Barriers to Adapting to Climatic Stress in Tanzania's Semi-Arid Environments

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Abstract

The adaptation barriers to climate variability and change in Tanzania's semi-arid areas are significant. Dodoma urban district is among the areas in the country that have been particularly hard hit by climate change, with frequent reports of food insecurity and hunger as a result of flooding or drought. Data were collected using both qualitative and quantitative methods, where quantitative data were analyzed using SPSS version 16 and Microsoft Excel in the form of factor analysis and descriptive statistics. Major barriers to climate change adaptation included inadequate financial and farm inputs (factor 1), low level of education and income (factor 2), arable land constraints (factor 3), information barrier (factor 4), and lastly was financial barrier and lack of institution support (factor 5). To address the plethora of such barriers at the individual farmer level, a comprehensive and dynamic policy strategy across a scales and governance levels would be required. This implies that the adaptation process ought to take into account the local-level realities for it to be successful in responding to climatic stresses. Thus, concerted efforts from all stakeholders and institutions are required to come up with a comprehensive approach across scales and levels to address barriers to adaptation.

Keywords: Adaptation, Barriers, Semi-arid, Food insecurity, Tanzania

Introduction

Climate change is regarded as one of the century's most pressing issues. It is anomalously changing from place to place, and African countries are the most vulnerable and facing challenges to adaptation (IPCC 2021). It is caused by natural and anthropogenic factors that cause spatial and temporal variation of natural components (Selvaraju and Baas 2007, Biesbroek *et al.* 2011, Pauline and Grab 2018, IPCC 2021). It was projected that the temperature around the planet would rise by 0.5°C in the 20th century (Kay *et al.* 2009, IPCC 2021). Similarly, by the end of the 21st century, the average temperature increase over the African continent is expected to exceed 2°C (James and Washington 2013).

Droughts and floods have been common in Eastern Africa over the last 30 to 60 years (Funk *et al.* 2012; Pauline and Grab, 2018). Furthermore, several CMIP-3 and CMIP-5 model for precipitation projected that rainfall in Southern Africa will decrease. Rainfall trends for the Sahel area show an overall decrease during the 20th century (e.g., Mohamed, 2011; IPCC, 2021). West and Eastern Africa will have wetter rain seasons by the end of 21[st] the century (Shongwe *et al.* 2011, James and Washington, 2013; Armah *et al.* 2015). Sea level rise, increased frequency and magnitude of flooding, reduced food production, loss of wildlife habitat, heat strokes or sunburns, water borne infections, skin cancer, and stress are all considered negative effects of climate change (Kay *et al.* 2009; Lesley *et al.* 2010; Armah *et al.* 2015). Due to these effects, climate change is regarded as one of the most serious risks to economic sectors and sustainable development (FAO 2006; Addaney and Cobbinah, 2019; Karimi *et al.* 2020).

Agriculture in developing countries particularly in sub-Saharan Africa is most affected where about 70% of the population is made up of smallholder farmers concentrated in rural areas (Anselm *et al.* 2010). It was predicted that half of Africa's food crop production would be lost by 2020 (Jones and Thornton, 2003). The loss in the Sahara region was projected to be from 2 to 7% by 2100, in Central Africa from 2 to 4%, in Northern and Southern Africa 0.4 to 1.3% (Boko *et al.* 2007; Eriksen *et al.* 2008). Africa's arid and semi-arid land area could grow by 5-8 percent (60-90 million hectares). It is estimated that climate change will result in a significant drop of cereal production by the 2080s (Boko *et al.* 2007). Therefore, this leads to food shortages that will result to famine and malnutrition (Anselm *et al.* 2010; Rashid *et al.* 2014).

In Tanzania, studies acknowledge that climate change is already having negative impacts to the agriculture sector in the country (URT 2007). Over the last 30 years (since early 1990s), the country has undergone six major droughts, with the most recent one in 2006 (Jack, 2010; Adaptation Fund, 2011; Ahmed *et al.* 2011; USAID, 2012; Pauline and Grab, 2028; Luhunga *et al.* 2018). Most studies predict that increases in temperature and rainfall will have negative impacts on Tanzania's people through food insecurity, climate and vulnerability, and economic consequences (Ahmed *et al.* 2011; Pauline *et al.* 2017). Droughts are common and severe in the country especially in the central part. This results in severe food shortages due to the country's strong reliance on rain which are becoming unpredictable that affect agricultural harvests (URT 2007). Likewise, Liwenga *et al.* (2007) reported food shortage in Dodoma communities as a result of climate change. The agricultural areas in Dodoma, especially Kongwa and Bahi districts have been affected by extended drought, water scarcity, inconsistent rainfall, and rising temperatures (Hozen *et al.* 2014). Lack of government attention on climate change adaptation is one of the impediments to climate change adaptation in Tanzania (Pardoe *et al.* 2020). Other barriers include those connected to financial, institutions, technology, culture, and cognition (Parry *et al.* 2007; Pauline *et al.* 2017).

A study by Armah *et al.* (2015) reported that, barriers to climate change adaptation are based on institutional and social dimensions of adaptation. Lack of financial resources, education, and social differences are barriers to adaptation to climate change among smallholder farmers. For instance, elders, who were less educated had lower scores (less adapted) compared to youth on their engagement in adaptation activities. Also, individuals belonging to farmers groups increased efforts on adaptation compared to pastoralists groups. An adaptation study by Naess (2008) shows that lack of local weather information and extension services hindered adaptation implementation in Tanzania. This led to unwillingness of farmers to de-stock voluntarily, especially during famines for farmers to buy food. A study by Suckall *et al.* (2014) revealed that, a significant lack of land for agricultural intensification in Zanzibar hinders climate change adaptation. Farmers need to spend more days on the farm and decrease in the length of the fallow period to increase production. Lack of law enforcement units that extend throughout Zanzibar's Exclusive Economic Zone (EEZ) to protect range of 200 miles from the shoreline to be used for fishing by its citizens has hindered adaptation to climate change (Suckall *et al.* 2014). As the need to adapt to a changing environment is increasingly recognized, efforts to facilitate successful adaptation face a number of constraints and barriers to promoting the adaptive capacity of those who are most vulnerable (Jones 2010). Adaptation has limits, some posed by the magnitude and rate of climate change. Therefore, the study seeks to uncover the barriers to adaptation and recommend solutions, taking Dodoma urban district (peri-urban agriculture setting) as a local case study. The study sought to answer the key question: what are the barriers limiting adaptation to climate change, and ways to address such challenges?

Methodology

This study was conducted in 2019 in Dodoma urban district in Dodoma region with prolonged known drought stress and food shortages (URT 2007). The district is located in the middle of the Country. It is boarded by Chamwino district in the East and Bahi district in the West. It lies between Latitudes 6.000 and 6.300 degrees South, and Longitude 35.300

and 36.020 degrees East. The area is a semi-arid zone which receives unimodal rainfall, ranging from 500mm to 600mm per annum, with majority of the residents depending on rain-fed agriculture (URT 2021). During the period 1923–77, Dodoma and the neighboring regions experienced 18 episodes of inadequate food supplies varying in severity from appreciable shortages requiring food imports to severe famine resulting in considerable loss of life (Christiansson, 1986). The annual mean temperature ranges from 20°C to 32°C. This study was done in four peri-urban villages purposively chosen based on involvement in rainfed agriculture and prior history on food insecurity. These villages include Mtumba, Mahomanyika, Mapinduzi, and Chololo (Fig. 1). As such, the study area provides an opportunity to gain a better understanding of the relationship between humans and the environment under specific socio-ecological conditions.

A mixed methods design employing both qualitative and quantitative approaches was used. The mixed methods design helped to triangulate findings so as to compliment the two methods. Primary sources included participant observations, focus group discussions, questionnaire surveys, and key informant interviews. Simple random sampling was used to select the respondents from the study population and a sample size of 5% was considered adequate (Boyd *et al.* 1981). A village register for each village, having a list of all households was used to randomly select the study sample. Ultimately, the sample size of 100 households of smallholder farmers from a population of 2035 households was considered adequate for questionnaire surveys. Key informants, include 1 District Agricultural Officer, 2 Ward extensional officers, 1 officer from the Tanzania Meteorological Authority (TMA), 1 officer from the Dodoma Urban Water Supply and Sanitation Authority (DUWASSA), 13 Key informants from experienced farmers in study villages, and 4 Village Extension Officers (VEO). Two groups were chosen for focus group discussions (FGDs) in each village (6-12 people in each group). Discussants for FGDs were purposively selected. One group included men and women discussants and the second involved women

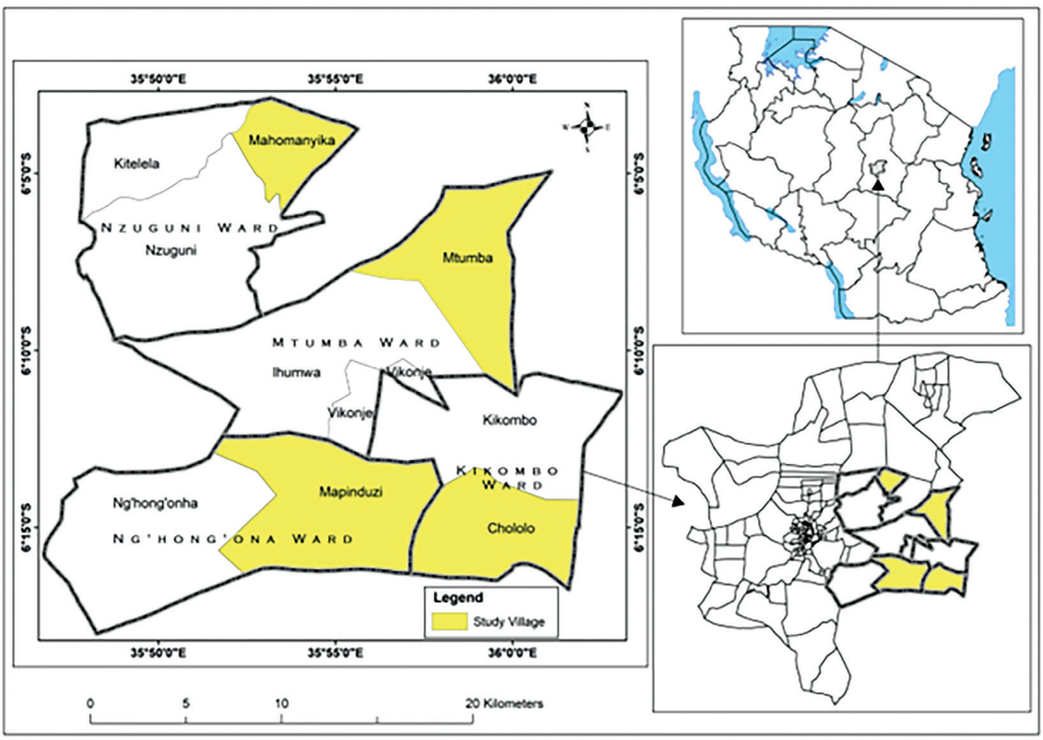

Figure 1: Map Showing the Study Area: Dodoma urban district

only. The groups were representative of farmers in the communities studied. Secondary data included rainfall and temperature records, which was obtained from Tanzania Meteorological Authority (from the Dodoma meteorological station) covering 30 years from 1987 to 2017.

Data were analysed using descriptive statistics such as means and percentages of adaptation strategies employed by smallholder farmers as well as barriers for adaptation. Moreover, factor analysis was used to identify barriers to adaptation by smallholder farmers in Dodoma urban. The method enables to identify common factors among many underlying factors based on eigenvalues (Johnson & Wichern, 2007). Varimax rotation was applied and the loadings were used to identify the five common amplified factors. These factors had specific variables which were highly loaded than others. Rainfall and temperature data were analyzed using Microsoft excel to show the trends of rainfall and temperature. Rainfall and Temperature records were entered into the excel and a trendline was drawn to show the pattern of such variables over time.

Results

Education level of respondents

Findings revealed that majority (72%, 88%, 80%, and 72%) of the respondents from study villages (Mapinduzi, Chololo, Mtumba, and Mahomanyika respectively) had attained primary level of education (Fig. 2). Farmers who had attained secondary level of education and above, was found easier for them to diversify livelihoods to adapt to the adverse impacts of climate change.

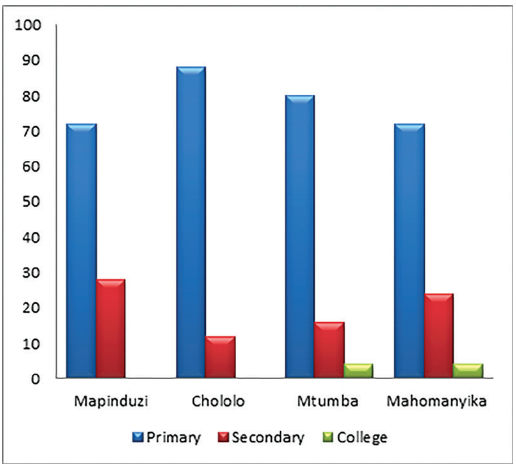

Figure 2: Education level of the respondents

Perceived and observed temperature and rainfall trends

Findings indicate that respondents are aware of an increase in temperature. Comparing with the past 30 years, most respondents (85%) reported that they were experiencing an increase in temperature. However, few respondents (10%) disagreed with that assertion, while 5% indicated they had not noticed any changes. Additionally, majority (63%) of respondents reported to have noticed abnormally high temperatures throughout the long rains season (Masika) weather conditions (Fig. 3). Likewise, majority (59%) of respondents agreed that dry season (Kiangazi) temperatures are becoming low, causing severe cold temperatures during such season (Fig. 3). Whilst, 31% of respondents opposed to that claim, and 10% were reported to notice no changes.

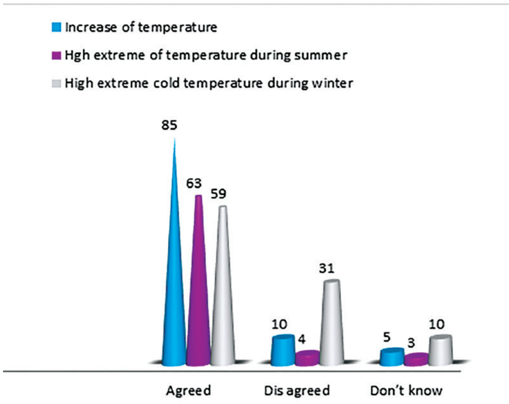

Figure 3: Smallholder farmers perception on temperature change

When corroborated with observed temperature records, respondents' perceptions were inline with both minimum and maximum temperature that had been increasing. Findings show that the mean maximum temperature had been increasing at the rate of 0.00227 per decade, and the mean minimum temperature had been increasing at the rate of 0.0042 per decade (Fig. 4 and 5).

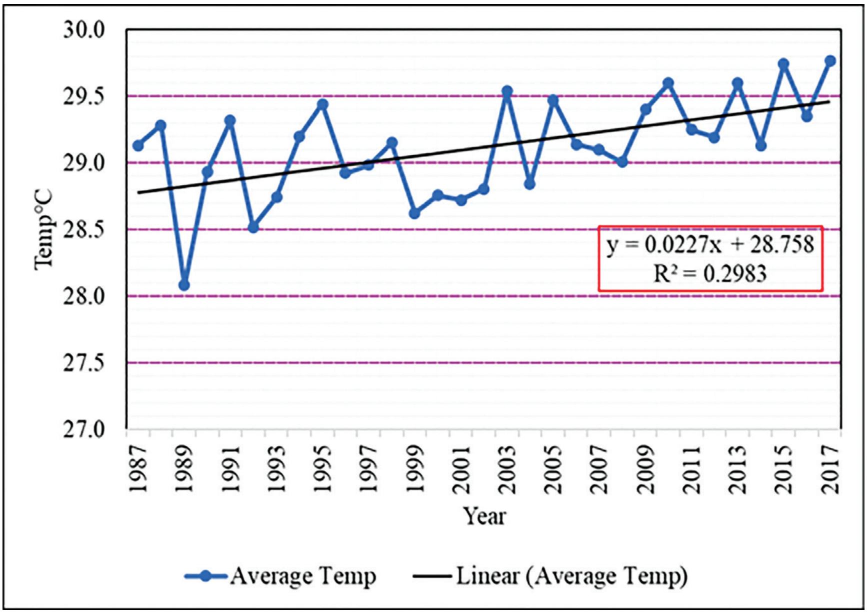

Figure 4: Maximum annual mean temperature

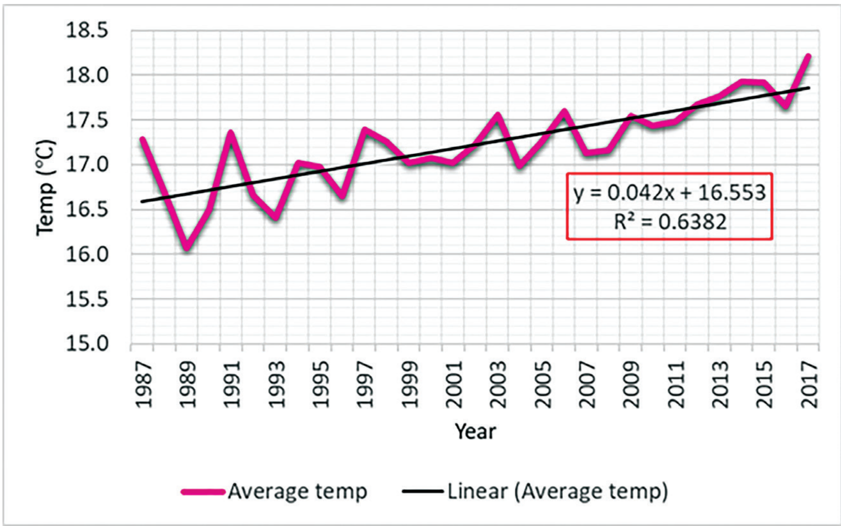

Figure 5: Minimum annual mean temperature

Results indicate majority (89%) of respondents perceived that rainfall had been decreasing compared to the past decades. Also, respondents perceived that the onset and cessation of rainfall had dramatically shifted. Most farmers (96% and 93%) noted that that, they had experienced rainfall coming late and ending earlier respectively. This finding was inline with narrations of discussants who said that the onset and cessation of rainfall were not predictable.

The perceived changes in rainfall patterns corroborates well with observed rainfall trends from the Dodoma meteorological station. Observed rainfall records show a decreasing trend in total average annual rainfall at the rate of 0.4 per decade (Fig. 7). The year 2005 recorded the lowest amount of total annual rainfall, whilst, years 1989, 1997, 1998 and 2009 recorded an increase in total annual rainfall over the past three decades (Fig. 7).

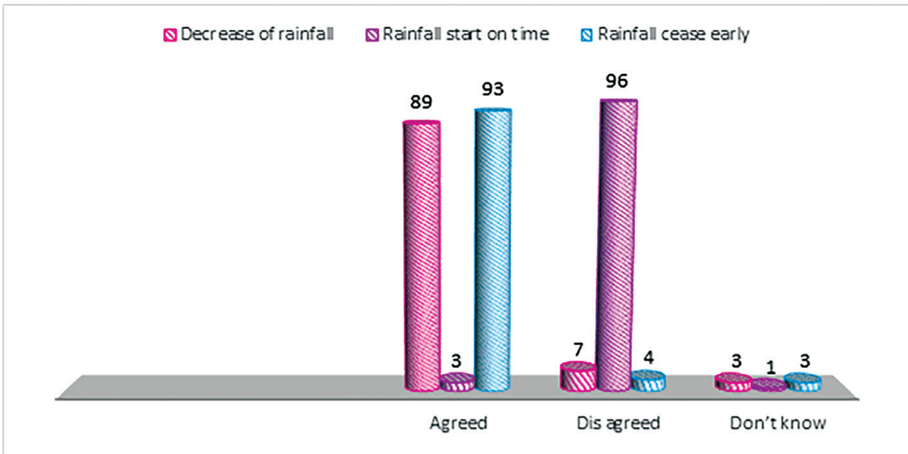

Figure 6: Smallholder farmers perception on rainfall pattern

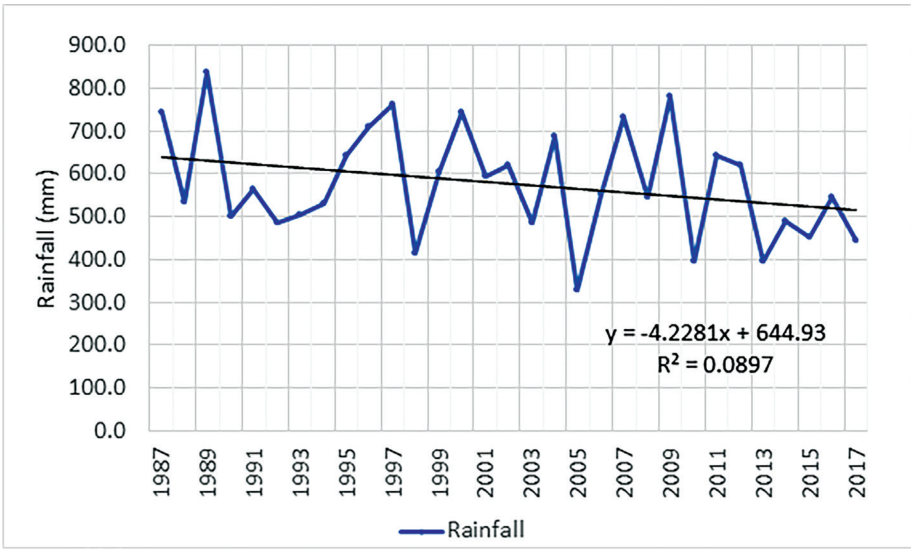

Figure 7: Total annual rainfall for Dodoma meteorological station

Adaptation measures

Agriculture production in the study area was more hindered by water shortage due to unpredictable rainfall and recurrent drought. Such extreme events had led to a decline in crop production. Hence, it was necessary for local communities to use long term adaptation strategies against the climate change impacts on crops production. About 90% of the respondents opted for planting drought tolerant crops. This strategy was common and it was used by many farmers from all the four villages. The most predominant tolerant crops grown by farmers were bulrush millet, sorghum, and cassava. Early planting was also a strategy applied by many farmers in the study area, about 84% of the household respondents claimed to have been using this adaptation strategy. It was also reported that, 66% of the respondents reported to have been using farm manure and other chemical fertilizers in order to increase soil nutrients and moisture to ensure production. Few farmers, who were economically successful, were applying organic fertilizers while many others did not use it because they could not afford its price (Fig. 8).

Apparently, relatively few (38%) respondents reported to have been using crop rotation and 29% were growing short-term maturing crops. Also, a small proportion of the

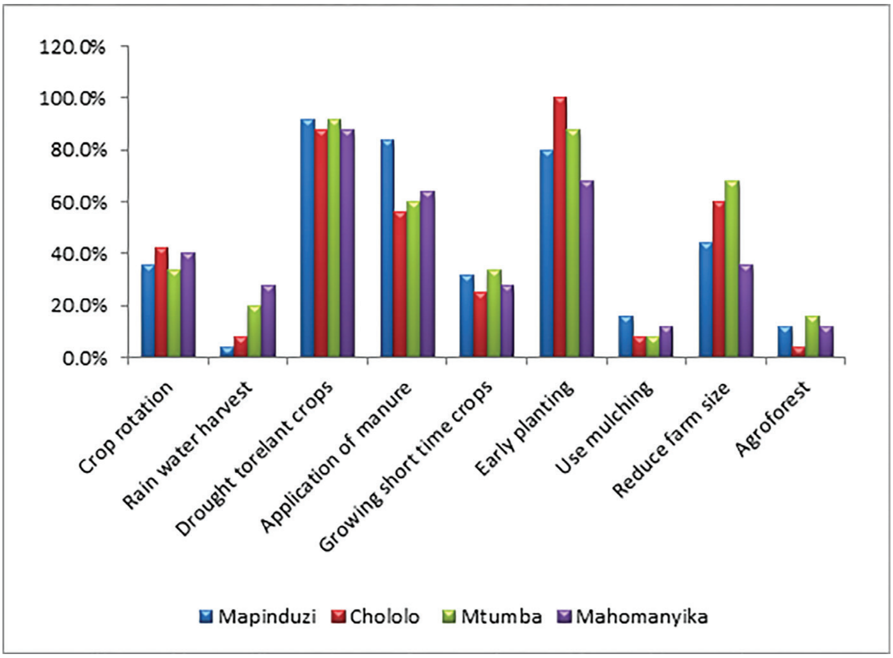

Figure 8: Long term adaptation strategies opted by farmers

respondents (15% and 11%) claimed to have been using harvested rain water and use of mulching respectively. The smallest proportion of respondents (10%) claimed to have been using agro-forestry (Fig. 8). However, strategy was not much preferred by many farmers because the trees did not survive and grow enough due to the nature of soil, recurrent droughts, and water shortages in the semi-arid areas.

Factors hindering adaptation to climate variability and change

This study revealed a number of factors that constrain smallholder farmers' ability to adapt to climate change and variability. Out of sixteen factors, only five factors had eigenvalues greater than 1, and finally five factors were retained to explain barriers to adaptation by smallholder farmers. Table 1 shows the constraints; where the first factor is financial barrier and credit constraints, amplified by lack of credit, which loaded (0.786), high cost of processing facilities (0.728), and financial constraints (0.525). The study found that the four villages in the study area had no credit facilities. These included macro and microfinance facilities, leading to poor credit circulation in the area. It was found that accessing credit required collateral for credit insurance, the most reliable collateral mentioned was a surveyed land with a title deed. However, land in the study area had not been surveyed, hence disqualified for use as collateral. It was further found that, processing the title deeds was not easy due to bureaucracy and associated costs. It was further revealed that, the government intervention hardly sufficed the adaptation needs except coping strategies. One key informant revealed that, the government budget for adaptation shortfalls every year. Fund allocated for adaptation both from the government budget and donors was very low compared to the actual needs.

Low level of education and income was a second factor which included low income of households, which loaded (0.676), lack of education and skills on farming (0.664), and high cost of fertilizer (0.514) as indicated in Table 1. The study shows that most household heads in the study villages attained primary education followed by who did not attain formal education. And few household heads had attained secondary school education. Therefore, the average literacy level of household heads was low (Fig. 2).

Barriers to adapting to climate variability and change were categorized into five factors

Table 1: Barriers to climate change adaptation

Barriers	Factor				
	1	2	3	4	5
Lack of credit	0.786	0.087	-0.146	0.220	0.076
High cost of processing facilities	0.728	-0.085	0.047	- 0.229	0.089
Financial constraints	0.525	0.004	0.304	0.018	-0.190
Natural calamities	-0.393	0.290	0.099	-0.240	0.317
Lower income	-0.095	0.676	0.150	-0.048	-0.224
Lack of education and skills	0.171	0.664	-0.076	0.002	0.053
High cost of fertilizers	0.232	0.514	-0.044	0.334	0.265
Bare land	-0.203	0.341	0.003	0.075	0.075
Land conflicts	-0.060	-0.012	0.797	-0.188	0.141
Traditional believes	0.081	0.218	0.604	0.320	-0.025
Poor hand tool	0.026	-0.283	0.427	0.242	0.300
Poor health	-0.151	0.151	0.367	0.227	0.025
Poor weather forecasting	0.085	-0.021	0.289	0.623	0.056
Poor information on early warning sign	-0.179	-0.152	-0.006	0.569	-0.005
Lack of institution support	0.026	0.029	0.163	-0.181	0.773
Lack of irrigation tools	0.042	-0.038	-0.025	0.344	0.356

which include; financial constraints, low level of education, land constraints, information barrier, and lack of government support. Factors which were loaded by 0.477 and above 10% were categorized as common factors.

Poor income generation was another factor. Income in the study area relied primarily on agriculture posing adaptation constraints. It was revealed that poverty is rampant in the villages that deteriorate adaptation efforts. During self-assessment of the informants, it was confirmed that, majority of the farmers in their villages were poor to the extent were unable to achieve their basic necessities that increased the level of vulnerability. In addition, it was revealed that farmers were unable to purchase inputs (such as fertilizers and pesticides), implements (such as irrigation pumps and tractors), and enhanced crop varieties that would boost agricultural production, and hence their ability to adapt to climatic challenges. It was further revealed that seeds, fertilizers, and pesticides were scarce and inaccessible in some villages throughout farming seasons due to poor infrastructure, such as road networks that made Chololo village inaccessible during rain seasons. Therefore, the scarcity of inputs on top of diminished soil fertility, which was another barrier factor led to lower crop yields in the area.

The presence of counterfeit inputs was reported to increase poverty, vulnerability for farmers, and made adaptation to climatic variability more difficult since crop production continued to decline. Discussants from Focus group discussions revealed that farmers did not grasp the varied sorts of soils and their suitability for different crops. Furthermore, farmers were unable to read the expiration dates on seed packaging, resulting in a rise of outdated and counterfeit inputs such as seeds, fertilizers, and insecticides. Also, due to low level of education and awareness about climate change adaptation, farmers used their own traditional measures that were designed for short-term (coping) rather than long-term (adaptation).

The third factor was land, traditional beliefs, and equipment constraints; this barrier was loaded by three variables land conflicts (0.797) and poor hand tool (0.427) as indicated in Table 1. The focus group discussion revealed the presence of land disputes among farmers and herders in the study area. Frequent conflicts erupted in the area as a result of resource scarcity which included water and pasture. In addition, population growth increased demand for land for settlement and extensive farming to ensure food security. In Mtumba and Mapinduzi villages both farmers and herders struggled to find water and pasture, especially during the dry seasons. The growth of land conflicts had been retarding development in agriculture activities. An old female respondent in Chololo village said that:

"My children spent two years in prison. Unlike in the past, today's conflicts have reached dangerous proportions. This is especially true after the central government's operations were relocated to Dodoma. As a result, people have been flocking to our village to buy land. As a result of this circumstance, some farmers have attempted to take land that is not theirs, resulting in conflicts".

The key informant revealed that, access to land has changed since the 1970s, when the population was small and residents could obtain more land granted by the village council, as opposed to the current system, in which land must be purchased and a title deed obtained. This had been a limiting issue since it had limited farmers' ability to cope with the changing climate, because it was difficult for a farmer to obtain irrigable land, for example, unless he or she had the financial means to rent or own it. Due to a lack of flexibility in securing alternate land, farmers found it difficult to fallow their farms.

Information barrier was the fourth factor, the variables that loaded highest were poor weather forecast (0.623) and poor information on early warning signs (0.569) as indicated in Table 1. Limited access to information such as seasonal weather forecasts from local weather stations and appropriate agricultural practices hindered adaptation to climate change. The precision of weather forecasts was low to suit farmers at a local level, and the packaging in statistics and bar graphs was complex for farmers to comprehend. In addition, poverty might have been a hindering factor for farmers to purchase radios and televisions, which were the key media for receiving weather forecasts. This was compounded by the fact that some of the study villages were not connected to the electricity grid. Moreover, poor signal quality due to remoteness, limited the information availability. Additionally, the forecast did not include recommendations for crop varieties, inputs, or rainfall amounts for the entire agricultural season.

Lack of institutional support was the fifth factor. The variable loaded high, was only insufficient institution support (0.773) as indicated in Table 1. The study showed that, there was insufficient government support to farmers toward achieving climate change adaptation. The key informants reported that, the absence of strong institutions dealing with adaptation delayed implementation of the laid down adaptation strategies, plans, and projects. In addition, the interventions in agricultural sector to ensure effective production, post-harvest loss, markets, agro-processing industry facilitation, and extension services had not met their objectives. For example, lack of coordination among government entities on crop markets exacerbated the threat of crop markets to be controlled by middlemen with unregulated crop prices. This was in contrast to the present free market system. This finding indicated the need for effective institutions.

It was reported that the agriculture policy does not directly provide for climate change adaptation, instead it provided for the increase of agricultural production. However, the National Adaptation Programme of Action (NAPA) of 2007 (URT, 2007) was well articulative towards climate change adaptation, but the financing budget was not well underlined. Discussants revealed the absence of institutional structure across levels and scales that support farmers' efforts towards adaptation. For example, at the district level, there was no specific plan or budget set aside to cope with un-anticipated climatic disasters. It was reported that only the Vice President and Prime Minister's offices had budgets, which, however, fell-short every year. The contributions made by NGOs in supporting farmers were recognized in the study area, but it was reported, some were repelled in the area due to various reasons. The objective to build irrigation canals had been set past many years, however, its implementation had not been done, while drought continued hitting the area in the recent decades, and irrigation pumps continued to be expensive.

Discussion

The main focus of this study was to observe barriers facing the smallholder farmers when responding to the impacts of climate change and variability. This study shows that adapting to climate change was a complex endeavour, and farmers' vulnerability was growing, necessitating a multifaceted approach. Non-climatic factors were primary barriers to climate change adaptation. The finding was consistent to Parry *et al.* (2007) and Pardoe *et al.* (2020) that impediments to climate change adaptation include those connected to finances, institutions, technology, culture, and cognition. The study found financial barrier and credit constraints as hindrance to climate adaptation in the study area. This might be a result of poverty among smallholder farmers, insufficient adaptation budget from government and donors on climate adaptation. This was in line with URT(2012) that Tanzania needs US$ 500 million every year by 2030, however, the amount received every year was below the needs. Increasing adaptation finances from the government budget and building capacities of local institutions engaging in climate adaptation would improve its implementation. For example, the increasing adaptation projects and facilitating the access of credits by farmers in Dodoma urban would provide a wide range of their involvement.

Most household heads in all the study villages attained primary education followed by who did not attain formal education. The level of education is a very important factor since household heads are decision makers for their families, particularly when it comes to issues of understanding weather forecasting and adoption of suitable farm inputs and implements. Some studies (e.g., Shultz 1975, Eriksen *et al.* 2008) affirmed that education brings knowledge and human capital asset which in turn leads to access to weather and climate information, therefore making decisions for better adaptation. Additionally, Deressa *et al.* (2011) reported that, the level of education determines one's ability to select response strategies to climate change. Likewise, the study by Yanda and Mubaya (2011) found that, higher education increases opportunities for engaging in non-farm activities, thus use such options to respond to food shortage. This indicates that investing in education, coupled with extension services, was likely to increase opportunities for farmers to engage in climate adaptation.

The study revealed that food production was low and poverty among farmers was rampant due to low income earned. Low income could not support farmers' adaptive plan of stocking food for a year leading to food insecurity. In addition, increases in food prices as a result of reduced food output are secondary effects of climate change on agriculture (Ahmed *et al.* 2009, Pauline *et al.* 2017). This is consistent to Calzadilla *et al.* (2013) that, higher market prices for cereal crops between 39% and 43% in Mali hindered farmers to buy food during drought. Building farmers' capability would aid in a better understanding of risk perceptions related with change and the ability to manage uncertainty (Pauline *et al.* 2017). This would enhance their ability to plan, learn, and reorganize utilizing simplified weather data collected in close stations across the country, increasing their climate awareness. Moreover, it would strengthen smallholder farmers' financial and emotional flexibility by making finance available to them, resulting in a higher level of interest in climate change adaptation (Pardoe *et al.* 2020). In comparison to Africa; Australia, Asia, and Latin America were doing better in overcoming hurdles to adaptation to climate stresses (Armah *et al.* 2015). This was because farmers mostly depended on resource availability for decision making and early planning on how to execute adaption techniques prior to the onset of such weather extremes (IPCC, 2007). Bangladesh had achieved successful adaptation, thanks to the collaboration of numerous institutions with smallholder farmers including government agencies, non-governmental organizations (NGOs), social, informal and corporate institutions, and farmer groups (Selvaraju *et al.* 2006). Improved land tenure and planned adaptation enabled farmers in north-western Bangladesh improve their adaptive capacity (Habiba *et al.* 2012).

Water use conflicts arose as a result of the lack of a clear institutional structure. Farmers in the study area had experienced problems in which farmers with plots in the upstream scheme block irrigation water, leaving downstream farmers without irrigation water during dry seasons. According to local authorities, there were no structures in place to manage the plan. As a result, some farmers had relied on traditional weapons to intimidate others and block water so that they can sufficiently irrigate their own farms during droughts. The findings are consistent with those of Reid and Vogel (2006) and Pauline, *et al.* (2017), who documented water conflicts in KwaZulu-Natal, South Africa and the Great Ruaha River sub-Basin, Tanzania, respectively, at periods of severe climate stress. Due to a lack of institutional support and proper governance mechanisms within the village irrigation project, these disputes were caused by a lack of water management and problems of uneven access.

Another barrier to adaptation was found to be poorly coordinated marketplaces. Because of the lack of coordination among institutions, most farmers were forced to sell their harvests on farms. Farmers reported receiving poor prices for their cash crops as a result of both parties' insufficient market oversight. Farmers' adaptive capacity has been eroded as a result of the lack of integrated institutions and structures in the market system in the study area, as they were unable to save and plan for calamities. Instead, they became exposed to climatic calamities as a result of a lack of savings to assist them endures the disasters and the time before the next harvest. This is consistent to a report by Suckall *et al.* (2014) that, lack of law enforcement units to the Zanzibar's Exclusive Economic Zone (EEZ) to protect its shoreline for fishing by its citizens had hindered adaptation to climate change.

Findings further showed that the villages in Dodoma urban had environmental and agricultural committees that were entrusted with environmental management in their localities. The villages, on the other hand, lacked climate change adaptation road maps. This could be due to a lack of government support and coordination. Despite the existence of strong strategies and plans, the NAPA (URT 2007) had not been successfully implemented in the lower levels of governance (i.e., villages). Studies (e.g., Agyie *et al.* 2013) show that strong institutions have a significant role in boosting local communities' ability to adapt to climate change. According to Ampaire *et al.* (2016), Tanzania passed a guideline in 2012 that would allow diverse sectors and policies to integrate climate change adaptation methods. However, there have been reports of poor performance (Smucker *et al.* 2015). This could be due to a lack of funding or a lack of comprehensive knowledge of climate change adaptation among government officials.

Conclusion

The barriers to adaptation represent place-specific differences among communities in Dodoma's urban district rather than inherent generalization characteristics. Understanding the various barriers to climate change adaption and how people adapt to increase sustainability is critical. The study concluded that the adaptation process must adopt local-level realities for it to be successful, thus enhancing farmers' adaptation to the impacts of both climatic and non-climatic hazards. Creating policies and structures that enable communities to improve their adaptive ability, such as expanding access to information, credit, and crop markets are examples of this. Furthermore, adaptation techniques should be learned at the local level and supported by national and international policies that create an enabling environment for greater access to essential resources and technologies.

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