information Service-WAMIS (2015). The monthlyweather bulletins provide a synoptic and weather summary; information on temperature, sunshine hours, and wind speed; satellite information including normalized difference vegetation index (NDVI); an agro-meteorological and hydro-meteorological summary; and the expected synoptic and rainfall situation for the next month. The monthly bulletin is produced every month throughout the year (WAMIS, 2015).

However, there are other institutions both at national and district level that have a stake in the production and dissemination of meteorological information. These include but are not limited to the Ministry of Agriculture, Food Security and Cooperatives (MAFC) through its departments located at each district in the country, Ministry of Water (through River Basins' Authorities),and Ministry of Livestock and Fisheries Development (MLFD). In addition, TMA is involved in regional consensus forecasts. The agency collaborates with regional centers such as the Intergovernmental Authority on Development (IGAD) and Climate Prediction and Applications Centre (ICPAC) housed by the Kenya Meteorological Department (KMD) for the Horn of Africa, and the Southern African Development Cooperation (SADC) for the southern part of Africa to produce regional climate outlooks that cascade into to country climate outlooks. Each piece of information carries different degrees of risk and uncertainty, and this is confusing for users, especially smallholder farmers who may lack access to expert advisers who could guide them through a meaningful interpretation.

This paper assesses dissemination pathways and uptake of agricultural weather forecasts by smallholder farmers

on the slopes of Mount Kilimanjaro in Moshi rural District, Tanzania. The paper also examines the accuracy and reliability of seasonal weather forecasts issued by TMA.

METHODOLOGY

Description of the study area

The study was carried in Moshi Rural District on the slope of Mount Kilimanjaro (Figure 1) between March and August 2014. It covered an altitudinal transect of 21 kilometres long and 3 kilometres wide from Kisangesangeni village Miwaleni Springs (700-900 m.a.s.l.) on the lowest part to Maruwa-Nduoni (1900-2100m.a.s.l.) KiruaVunjo on the highest location. The area was divided into four altitudinal zones: lower zone (700-900m.a.s.l.), mid lower zone (900-1500 m.a.s.l.), mid upper zone (1500-1900 m.a.s.l.) and upper zone (1900-2100 m.a.s.l.) based on temperature and humidity. Segmenting this study area into altitudinal zones was useful for comparison analysis of the needs of weather information based on different agro-climatic parameters and biophysical characteristics of each zone. To be able to collect large and representative information of the study area, eleven (11) villages were randomly chosen for primary data collection. These villages included Nduoni and Kwamare in the upper zone; Iwa, Kopachi and Sumi in the mid upper zone; Kisangani, Mafurwanjeni and Uparo in the mid lower zone; Yamakaa, Uchira and Kisangesangeni in the lower zone (Figure 2).

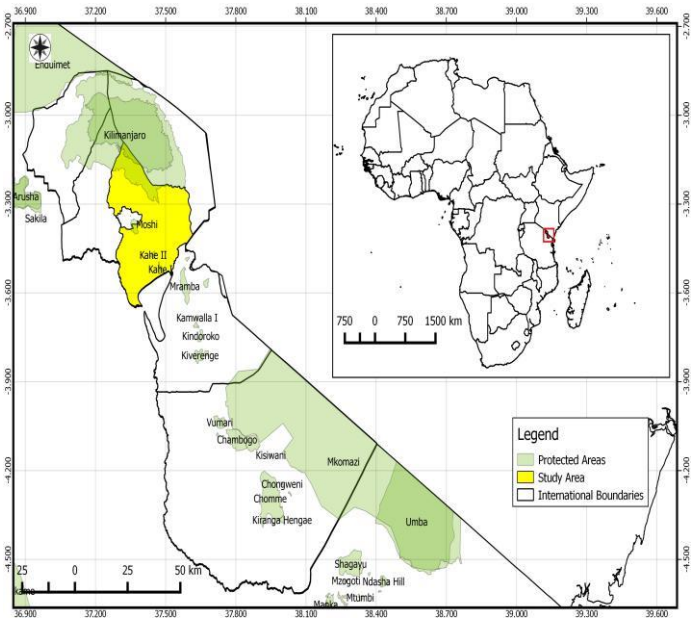


Figure 1.1. Tanzania showing Kilimanjaro region and Moshi rural district
Source: Shirimamiro GIS lab (2015)

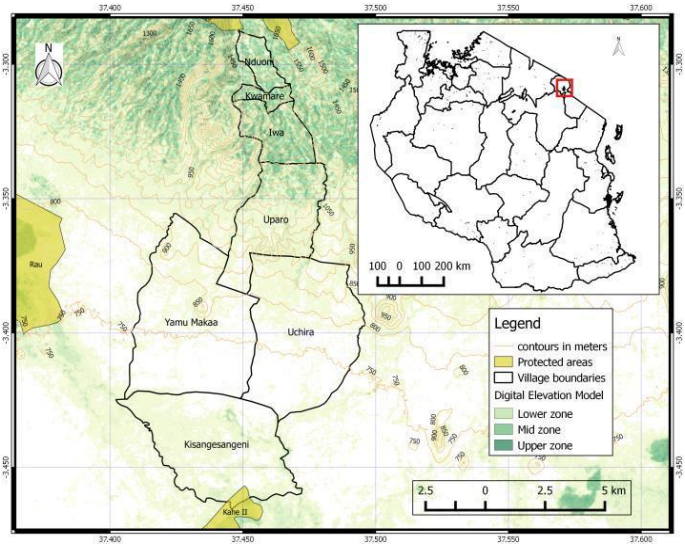


Figure 1.2: Study transect and sample villages
Source: Shirimamiro GIS lab (2015)

Data collection

A combination of participatory and qualitative research methods (PRAs), namely key informant interviews (KII), focused group discussions (FDGs) and household surveys (HHS) were used to explore the perceptions of local communities on their use and perceived reliability of weather forecasts, and their experience of available weather forecast communication pathways. Challenges embedded in the packaging and dissemination of seasonal weather forecasts to smallholder farmers were assessed, using expert interviews and household surveys.

Each of the methods included open and semi-structured questions that allowed open-ended and flexible dialogue between researcher and respondents. Adopting a similar approach to representivity as Leech (2005), Mason and Mark (2010), eight percent (about 20 households) of the total households in each village were included in the survey, totalling 375 randomly selected households, from all eleven villages. A purposive sampling procedure was also used for administering key informant interviews and FGDs. A total of 23 FGDs using flexible open and semi-structured questions were conducted across the study transect. Twelve of the FGDs were homogenous in terms of gender and were conducted in three villages; four FGDs in one village in each zone i.e. Nduoni in Upper zone, Iwa in mid zone and Kisangesangeni in the lower zone. Eleven (11) mixed participants FGDs, one for each of the remaining villages, were also administered. The dialogues were recorded manually and using voice recorders. Venn diagrams developed by the researchers, showing possible information dissemination flows from forecasters to users were used during the FGDs to help farmers identify suitable options for weather forecast communication pathways according to the conditions in their localities and preferences.

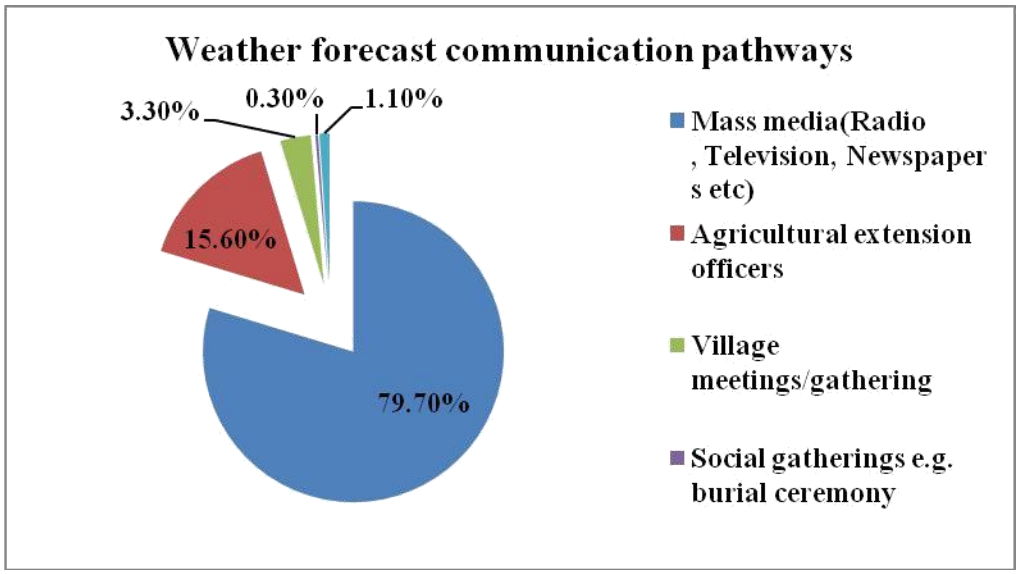


Figure 2. Community weather forecast
Sources: Household survey, (2014)

Data analysis

Predictions and forecasting diagrams were used to identify the potential impact of each source of weather and climate information on the information pathways from forecasters to users. To gain an overview of existing communication systems and weather forecasts production practices in comparison to the study data, a documentary review was also conducted. Thematic and content analysis was used for analysing the key informant interview and FGD data, while descriptive statistical analysis using Statistical Package for Social Sciences (SPSS) version 21 and Microsoft Excel software were used to analyse the household survey data.

RESULTS AND DISCUSSION

Current weather forecast communication pathways

Analysis of FGD and expert interviews with participants in all survey zones revealed that there is a high demand for area-specific weather information for farm level decision-making. It was also observed that, men and women use climate/weather information differently. The analysis of the household survey data indicated that although 94% of all respondents along the altitudinal gradients are aware of the TMA's weather forecasts, only 14 % of them use it. 42% of respondents use traditional weather forecasts while 42% combines both traditional and conventional seasonal weather forecasts. The overall weather forecast communication pathways currently used in Tanzania are presented in figure 3. However, majority of respondents (80%) who get weather information through their radios receives it incidentally i.e. alongside listening to other news and events of interest to them such as political and/ or sports reports. However, according to the TMA, weather forecasts from the central forecasting centre are channelled through radios, televisions and print media, websites, cards and mobile phones, the last means being at audition try-out period. FGD participants along the altitudinal gradients confirmed that the forecasts received contain general information on the patterns of rainfall, amounts, distribution, onset and offset of rains, and its associated impacts, including advisories of possible actions to be taken by users in risk areas. However, respondents informed that availability of some radiofrequencies were highly variable depending on altitude. Low land dwellers in Kisangesangeni village had poor Radio-one frequency receivership compared to highland dwellers in Nduoni village.

Discussions conducted with experts at TMA revealed a potentially important communication channel between TMA and MAFSC. TMA has fully attached staff at MAFSC who works with the MAFSC's department of food security and early warning. However, interviews with experts at Moshi Rural District suggested that the communication link between MAFSC and its departments of agriculture and food security at the regional, district, ward and village levels is weak. Key informants at TMA further clarified that the Central Forecasting Office (CFO) through its National Telecommunication Centre (NTC) collects and exchanges observational data at national, regional and international level by using the Global Telecommunication System (GTS) and the Aeronautical Fixed Telecommunication Network (AFTN). The Centre is equipped with the African

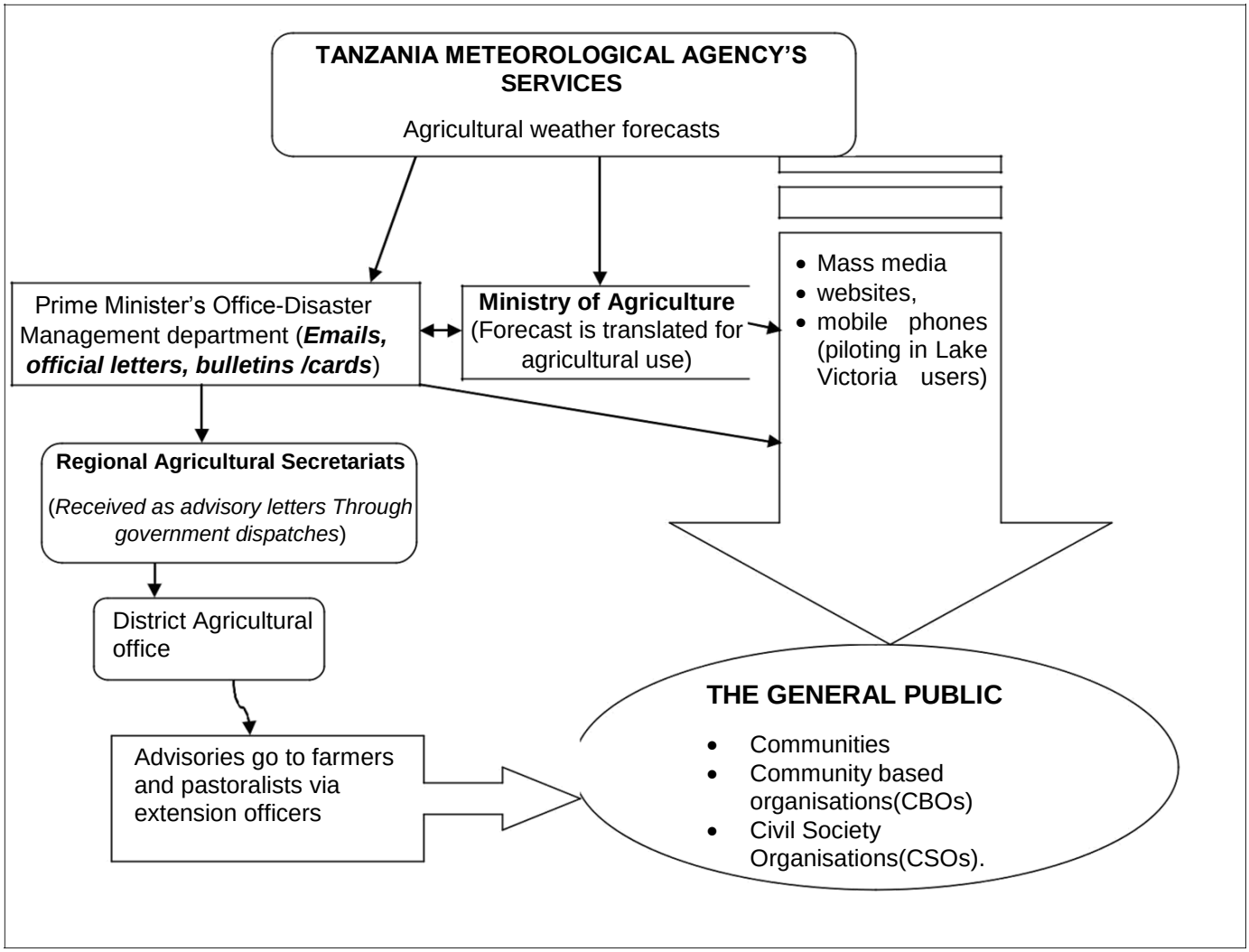


Figure 3. Current weather forecasts communication pathways in Tanzania

Meteorological Environmental Diagnostic Integrated System (AMEDIS) which is integrated with the Satellite Distribution System (SADIS) and the Meteorological Data Distribution (MDD). Unfortunately, none of these information products reaches local advisers or farmers in a friendly package and in good time according to users' seasonal activity schedules.

Figure 4 below describes the existing weather communication framework in Tanzania from the TMA to end users. According to key informants, delays in the flow of information typically occur between the regional secretariats and district councils (depending on the persons in charge). There is also information distortion and loss accruing from the need to translate difficult technical language. For example, both agricultural experts and farmers as described in Box 1 & 2 during interviews at Moshi Rural District Council, and study villages respectively, noted the difficulty of interpreting TMA forecast. Translation occurs at different levels throughout the pathway before reaching end users. The translation processes contribute to delays in the delivery of the information to intended users. This was confirmed by extension staff who stated that they too receive and often prefer to rely on weather forecast information from the radio and television rather than the translated forecast from the regional secretariat and district council.

Effectiveness of existing weather forecasts communication pathways.

Farmers in the study area have different opinions of the existing. TMA communication pathways. About a quarter of the respondents (26 %) perceived the existing systems as very effective, and 48% perceived these as acceptable, but the remaining 23.0% considered the communication systems as not effective. The FGD participants from all four zones indicated that they thought the radio is the main

BOX 1: Mr. Antony Msaki (76 years old), a retired school teacher and currently a farmer at Iwa village, bewail on TMA forecasts as hereunder:-

..i always hear TMA forecast on Radio One in most cases, but every time I try to concentrate I fail to understand what they exactly mean…for example they say Mvuazahapana pale..Mikoayakaskazini Kilimanjaro, Tangana Arusha...(--scattered light rain showers over few areas along Northern regions, Kilimanjaro, Manyara and Arusha) now I try to understand where is" hapa"(here) and "pale"(there) in our area?..tell me! Is this clear to a village farmer like me and my fellows? You tell me rains are expected to start in mid March but I have already seen rains in February…! Isn't this confusion?"

BOX 2: Review of weather outlook for March – May 2014 rainfall season in Tanzania issued by TMA (press release on 27th/02/2014(TMA/1622).

"D: MAM 2014 RAINFALL OUTLOOK

(i) Long Rainfall Season (Masika)

The long rainfall season in the northern sector (bimodal areas) of Tanzania is due to commence in the first week of March, 2014. The details are as follows: (PP.3, 6 para) **North eastern highlands** (Kilimanjaro, Arusha and Manyara regions): The onset of rainfall is expected during the second to third week of March, 2014 and the rains are likely to **be normal to above normal over much of these areas** except for some parts of Kilimanjaro region (Same district) where below normal rains are anticipated (pp 4, 2 para)"

Source: TMA, (2014)

means of communication between TMA and end users in most rural setting, like the study area. They further indicated that although the radio appears to be a suitable media to communicate with rural communities, compared to television and newspapers, not all people in the study area had access to or the ability to own radios.

The elders in Nduoni village further emphasized during the FGD interviews that even those who owns radios do not regularly access weather forecasts because of a number of reasons: lack of interest in the information, inadequate and inconvenient time slot allocated for SCFs broadcasting in relation to farm activity schedules of the rural people; and poverty that limits people's ability to buy batteries for radios all the time when needed. During the study it was further reported that some radio frequencies were not accessible at all times in the study areas. FGD participants stated that in any case only Radio-One, which has a national coverage, routinely broadcasts weather forecasts. Additionally, respondents were concerned that Radio-One broadcasts weather forecasts bulletin once a day at five a.m at a time when some farmers are not yet awake and others are already too busy with farm activities, and therefore unable to tune in and listen. Additionally, some respondents in the upper zones appeared to prefer Radio Maria, a popular local FM station that does not broadcast weather information.

With regard to official government weather forecast communications, all respondents confirmed they did not receive SCFs from any government officials. This was later emphasised by one village extension worker who stated that:

"Even we agricultural extension officers who have the responsibility to advise farmers on how to apply weather information for farm level decision making do not get weather forecast officially from our superiors except from media particularly radios just like farmers do. But I hear that each year TMA issues weather forecast for agricultural use via our ministry (Ministry of Agriculture), but the information ends at the district level…this way of information sharing requires serious improvement if weather forecast is to be a tool for making farm level planning and decision making."

A key informant at the Moshi Rural District Council department of agriculture also confirmed that in his view SCFs provided by TMA are not end user friendly. The information is packaged in such a way that even agricultural officers, who are expected to translate it into simple, understandable and applicable information for their farmers, cannot understand it. He further explained that, in addition to a problem of the technical language used in packaging the information, the forecasts are too vague and general: they lack specifics on time, dates, and locality (Box 1). These negative attitudes towards TMA weather forecasts were confirmed during the FGDs.

The review of the weather outlook for the March – May, 2014 rainfall season, issued by TMA as a press release on 27th/02/2014 (TMA/1622) was used to crosscheck information given by respondents (such as that of Mr Anthony

Table 1. TMA enhanced climate monitoring equipments capacity

S/N	Description of equipment/ stations		Number of Stations		
		Current	Operational	Needed	Shortage
1	Conventional surface synoptic stations	28	28	32	4
2	AWS surface synoptic stations	28	26	113	75
3	Agro meteorological stations	12	12	20	8
4	Ordinary climate stations	150	50	250	100
5	Rainfall stations	2056	500	500	Nil
6	Automatic rainfall stations	Nil	Nil	2500	2500
7	Marine weather stations	2	2	12	8
9	Upper air stations	1	Nil	4	3
10	Pilot balloon	1	-	5	4
11	Weather radar	2	2	7	5
12	Lighting	0	0	10	10
13	Orbiting satellite receiver	-	-	1	1

Source: KII with TMA, (2016).

Antony Masaki in Box 1). The six page climate outlook dealt with the performance of the October to December (OND) 2013 short rainfall season, the ongoing seasonal rains (starting from the date of forecast release) over the central, western, south western highlands, southern region and southern coast, and an outlook for the March to May (MAM) 2014 Masika (TMA, 2014). Section D (i) page 4, paragraph 2, covering the Northern highlands with regard to March-April-May rainfall forecast (box 2) reads:

A closer examination of the details of the long rainfall season (italicized lines in box 2), reveals that the forecast was at least specific with respect with a statement like "*normal over much of the areas except Same district"* which may well be understood by experts in the field and producers, but not by smallholder farmers in Nduoni village who exactly cannot tell which locations are covered by "*over much of these areas"* within Moshi district. It is also difficult to interpret what is meant by "*normal to above normal"*. This way of packaging information, coupled with issues of variability of the forecasts in terms of accuracy and timeliness, discourages potential users.

Respondents' Perception of TMA weather forecasts

The results of the household survey indicate that 46% out of 366 responses along the altitudinal gradients perceive conventional TMA weather forecasts as not reliable and therefore not useful, while 25% were not sure. Only 26% perceived them as reliable and useful, a percentage also reported by other researchers (Chang'a *et al*., 2010, Chagonda *et al*., 2010, and Kijazi*et al.*, 2012). Further analysis of the FGD results indicates that TMA seasonal weather forecasts are perceived not to be reliable, not area specific and difficult to interpret by ordinary people, hence poor uptake and use.

Interviews with key TMA experts indicated that the agency is also aware of the problems of the current forecast bulletins and communication systems. In order to make constructive suggestion on how to improve TMA's ability for future provision of reliable agricultural weather forecast, further discussion with TMA key officials were conducted with emphasis on unreliability of information as reported by end users in the study transect. Some of the technical reasons for TMA's incompetence in weather forecasts and delivery of quality service include:

i. Shortage of weather stations in the country and other required equipments as described in table 1.
ii. Lack of central forecasting office that hinder installation of some of meteorological equipments.
iii. Inadequate skilled personnel for meteorological data collection, analysis, packaging and dissemination of area specific forecasts.
iv. High cost involved in running weather stations
v. lack of central forecasting office that hinder installation of some of meteorological equipments, inadequate skilled personnel for meteorological data collection, analysis, packaging and dissemination of forecasts especially at local level
vi. High cost involved in running weather stations

Studies carried out in other parts of Africa show limited adoption of SCFs by farmers because of serious bottlenecks, including poor trust in SCFs, low awareness and inability to translate the forecast into useful information (Chagonda *et al*., 2010 and Makwara, 2013);

these constraints also surfaced in the present study. Of the 96% of the respondents who use climate information in our study, at least 49% rely on the use of indigenous forecasts and 34% combine both Indigenous Knowledge-Based Forecasts (IK-BFs) and SCFs for planning farm activities. This farmers' response highlights the significance of indigenous knowledge based weather forecasts (IK-BFs) at community level (Chengula and Nyambo, 2016).

The unreliability of weather forecasts also emerged during the FGDs as another constraint to the use of climate information. Respondents were invited to recast their opinions on integrating IK-BFs into SCFs production system. Results show that about 96.2% out of 365 respondents voted for yes, while only 3.8% voted for no. During the FGD participants reiterated the point that integrating IK-BFs and SCFs was the only solution to the existing challenges associated with both sciences. Respondents further informed that integration of both sciences would also sanctify indigenous knowledge and thus help to revive and rescue the knowledge from disappearing. Secondly, FGD participants were convinced that this would increase the accuracy of both forecasts and thus increase usage and application of weather and climate information than it is currently the case. Thirdly, integrating the two would increase people's awareness, trust of information and uptake by future generations. Moreover, there were pessimists who thinks integrating the two would not work because so many of the traditional weather forecast indicators and IK-BFs custodians have already disappeared.

Unfortunately, IK-BFs knowledge is in the domain of elders many of whom are very old and therefore their knowledge of trends over time is likely to die out unless a purposeful strategy to conserve their knowledge for future use is put in place. This could be done, for instance, by incorporating their knowledge into national, regional, and local education policies and curricula. 86% of respondents in our study reported observing a correlation between SCFs and IK-BFs and thought both systems have strengths and weaknesses. The challenge to providing a complementary information package that draws on both bodies of understanding is that the nature and extent of this correlation is not well documented, and ways of integration are not well established, both would require additional research. Furthermore, the integration of IK-BFs is challenged by the gradual disappearance of some of the biological indicators that farmers' draw on to assess weather trends, largely due to on-going climate changes and changes on landscape use. For instance, some communities reported in the FGDs that indicator birds like the malachite sunbird (which sings in January and February or in the middle of a prolonged drought indicating rainfall onset) are increasingly becoming rare, and reliable plant species whose phenology was used a long time ago to assess whether trends are no longer found because of the pressure of land clearing for crop production.

Suggestions on how to improve weather forecast communication pathways

Farmers and key informants throughout the study area voiced strongly the need to improve the existing weather forecast information flow. 51.5 % of respondents in the HH surveys suggested the use of mobile phone text messages to compliment radio broadcasts. 27.12% suggested the use of local radios whose frequencies are more accessible and highly preferred in the area, such as Radio Maria FM and Radio One FM, while 21. 40% suggested use of religious institutions. The results of the FGDs and KIIs revealed that many respondents preferred the use of mobile phone text messages because they are instant convenient and economical in terms of operational costs. Participants commented that the invention of mobile phones has already transformed communications for many social and economic members of the rural population, as 86 years old Mzee Josephat Mwanda in Kisangesangeni put it:

"*Even we elders who cannot read or write, can still use mobile phones with the help of our grandchildren*"

The TMA in face already is piloting the use of mobile phones to communicate weather forecasts under the Mobile Weather Alert (MWA) project in Lake Victoria and intends to use the lessons learned to scale up mobile phone use throughout Tanzania. Respondents emphasized the need to package the information in a simple understandable format. FGD participants further insisted on the need to empower local extension officers with harmonized easy to translate forecasts. According to participants, this would facilitate a dialogue between farmers and extension officers to make sure that the implication of a forecast so given is adequately understood and can easily be applied by farmers.

The FGDs with village government members in Kwamare village revealed that almost 99 % of the upper zone and mid zone dwellers are Christians, of whom 90% are Roman Catholics. The low land dwellers are in different religious denominations such as Lutheran, the Catholics and Muslims. The village government prefers to use the church and mosques, through the parish priest and mosque sheikh, to communicate information to their villagers, a platform that could also be used to communicate weather forecasts. A similar situation was reported by Sheikh Ramadhan of the Uchira Mosque. Despite insisting that religious institutions are primarily for

worship, Sheikh Ramadhan indicated that they have always allowed various experts and individuals, including government agents, to deliver development messages through religious institutions provided that the information has no implication for people's religious doctrines. However, it was noted that since weather forecasts are basically technical information, it might be difficult for religious leaders (taking his case on board) to interpret and provide proper advice to farmers. He therefore suggested that, agricultural extension officers available in the villages could fill up this gap.

The framework presented in figure 5 represents the recommended flow of information based on farmers' and key informants' suggestions and observations along all four altitudinal gradients and institutions visited. This can be achieved with a supportive policy framework.

CONCLUSION

Communities in the study transect are aware of the value of weather information for farm level decision making and hence continue to cherish use of indigenous weather forecasts (IK-BFs) that are easier to apply because they are linked directly to people's livelihood systems. IK-BFs lacks formal communication framework but still popular among the communities because they are more reliable. Unreliability of TMA's weather forecasts in terms of spatial and temporal distribution coupled with the use of highly technical language in a less coordinated and untimely landscape of communication pathways limit its uptake and use by farmers. This has been partly due to by administrative red tapes within the governments' institutional landscape responsible for production, packaging and delivery of climate information. Faced with continued weather and climate variability and increased food insecurity at national level, a review of TMA's current procedures of weather forecasts, packaging and distribution is inevitable to enhance uptake and use.

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