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Effects of climate stress to pastoral communities in Tanzania: A case of Mvomero District

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Abstract

The study was conducted in Mvomero District in Tanzania to assess the effects of climate stress on grazing land and pastoral livelihoods in particularly on milk production. A total of 90 households (*Bomas*) were randomly selected. Primary data were collected through individual interviews using structured questionnaires, focus group discussions and key informants using a designed checklist. Climate and other secondary data were collected from Tanzania Meteorological Agency (TMA), United States Geographical satellite (USGS), published and unpublished reports.

Analysis of climate data over 28 years revealed a linear increment of temperature for 0.02% and decline of precipitation for 3%. These findings were comparable to how pastoralists perceived trends of climate in Mvomero district. Most of the pastoralists (about 90%) agreed that there has been an increase of temperature and unpredictable rainfall. Analysis through satellite images showed that pasture resources decreased from 82% in 1985 to 5% in 2015. This decline was directly associated with climate stress leading to milk reduction which directly affected pastoralists livelihoods. If innovative and adaptive measures are not taken, climate variations will continue to stress pastoral communities to the highest and they are likely to suffer the consequences more than other land users in the country.

Keywords: *forage resources, livelihoods, milk production, rainfall variations, temperature trend*

Introduction

The current most serious challenge in the global community is the change of the world's climate and has been affirmed by scientists to continue changing at unprecedented rate. The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC 2007) pointed the main reasons for an increase of global average air and ocean temperatures leading to wide spread melting of snow and ice, precipitation increases leading to flood while decreases causes drought as well as rising global average sea level. Thus to present, many countries including Tanzania undertake numerous studies to understand more existing changes in climate.

The impacts of climate change were reported under several studies (Sangeda et al 2013; Mendelsohn and Dinah 2005; UNDP 2004; UNFCCC 2007). They reported impacts such as changes in cloud cover and precipitation, melting of polar ice caps and glaciers, and reduced snow cover, rising of sea waters, extinction of plant and animal species, and worsening drought. Over the course of last century, Africa has experienced a 0.5^0C rise in temperature with some areas warming faster than others (Eriksen et al 2008). Africa has been claimed to be the one of the most vulnerable continent to climate change due its dependence on climate activities (IPCC 2007). These impacts lead to the rise of temperatures which decrease wet periods resulting into longer dry periods that increase pressure on grazing lands leading to a significant rise in destitution among pastoral groups depending on meat and milk products (Ced and Cotula 2006).

In Tanzania, periods of critical drought has been observed. For example, a mean annual temperature increase of 1.0^0C was recorded since 1960 with decreasing rainfall at an average rate of 2.8 mm per month and 3.3% per decade (TCAR 2015). In 2016, massive death of livestock due to climate stress was a big challenge to pastoralists. Currently, Mvomero district is among the most vulnerable districts because of high dependence on climate sensitive livelihood activities and low adaptive capacity. Furthermore, it's among the pastoral districts contributing into pastoral economy in the country (World Bank 2006).

In a nearby district of Gairo, climate stress affects the amount, patterns and distribution of rainfall (Sangeda et al 2013). This causes longer dry periods and floods that leads to not only the failure and damaging of crop but also livestock resulting to food shortage (Liwenga et al 2007; Kangalawe and Liwenga 2005). It also affects livestock production indirectly by decreasing grazing land (Herrero et al 2009). Livestock are central to the livelihoods of pastoralists in Mvomero district who rely on them for income mainly from sales of milk and meat (Sangeda and Malole 2014). The aim of this study is to analyse some challenges brought by negative effects of climate change to rural pastoral households in this district so as to inform practitioners and policy makers to take appropriate measures to address the challenge. The study is therefore addressing three basic questions related to trends of

temperature and rainfall over the past 30 years, effects of drought on forage resources and its consequences in quantity of milk produced by pastoral households in the study area.

Materials and methods

Description of the study area

The study was conducted in Mvomero district, Morogoro region in Tanzania. The district is located between latitudes 05° 80' and 07° 40' S and between longitudes 37°20' and 38° 05' E. The district has a total area of 7,325 km. Sq. Respondents were drawn from two wards Mvomero and Melela (Figure 1). From each ward, one village was selected (Wami- Sokoine and Melela) respectively. The district has temperature range from 18°C to 30°C with annual rainfall from 600 mm to 1000 mm. The area experiences bi-modal rainfall pattern where long rains are from March to May while short rains occur from October to November. The dry seasons are from June to September and December to February.

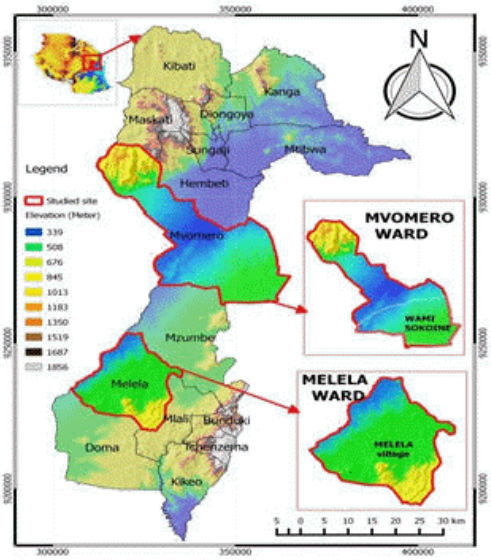

Figure 1. Map of Mvomero District showing study villages, Tanzania

Sampling procedures and research design

Random sampling technique was used to select two wards in Mvomero District. In each ward, one village was selected followed by selection of pastoralists' Bomas based on the presence of elderly people from each of them where a total of 45 Bomas were interviewed making sample size of 90 Bomas. A cross-sectional research design was employed in this study as data collection was done in a particular place at once and enabled descriptive study for the determination of relationship between the independent and dependent variables. The design was efficient for data collection given the time and financial resource availability.

Data collection

Data were collected from pastoralists (men and women) using structured questionnaire and focus group discussions and key inform using a well-designed check list. The questionnaires were used to obtain information about climate change pattern, indicators, perceptions and effects on pasture and quantity of milk produced by the pastoralists. Focus groups and key informants were used to triangulate information obtained from questionnaire survey for validity. Data on rainfall and temperature were obtained from Tanzania Meteorological Agency (TMA), Morogoro Station. LANDSAT imageries of 1985/1995/2005/2015 were downloaded from United States Geographical Satelite (USGS) website; the images were used to assess the effect of drought on vegetation in grazing land for interval of ten years. Table 1 shows the characteristics of remote sensed data acquired.

Table 1. Characteristics of acquired remote sensed data

Satellite	Sensor	Spatial resolution	Season	Period
Landsat4	TM	30 m	Dry	1985
Landsat5	TM	30 m	Dry	1995
Landsat5	TM	30 m	Dry	2005

Data analysis

Data collected through questionnaire were coded and analyzed using Statistical Package of Social Science (SPSS) IBM 20. Descriptive statistics such as frequencies and percentage were computed. Climate data such as annual average temperature in °C and rainfall in mm were computed as from 1985 to 2013. Microsoft Excel and SPSS IBM 20 were used to analyse the meteorological data and quantitative data. Arc GIS and Q-GIS were used to analyse the satellite data for land cover/grazing land.

Results and Discussion

Temperature trends and variations

Results of surface temperature for the 28 years from 1985 to 2013 showed temperature increment of about 0.02%. Although there were fluctuations in temperature within five years, the projections and variations were as presented in figure 2, which showed a linear increment of temperature.

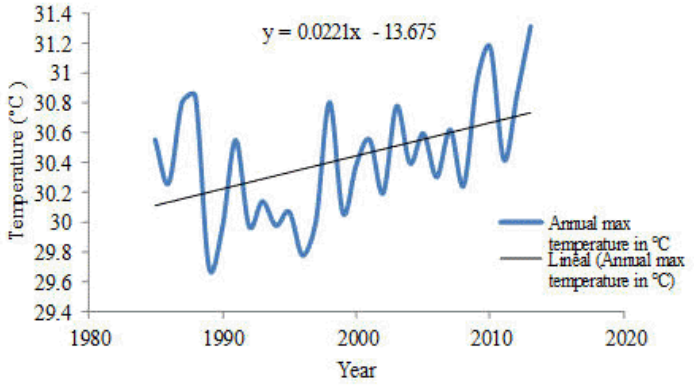

Figure 2. Average temperature trends in Mvomero district Tanzania (1985-2013)

The higher peaks above 30°C for long time probably led to unavailability of pasture and water resources to livestock. These results are in line with those reported by Sangeda et al 2013 in a nearby district of Gairo. They are further supported by pastoralists' response in household survey whereby 75% claimed that temperature increased with time. Some key informants further claimed that they would not forget the drought stress of 1999 and 2016. According to Mr. Mumba Ngare (A Maasai pastoralist from Mvomero), 1999 and 2016 are the years that he lost the largest herd of cattle due to drought. He was quoted saying " *I personally lost 38 large cows in 1999 and 51 in 2016; I can't forget these years.....this means a lot to myself and my family livelihoods* ." When Ngare was more interrogated, it was discovered that in their *Bomas* they lost in total 209 cows worth 8,360,000 Tanzania shillings equivalent to US$ 38,000 in the drought stress of 2016. In a very sorrowful face, Mr. Ngare claimed that the main reason to this massive death was stress caused by lack of forage. According to IPCC (2007), a further increase of mean temperature is expected to approximately 0.74 ^{0}C by the year 2030 and a possible increase by 3% by the year 2050. This denotes that Tanzania and its pastoral districts cannot escape the associated stress due to temperature increment if local and international innovative adaptation and mitigation measures are not contemplated and implemented.

Rainfall trends and variations

Results revealed that like temperature, rainfall was not uniform each year. It varied from time to time with several lower peaks recorded as shown in Figure 3. The negative slope implied that rainfall decreased substantially for some years especially in 2003, 2005 and 2013.

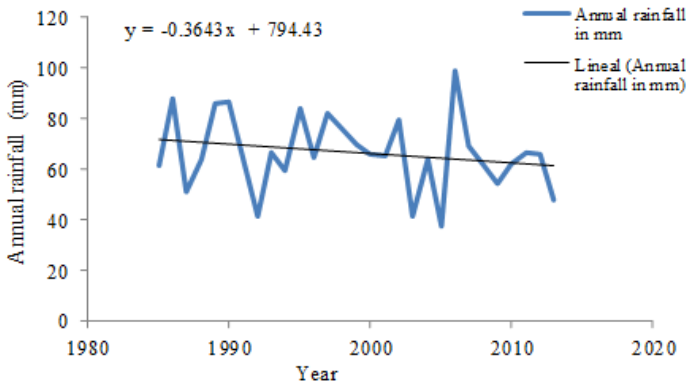

Figure 3. Rainfall trend in Mvomero district, Tanzania (1985-2013)

These findings are in agreement with previous studies in the country. For example, (TCAR 2015) reported a decline in rainfall at an average rate of 2.8 mm per month and 3.3% per decade. Furthermore, majority of respondents (77%) agreed that rainfall has decreased in amount and its timing has become unpredictable. During focus group discussion, it was noted that Mvomero district rarely receives short rains commonly known as *Vuli*. This was confirmed by a maasai elder Mr. Lekule that " *We have not received the Vuli rains since 2010....we live using a single rain per year like our neighbours in Gairo District"* . Mr. Lekule added by saying " *Rainfall is very crucial for pasture growth as it increases the amount of moisture in the soil. Insufficient rainfall results to the drying up and retardation of vegetation* ". Pictures in Plate 1 shows some of Mr. Lekule's cows feeding on sisal plants in his *Boma* (maasai household where they live three brothers with their spouses and kids) during 2016 drought in Mvomero district.

Plate 1. Pastoralist household in bare grounds and feeding cows with sisal during critical forage shortage in drought stress of 2016, Mvomero Tanzania.

Key informants further argued that rainfall was not only scarce but rather erratic. They reported that, for some decades, rainfall has been starting from November to March, but since 2010, the rainfall season has changed. It comes very late and one cannot tell exactly when it may commence. This variability affected several planning schedules and consequently growth of natural pastures. Reduced amount and scarcity of rainfall in Mvomero district has led to shortage of feed for livestock and consequently reduction of milk production and its products.

Effects on pasture resources

The dominant pasture species found in the study area include native *Cencrus ciliaris* (Buffel grass) and Chloris spp (Rhodes grass) for grazers. Browsing animals were found to feed mainly on Acacia and Commiphora species. However, in the dry season it was observed that most grazers like cattle ended up feeding on sisal or became browsers when the understorey herbaceous vegetation was exhausted. This field observation was also confirmed during group discussion session whereby elders argued that, it was their first time to see cattle feeding on tree twigs and branches like goats or giraffes. It was also their first time to observe cattle feeding on poisonous weedy plants and rice bran due to scarcity of pasture. According to IPCC (2007), the projected global increase of temperature to 2.5 °C will result to major losses; one of them being a high risk of extinction of 20-30% of all plant and animal species. This is because livestock sector is among the sectors in the country that are worst hit by climate change (Plate 2) through repeated droughts(Ceven *et al.*2010). One of the drought hits in Mvomero district was in late 2016 where substantial number of animals died due to inadequate forage.

Plate 2. Goats searching for browsing resources and cows died due to insufficient pasture in Mvomero district in 2016

Pastoralists pointed out that there is an increased rate of animal collapsing and death, attributed to the lack of enough pasture and water due to prolonged drought. Ceven *et al.* (2010) reported that in recent years, deaths of large numbers of livestock due to lack of water and pasture has been of frequent occurrence in Tanzania; threatening the livelihood of pastoralists as also observed in 2016. Furthermore, pastoralists explained that sometimes they choose a hard decision of slaughtering animals that collapses and seems to be on the verge of death; others admitted that they also slaughter dead animals for their own consumption, a fact that was also supported by one of the key informants. They do so believing that it is a way of minimising losses due to animal mortality; that at least they should benefit from their dying animals.

Assessment of grazing land in terms of its resources was built on Landsat classification. Resources were classified in terms of cultivated land (crop residuals), grasses, shrubland, forest and woodland as the components of grazing land. It was revealed that there was substantial pasture resource change in all the classes. The Landsat images in spatial temporal land cover change from 1985 to 2015 are presented in Figure 4.

Figure 4. Spatial land cover change from 1985 to 2015 in Mvomero district

As shown in Figure 4, areas of grasslands in 1985 had been changed to shrubland in 1995. Land cover change from 1985 to 2015 for the five classes is presented in Table 1.

Table 2. Grazing land cover change in Mvomero district, Tanzania

Land cover types	Year (Area in Percentage (%))			
	1985	1995	2005	2015
Cultivated land	5.5	22.8	30.5	40.2
Grasses	82.1	7.9	4.9	5
Shrublands	7	7.9	26.1	29
Forests	46.8	32.8	15.6	4.7
Woodlands	17.3	18.5	30.3	33.9

Source: USGS, 2016

These results goes in line with Hoffman and Vogel (2008) who reported that the increase in the concentration of atmospheric CO_2 could enhance the process of bush encroachment due to less transpiration; which could result in more plant available water, particularly at greater depths, where deeper-rooted trees and shrubs have their roots. Hence greater access to water could increase the length of their growing season and increase their competitive dominance to the exclusion of shorter growth forms such as grasses and perennial herbs. The increase in temperature leads to higher evaporation which diminishes the growth of grasses and support other vegetation types.

Effects on milk production and livelihoods

Results showed that all respondents (100%) perceived a decline in the amount of milk produced (Table 3). This was due to lack of enough water, pasture and the associated long walking distances covered in search for these resources, making the livestock weak.

Table 3. Responses on the reduction in milk quantity

Response	Frequency	Percentage (%)
Agree	90	100

Source: Field survey, 2016

It was pointed out that in previous years, an indigenous cow (Short Horned Zebu), produced up to 5 litres of milk per day, contrary to the time of data collection (November, 2016) where it was difficult to obtain a litre of milk from lactating Zebu. The implication was that, livestock feeds were not enough to provide the cow with energy and protein sufficient for milk production, and at the same time the animals got tired due to walking over long distances for pasture and water as observed by Mtengeti et al 2008 and Njombe et al 2011. Majority of the pastoralists (98%) agreed that drought stress has destabilized their life. They claimed to depend on milk production to sustain their life; selling the milk to get their daily basic needs.

Table 4. Climate change destabilized milk produced by pastoralists

Response	Frequency	Percentage (%)
Agree	89	98.8
Neither agree nor disagree	1	1.1

Source: Field survey, 2016

Furthermore, given the adverse drought and nature of pastoralists' life, they have become a vulnerable group in the country. Livelihoods for Masaai, Barbaig and Nyaturu in the district largely depended on livestock keeping. They have therefore been and will continue being forced to modify their traditional life style, from pastoralists to agro-pastoralists and diversify their earning sources. Personal observations in other pastoralist districts in Tanzania such as Kilosa, Kiteto and Kilindi revealed that Maasai women have become vendors of vegetables and charcoal and young men engaging in *Bodaboda* business (Motorcycle taxies), watchmen in town centres and hair dressers in women beauty salons. If innovative and adaptive measures are not taken, climate variations will continue to stress pastoral communities to the highest and they are likely to suffer the consequences more than other land users.

Conclusion

- That drought stress is a major challenge in Mvomero district and it has negatively affected grazing resources and pastoralists livelihoods in various ways.
- This is due to a decrease in annual rainfall and an increase in temperature both of which have adverse effects.

- The pastoralists' livelihoods have in turn become more vulnerable as they are dependent on livestock products to obtain their basic needs.

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