Prospects for Climate Services for Sustainable Agriculture in Tanzania

By

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Abstract

Climate services offer information on temperature, rainfall, wind, soil moisture, early warnings, and long-term forecasts for agriculture**.**

The objectives of this study are to explore the current state of climate services for farmers in the Morogoro region of Tanzania, to clarify the importance of climate services in decision-making, to identify sources of climate information available for farmers and to formulate the requirements to improve the system of climate services.

The results show that accurate forecasts, both the short term and long term, could help farmers to decide when and what to plant and how to attend their crops.

This information will be used to provide potential production choices, improved productivity and decreased risk. The major sources of information for farmers were essentially family, neighbours and friends. The results emphasised the importance of access to information and knowledge for farmers, for the agriculture sector and for general livelihood. The results showed that a participatory approach could achieve integration in designing and using a mobile application in agriculture to achieve sustainable development.

Key words:

Climate Services, Mobile Application, Tanzania, Morogoro, Weather forecasting

1. Introduction:

Climate services offer information on temperature, rainfall, wind, soil moisture, early warning, and long-term forecasts. Whilst there are numerous definitions of climate services; we define them as the provision of climate information in such a way as to assist decision-making. (Buontempo, 2018).

Since agriculture is mostly carried out in the open air, and always entails the management of inherently variable living plants and animals, it is especially exposed to various risks.

Production risks comes from the unpredictable nature of the weather and uncertainty about the performance of crops or livestock, as an example, through the incidence of pests and diseases. (Hardaker, 2015).

Weather is an important production factor, and at the same time, one of the greatest sources of risk in agriculture. It is a matter of common knowledge that weather represents the major source of uncertainty in crop production. It is expected that weather fluctuations will increase in the future due to climate change. (Oliver, 2011).

In the shorter term, since farmer's dependence on rainfall, current weather variability and associated shocks are creating vulnerability for farmers. Therefore it is essential to help them to build their livelihood resilience through coping better with current weather-induced risk as a prerequisite to adapting to future climate change. A new weather information delivery system is proposed which enables effective, locally and purpose specific weather information delivery to farming communities and other stakeholders in the agricultural sector. (Feleke, 2015).

Whilst temperatures are already increasing and changing rainfall amounts and patterns may begin to become significant in the future, the question remains to what extent farmers will experience conditions under progressive climate change that they are not already experiencing today. (Cooper, 2011).

Climate services seek to allow decision makers to increase resilience to, or maximise gains from current and future climate conditions through the delivery and use of climate information. (Golding, 2017).Over the past decade, there has been a dramatic increase in the awareness across society about the usefulness of integrating climate information in decision-making. (Buontempo, 2018).

We distinguish between scientific information and indigenous knowledge regarding weather and climate. Local knowledge encompasses "the knowledge and practices that are acquired by local people over a period of time through the accumulation of experiences over generations, society–nature relationships, and community practices and institutions" (Kniveton, 2014).

Weather and climate information has an important role in building the local knowledge which shape understanding of climate risks and guide decision-making across scales. (Singh, 2017).

In order to get higher yields and resilient food crops, African farmers need access to knowledge to improve agricultural productivity. (Hansen, 2011).

The United Republic of Tanzania is among the developing countries located in Eastern Africa, neighbouring to Kenya, Uganda, Ruanda, Burundi, Democratic Republic of Congo, Zambia, Malawi and Mozambique. Tanzania covers an area of 947,300 square kilometres and has a population of 54 million, according to the latest estimate. Used land area is divided in a following way; agriculture (43.7%), forestry (37.3%) and others 19%). (CIA 2017). It is estimated that 80% of the total working force in Tanzania consist of farmers and more than 90% of them are smallholder farmers living in rural areas. Among the smallholder farmers

49.9% are males and 50.1% are females (NBS 2013). Like other countries in the Sub Saharan Africa, Tanzania is experiencing the adverse impacts of climate change. Viable impacts of climate change in Tanzania include changing geographic and temporal patterns and intensity of drought, flooding, and seasonal rainfall shifts, with corresponding impacts on small scale agriculture and forestry.

Our research is implemented in the Morogoro region, which is among the 30 administrative regions of Tanzania. According to NBS (2013), by year 2012 the region had a total of 2.2 million people, with an average household size of 4.4. The economy of the region is dominated by agriculture and the allied activities. The major activities include small scale farming and cattle keeping. The major crops grown are Maize, Rise, Cassava and Banana. (CIA 2017).

The uncertainty about seasonal weather forecasts is one of the most critical factors which forces farmers to continue using Indigenous Knowledge. Farmers need the provision of timely and accurate weather forecast information to enhance their coping and adaptation strategies under varying climate conditions, in addition to a clear policy framework on the dissemination of information related to weather patterns in rural Tanzania. (Elia, 2014).

2. Objectives of the research:

The objectives of this study aimed to:

- Identify the current situation of climate services in the area of study;
- Understand the sources of weather information available for farmers and how they use forecasting in decision-making process; and
- Explore the framework of climate services for farmers by using a climate service mobile application.

3. Research methods

For this research on the importance of climate services for local farmers, Tambuu village in the Morogoro region of Tanzania will be used as the case study. This district was selected due to its diversity in production and range of available ICTs such as TV, community radio and mobile phone networks.

Our first task was to answer the question: what is the source of information for forecasting available today and how do farmers use this information to make decisions.

Data was collected through interviews and workshops in Tambuu village. A total of 13 smallholder farmers participated in the interviews. We utilised the collected descriptive and statistical data, as well as other international and local Tanzanian datasets and materials to understand the relationship between farmers and weather information, and how they use this information, in order to create the prototype for Climate service mobile app.

4. Results and Discussion:

4.1. Current situation of climate services for farmers in Morogoro region in Tanzania

The World Weather Information Service, which operates under World Meteorological Organisation (WMO), coordinates the worldwide efforts that are prerequisite for the production of accurate and timely weather forecasts, (WMO, 2018) and the Regional Climate Outlook Forums (RCOFs) produce consensus-based, user-relevant climate outlook products in the right time in order to reduce climate-related risks and support sustainable development for the coming season in sectors of critical socio-economic significance for the region in question. These Regional Climate Outlook Forums are followed by national forums to develop detailed national-scale climate outlooks and risk information, including warnings for communication to decision-makers and the public. At the same time, the Tanzania Meteorology Agency (TMA) is working with other Meteorological agencies in the developing world to provide longer-term forecasts tailored for farmer's needs. The Agency is responsible for the provision of Meteorological services; weather forecasts, climate services, warnings, and advisories information to the agriculture sector, in order to improve quality of production and hence reduce losses and risks.

By providing forecasts for a longer period and offering appropriate information to farmers, the Meteorological agency is trying to meet farmers' demand for climate information and better decision-making abilities.

Immediate priorities include the provision of tailored weather and climate forecasts to help pastoralists cope with drought, disaster managers to prepare for flooding and the health sector to anticipate outbreaks of malaria, cholera and other diseases. (WMO, 2018).

In Tanzania, as well as elsewhere in the world, information about weather conditions expected in the next couple of days is known as a "short range weather forecast". Whereas information ranging up to around ten days is called a "medium range weather forecast". Information about average weather conditions expected during the longer period is known as a "climate outlook". (Tanzania Meteorological Agency, 2018).

According to our interviews, smallholder farmers in Tanzania are already using seasonal forecasts and forecasts of the start and end of the rainy season, to aid in their decision-making. They identify a lack of additional forecast information, such as updates on the progress of the season, wind forecasts from the TMA, information on climate change impacts, among others, to be delivered at least one month before the rainy season.

4.2 Sources of weather information available for farmers and how they use forecasting in decision-making process

There is a regular broadcast through television, radio, the TMA website (www.meteo.go.tz/) and via a mobile app (GSMA, 2016) to get information about weather. Users are most familiar with these short- and medium-range forecasts. However, there is a lack of trust in this weather information as farmers have found even the state of current weather forecasts to be inaccurate sometimes. The majority of farmers in Morogoro need information on weather conditions (95% of those asked), with mostly rice farmers complaining about a lack of current and timely information on weather conditions. This is probably because of climate change, which has resulted in unpredictable rains and variability, hence farmers fail to plan the right time to plant their crops. (Benard, 2014).

Ministry of Agriculture, Food Security and Cooperatives, extension officers, non-governmental organisations (NGOs), and private sector actors use the short-term weather

forecasts widely. Examples given by farmers on how the information is used includes: knowing when they should seed or when to use fertilizer. See figure (1).

When most people think of a weather forecast, they usually think of a forecast for 1-10 days in advance. While these forecasts are the most familiar, they are only one end of a spectrum.

On the other hand, farmers in the developing world are increasingly using forecasts that range up to months in advance (climate outlooks) to make decisions that directly affect their livelihoods. (climatesociety.ei.columbia.edu, 2016)

Accurate forecasts at both the short term and long term could help farmers to decide when and what to plant and how to attend their crops. If farmers had a good way of telling when the rainy season would start, they could decide when to plant so that their seeds would get enough moisture. If they knew the conditions a week or more in advance, farmers could decide whether to apply fertilizers or pesticides. If they knew how wet the year's rainy season is going to be, farmers could make decisions about what crops to plant to get full advantage of the rainfall.

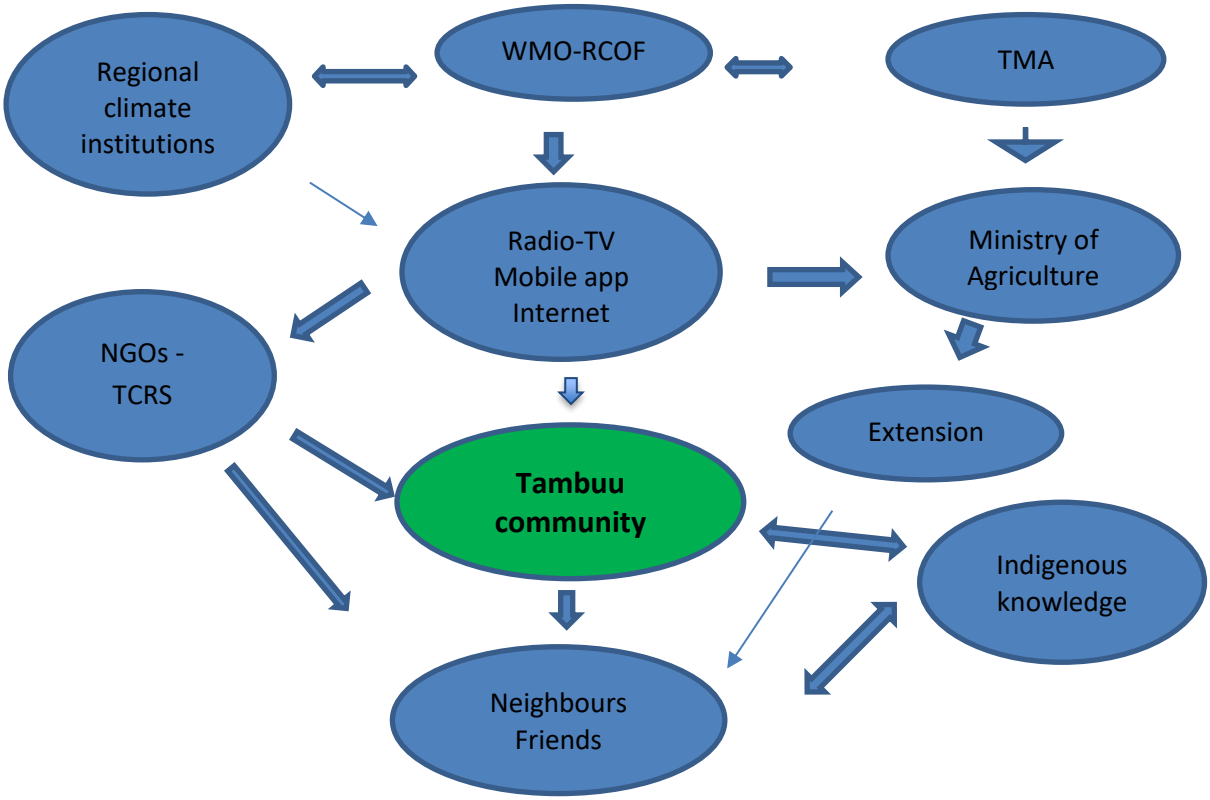


Figure 1: Source of weather information for farmers

Note: *The thickness of the lines indicate the degree of the information flow*

Farmers want to increase their crop yields and achieve maximum return in minimum cost, in order to improve their income. They require accurate, and timely agricultural information and knowledge about their farm potential, to support their decision making on their farms.

The weak linkage between farmers, researchers and extension staff in Morogoro leads communities to depend on indigenous knowledge.

Nowadays, the rapid development of using mobile phone technology and improved internet access in Africa presents an opportunity to develop new innovative and technological tools that

promote agricultural sustainability through the provision of essential information on weather and best agricultural practises.

Farmers depend on friends and neighbours in getting information about weather. This takes a social form in exchange information and forecasting. Over many years this has become a fundamental component of decision making for farmers.(Dare Kolawole, Wolski, Ngwenya, & Mmopelwa, 2014)

Indigenous knowledge has a wide role in agriculture and mobile apps could be used to share and make this local experience available for other communities as well. (Hansen, 2011).

However, this knowledge becomes less effective due the effect of climate change, resulting in poor decision making by farmers.

To help farmers, we need to rebuild the trust between the Meteorological agency and farmers. This requires, at first, offering accurate and on time information. It is important to focus on providing locally appropriate climate information, while at the same time engaging and training farmers for better understanding and use the information in their farming decisions. In this area, integration of meteorological information with local indigenous knowledge has been suggested to foster trust, local relevance and use, but rigorous evidence is still lacking.(Tall et al., 2014).

4.3. Framework of climate service for farmers by using mobile app

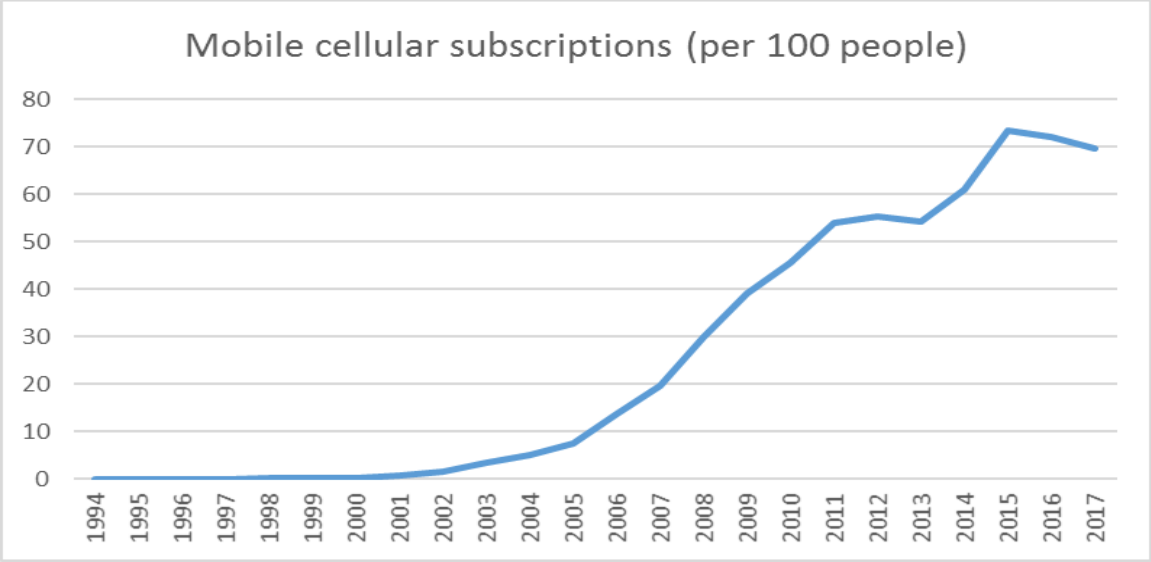
For African farmers there is not currently sufficient access to information, knowledge and practices through climate services. Instead they have only basic data to make decisions on their farms. This knowledge gab needs to be identified, so that specific and formal ability to use of Information and Communication Technologies, such as mobile phone technology can be build. Use of participatory approach in designing applications, to provide useful information for effective decision making that will enhance agricultural productivity and a sustainable livelihood, is critical.

The climate services app aims to provide farmers and extension staff with various information categories by using mobile application as a platform. It allows informed and accurate decision on agricultural and farm management practices by using the information on weather and climate generated through the use of mobile application.

In Tanzania, small scale farming is the main form of crop production, and employment in agriculture, while it is being increasingly challenged by the effects of the climate change (Government of Tanzania, 2014). On the other hand, Tanzania had an estimated 19 million mobile internet users at the end of 2017 (Tanzania Communications Regulatory Authority, 2018) and mobile use in Tanzania is among the cheapest in Africa (ResearchICTAfrica.org, 2016).

The statistic showed that mobile-cellular subscriptions per 100 inhabitants in Tanzania are developing very quickly. See figure 2.

Figure 2: Develop Mobile cellular subscription (1994-2017) in Tanzania



Data Source: World Development Indicators-Tanzania

We can say that using a mobile application, as a platform for climate services, and a participatory approach in design, is a prominent way of generating income and employment for a large number of people and especially for small-scale farmers.

4.4 What is Mobile Application of Climate Service:

The Mobile Application of Climate Service is a smartphone-based application that is connected to internet-based database that allows users to access, use and share climate knowledge and information relevant to the unique potential of each farmer.

The Mobile Application of Climate Service allows individuals and organizations to use smart phones to determine the potential of any given farm in supporting certain crops under the prevailing climatic conditions. This is based on accurate weather data and climatic information, as well as on scientific and local knowledge, which enables users to identify the best practises and crops.

The app obtains site-specific data, including rainfall and temperature distributions per year, average annual precipitation, available soil moisture, elevation, length of growing period in days and the aridity index for given location. The MACS will be freely accessible on the Android platform and can also be used to collect local information from the farmers.

We will using participatory approach in designing the application. The MACS provides information for different user groups at varied scales. Therefore individual farmers or producers from various locations and backgrounds are able to use the app to answer questions about sustainable farm management options.

Extension workers are also able to directly access the best available information and interpret it in the context of local socio -economic conditions and local values, including crop choice.

By using MACS, policymakers are able to aggregate data across larger areas without losing key pieces of information, such as the attending of small, highly productive or vulnerable sites within a region.

Users will have the opportunity to provide data to feed into the app through answering to a series of feedback questions or submitting their own observations and best practices. This

information will be used to provide potential production choices, for other farmers in similar conditions.

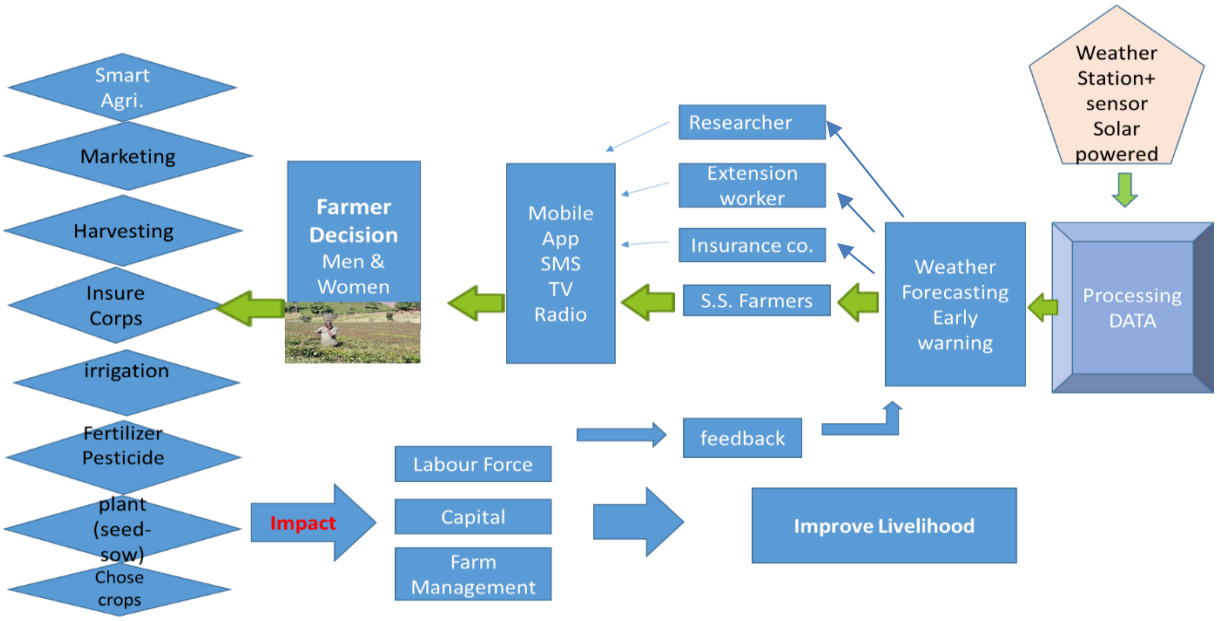


Figure (3): Framework of Climate Service for farmers

The framework of climate service shows that generating data comes from local weather stations and the National Meteorology Agency. This data is transferring through modelling to forecasting. Farmers can then access information and make decision in their farms. See figure (3)

The factors of production are land, which involves natural resources, labor is associated with human resources, capital includes manmade resources, and farm combines all the factors, to carry out the production process in the farm. The technology, in this case, can help farmers to increase investment capital, labor and land distribution. As a result, when a farmer's income increases, it leads to improving livelihood and helps to achieved sustainability.

5. Conclusions:

- Climate Services play vital tool for farmers in decision making and increasing their income.
- Future mobile apps should cover more fields of agricultural activities, while being easy, simple and flexible to use for all users.
- Climate change and variability reduce the reliability of indigenous knowledge in forecasting, therefore farmers need urgent timely and accurate weather forecast information from National Meteorology Agencies.
- The main sources of information for farmers were essentially family, neighbours, and friends.

The result emphasised the importance of access to information and knowledge for farmers, agriculture sector and livelihood. The results showed that participatory approach could achieve sustainability in designing and using mobile application in agriculture to achieve sustainability.

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