Journal of the Geographical Association of Tanzania, Vol. 40, No. 1: 100–119

Assessment of the Understanding of Climate Change Among the Ngerengere Maasai Community in Morogoro, Tanzania

Dotto P. Kuhenga*

Abstract

This paper sought to assess the understanding of climate change among the Maasai community in Ngerengere Division, Morogoro Region, in Tanzania. A recent study that involved 70 participants in an embedded case study design revealed that the Maasai pastoralists and farmers understand the weather patterns and can cope well with climatic variability typical of semi-arid areas. This understanding helps individuals and social groups to access and process climate information to the level that raises their capability to adopt relevant mitigation measures. Presented narratives obtained through the triangulation of data indicate that the Maasai people have established coping strategies to help them reduce the impacts of climate change in their contexts. Captured strategies include: shifting from livestock to small-scale farming, cattle raiding, and increasing the number of livestock. The paper uncovers that the target community has developed indicators that help individuals and social groups to access climate change knowledge in their area, and adopt necessary and useful measures. Cited indicators include; prevalence of new types of diseases, change in patterns of human activities, extreme fluctuations of Ngerengere river volume, and shifting of the river flow.

Key words: *climate change, climate change understanding, climate change perception, climate change adaptation, indigenous knowledge*

1. Introduction

Maasai pastoralists are among the indigenous communities of Tanzania, practicing transhumance in Ngerengere and Ngorongoro crater. Maasai pastoralists have adequate knowledge on the weather patterns, and are able to cope with climatic variability typical of semi-arid areas (Kerubo, 2016). Over 90 percent of their livestock are indigenous (Van Aelst & Holvoet, 2017). Their cattle species can withstand water and pasture scarcity, and have a high degree of disease resistance (Ndesanjo, 2017). However, in extreme water and pasture scarcity incidents, livestock deaths are inevitable (ibid.).

Climate change, as a global challenge, has impacts on human systems and crop yields, as well as on arid and semi-arid rangelands (Galvin et al., 2001; IPCC,

*School of Journalism and Mass Communication, University of Dar es Salaam: kuhenga.pdotto.udsm.ac.tz

2015). Many terrestrial, freshwater and marine species have shifted their geographical ranges, seasonal activities, migration patterns, abundances and species interactions in response to climate change (IPCC, 2018). Tanzania is also experiencing adverse impacts of climate change in many sectors, including pastoralism and agriculture in rural areas (Shemsanga et al., 2010; URT, 2007c; Sangeda & Malole, 2013). For instance, a mean annual increase of temperature of 1.0°C has been recorded since 1960, with decreasing rainfall at an average of 2.8mm per month, or 3.3% per decade countrywide (TCAR, 2016; Magita & Sangeda, 2017).

Understanding how indigenous communities perceive climate risks is vital in shaping actions against climate change impacts (Egeru, 2016). The way individuals and social groups perceive climate change influences how they deal with its adverse impacts (Adger et al., 2009; Patt & Schröter, 2007). For instance, through perceiving the adverse impacts of climate change, the Maasai agro-pastoralists of East Africa have, in the past, been able to successfully discern and track climate variability and employ a diversity of adaptation strategies to secure their livelihoods. The strategies included transhumance and migration, herd splitting, and keeping species-specific herds. These activities have been interspersed with minimal cultivation (Galvin et al., 2004; Homewood et al., 2009). In Ngerengere, the grazing areas were used in a transhumant fashion, locally known as *ronjo*. During the rainy season, herds returned daily from pastures to the homesteads (Loos & Zeller, 2014).

1.1 Understanding of Climate Change

Understanding of climate change—the focus of this paper—implies the ability to access and process climate information. Its relevance relates to facilitating a community's capability to engage with, and make decisions on, processes of change, predictions, and associated uncertainties (Ensor & Berger, 2009). It encompasses the ability to describe clearly and sufficiently the meaning, causes, features, and impacts of climate change (IPCC, 2015).

Understanding of climate change is one of the critical areas of concern as it helps in recognising the need for actions to address climate change impacts. It is a vital tool in assessing the past, current and future trends of climate change (Ensor & Berger, 2009; IPCC, 2015). The understanding and related perceptions on climate change in pastoral communities, for instance, are critical to inform decision-makers and planners on appropriate actions that will enhance pastoralists' capacity and adaptation to climate change (Debela et al., 2015; Juana et al., 2013; Fosu-Mensah et al., 2012). According to Pahl et al. (2014), perceptions of climate change, especially in relation to people's understanding, are things that are socially produced or constructed, based on how social practices prioritize particular elements of reality as salient to their goals.

This understanding is crucial as it helps in vulnerability reduction, building adaptive capacity, and strengthening resilience and mitigation abilities. Adaptation requires understanding of the causes and impacts of climate change. Through this understanding individuals attain the ability to access and process climate information to accommodate the adverse impacts of climate change, and modify the livelihoods and means of sustenance of communities vulnerable to climate change (Practical Action, 2010).

The significance of the understanding of climate change globally necessitated the establishment of the Intergovernmental Panel on Climate Change (IPCC) in 1988. This body's mandate is "… to assess on a comprehensive, objective, open and transparent basis the latest scientific, technical and socio-economic literature relevant to climate change" (IPCC, 1988, as cited by Ensor & Berger, 2009). It provides the most well-known and authoritative scientific understanding and assessments of the past, current, and future trends of climate change (Ensor & Berger, 2009). Thus, exploring the understanding of climate change among different populations—such as the Ngerengere Maasai, the focus group of this study—is important to determine the adaptive and mitigation capacities of concerned societies (Mung'ong'o & Yanda, 2016). The understanding of climate change referred to in this study implies the general knowledge and ability to acess and process climate change information. Climate change, in this regard, is perceived as a shift in the state of a climate that can be identified by changes in the mean and/or the variability of its properties.

1.2 Maasai Rural Communities' Livelihoods and Climate Change

Maasai communities of Tanzania such as those in Ngerengere Division are among the rural people who mostly practice pastoralism—a form of livestock production or traditionally arranged ranching where mobility is also an option (Hesse, 2006; Mero, 2011). They follow seasonal changes with their herds, and pastoralism constitutes their main livelihood system based on livestock keeping. Together with pastoralism, they also have other reasonable economic engagements embedded in firm socio-cultural and environmental objectives (Baxter, 1994; Hesse, 2006). Pastoralism, as a land-use system associated with the use of natural rangelands by pastoralists, encompasses humans, rangelands and herds as three interlinked pillars (Abdalla & Gaiballah, 2016). It is a natural resource-based land-use system, and among the main livelihood practices in semi-arid areas of East Africa. Because it is a natural resource-based land-use system, it is also the most affected by climate change compared to other land-use systems in the region (ibid.).

Climate change affects livestock production in multiple ways: directly by impacting on livestock performance; and indirectly by affecting the environment, society, and the economy (FAO, 2016). In particular, climate change has adversely affected rainy seasons leading to long dry seasons, reduced pasture areas and overgrazing, as well as limited amount of water (Awuor, 2011). In addition, scarce

resources, coupled with high levels and trends of demographic growth, have led to stronger competition of resource use between pastoral communities and and other groups, hence resulting into conflict and violent clashes (CCCD, 2008).

Climate change and environment in Maasai communities are subject topics commonly communicated and taught to the *moranis*[1] in particular, because of their roles of looking out for fertile areas for pasture and organising the move to such new areas, and other members of society in general. The topics are on plants and animals, various land features and their importances, different human and bovine diseases and their treatments, quality of pasture, as well as the significance of salt licks and saline springs. These are communicated comprehensively through their indigenous knowledge and traditions related to the environment (Kerubo, 2016). For instance, on the quality of water, they have indigenous ways of telling good water from bad (Tabuti, et al., 2016). Also, the Maasai have a group of diviners locally known as the *iloibonok*, who predict calamities and future events like weather changes and matters of diseases (Saitabau, 2014).

2. Context and Methods

2.1 The Context

The study that led to this paper was conducted in Ngerengere Division, Morogoro district, in Morogoro region. At an altitude of 100– 300m above sea level, the Ngerengere area features sparsely wooded, rolling plains that connect the coastal lowlands with the higher elevations of the central region. River valleys and basins shape the landscape, and provide a continuous water supply throughout the year. Bodies of water are crucial to the survival of Maasai pastoralists during the dry season, which usually lasts from June to mid-November. The 500–1,000 mm of precipitation that falls during the rainy season follows a somewhat bimodal pattern, with a dry spell around February (URT, 2007b). Average monthly temperatures are around 25–28°C (URT, 2008).

Ngerengere Division receives bimodal rainfall. The first short rainfall season (*vuli)* starts in November to early January, followed by a short dry season. The second long rains season (*Masika*) starts at the end of February and goes to May, followed by a long dry season. The annual rainfall varies from 800–1,000mm, except for the Uluguru Mountains with a mean rainfall reaching over 1,500mm (Yanda & Munishi, 2007; Van Aelst & Holvoet, 2017). The specified rainfall seasons recharge the Ngerengere River catchment, which covers most parts of the Ngerengere Division. The catchment extends from the western part of the Uluguru mountain ranges, and eastwards to the mid-plains of the Ruvu catchment towards the Indian Ocean (Mero, 2011).

[1]The *morani* are Maasai young warriors who have transitted from boyhood through the rites of passage of circumcission. It is in this period that they they taught about history, culture and traditions. It is an age set with traditional reaponsibilities of protecting the community against enemies (raids) and predators, and raiding other tribes for livestock, among others (Kerubo, 2016).

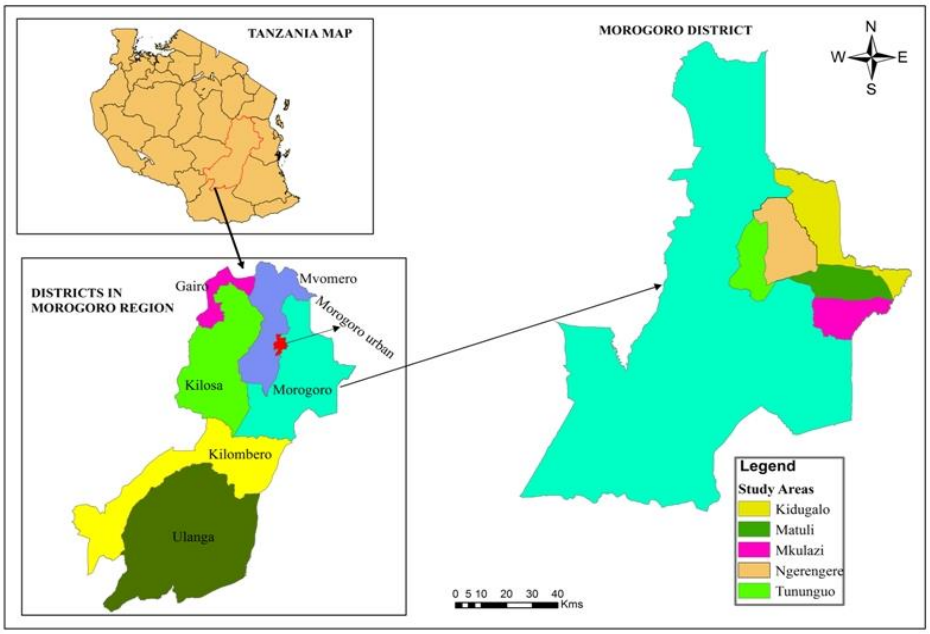

Figure 1: Ngerengere Division
Source: Geography Department, University of Dar es Salaam (2018)

Many factors have contributed to the reduction of pastoralists' mobility, including urban expansion and increased agricultural lands at the expense of rangelands (Gaiballah & Abdalla, 2016). Similarly, the mobility of pastoralists away from Ngerengere has decreased: most permanently reside in the area because Ngerengere river is a secure water source for livestock watering. About 25 percent of the total livestock population of Morogoro Region is found within the Ngerengere catchment area (IUCN, 2010). Significantly, pastoralism and farming activities in Ngerengere are attracted more by Ngerengere River. There is a high increase in the rate of agricultural activities and population growth in the downstream zone, which exacerbates siltation and water pollution. Crops cultivated in the area include maize, bananas, tomatoes and vegetables (Kihila, 2005). Ethnic wise, the Ngerengere division consists of 80 percent Maasai. Other ethnic groups include the Kwere, Mang'ati and Khutu (Mero, 2011).

The division was chosen for the study due to several reasons. First, it is characterised by both agriculture and pastoral production systems (ibid.). Second, the Maasai of Ngerengere are among the notable indigenous communities in Tanzania that have been organising themselves (IWGIA,

2009), and engaging in various climate change adaptation activities (Van Aelst & Holvoet, 2017). The division was also chosen because the area is an under-researched as compared to other Maasailands in Tanzania (Loos, 2014)—such as Loliondo and Simanjiro districts—where many studies on the Maasai have been conducted (Ndesanjo, 2017).

The Maasai pastoralists in Ngerengere graze their livestock on communal and government-owned rangelands, sometimes far from their homesteads. During the rainy season, herds return daily from pastures to homesteads (Loos & Zeller, 2014). During the dry season, the grazing areas to the southeast provide sufficient fodder reserves. Ngerengere River is also a water source for livestock (Mero, 2011). More than 90 percent of the livestock kept by Maasai pastoralists, such as in Ngerengere, are indigenous. Maasai pastoralists have adequate knowledge of the weather pattern, and can cope well with climatic variability typical of semi-arid areas. The same is true for their cattle species that can withstand water and pasture scarcity, and also have a high degree of disease resistance. However, as mentioned earlier, in extreme water and pasture scarcity incidents, livestock deaths are inevitable (Ndesanjo, 2017).

Observations from field visits and an analysis of land-use maps indicated an increased rate of agriculture activities and population growth in the study area, which might exacerbate climate change impacts. The types of crops cultivated in the division include maize, banana, tomatoes, and vegetables (Mero, 2011) mainly in the upstream zone. Generally, over a half of the cash income in Ngerengere is generated by agriculture and livestock husbandry. The reminder comes from non-farm sources such as wage income, self-employment and remittances (Paavola, 2004). Livelihoods literature (e.g., Ellis & Mdoe, 2003; Ellis & Allison, 2004; and Paavola, 2004) indicate that low levels of income, high proportion of income used for food, and the dependence on risky agriculture create vulnerability. These factors characterise the situation of most of the people in the Ngerengere area; and hence signal their vulnerability to the current climate variability, as well as to future climate change (Paavola, 2004).

2.2 Methods

2.2.1 Research Design

This study employed an 'embedded case study' design. This type of design involves more than one unit/object of analysis, and is not usually limited to qualitative analysis alone as it can integrate both qualitative and quantitative methods and approaches. In this kind of design, the multiplicity of evidence is investigated partly in sub-units, focusing on different salient aspects of the case (Scholz & Tietje, 2002). It also allows for the use of triangulation (mixed methods such as observation, survey, and case study) to collect data. Since it allows for multiple units of analysis (Skogerbo, 2011), it is suitable for studies

that analyse the relationship between variables (Churchill, 2002). This design employs methods of knowledge integration that help explain the data under consideration, thereby making data and inferential processes more transparent (Scholz & Tietje, 2002).

The population of the study comprised individuals from households in Ngerengere division (Table 1). It also involved agricultural and livestock extension officers working in various villages in the area. Four out of five wards of Ngerengere division—namely, Ngerengere, Mkulazi, Kidugalo, and Tununguo—were selected for the study. In all, 20 villages of these wards were reached (Table 1). The Matuli ward was not selected because, based on observations from field visits and the Ngerengere Division local government leaders, it is not resided by the Maasai, who were the subjects of this study.

Table 1: Study Wards and Villages

SN.	Wards	Codename	Villages
1.	Ngerengere	Ward A	Ngerengere Mgude Sinyaulime Kiwege
2.	Kidugalo	Ward B	Kidugalo Visaraka Kisemo Magera Pulambili Seregete A Seregete B Lubumu
3.	Tununguo	Ward C	Mlilingwa Dete Kisanga Stand Tununguo
4	Mkulazi	Ward D	Mkulazi Chanyumbu Usungura Kidunda
Total		**4**	**20**

Source: Field Data (2018)

2.2.2 Sampling and Data Collection

Non-random sampling technique was used to select respondents among the population of the study at three levels of the ward, village, and individual levels of households. The purposive selection of interviewees was carried out with guidance from local government leaders of the respective wards and villages

based on the roles, knowledge and experiences of a respondent (pastoralist and farmer) with climate change in the area of study from the perspective of the understanding of climate change. Second, the selection of respondents considered obtaining representatives of each village in the division. Also, each respondent had to come from one particular household so as to avoid duplication of information offered if more than one respondent would be obtained from the same household. The respondents who met the set criteria were co-opted into the study until a data saturation point had been reached. In addition, age—that is, of both the youth and elders—was a factor that facilitated the representation of important groups in the Maasai community (Table 2). The selection included both young and elderly Maasai to capture views representing the nexus of climate change perceptions. Finally, after the data collection had reached a saturation point, the distribution of the respondents in the four wards ended up as follows: Kidugalo – 15; Ngerengere – 8; Tununguo – 15; and Mkulazi – 12. The Ngerengere ward had more respondents as it was also home to local government leaders who added value to the collected data (Table 2).

Table 2: Ngerengere Maasai Respondents from Selected Wards

Wards	**Frequency (study respondents)**	**Age**		**Sex**	
		Youth (18-39) ***With a stay of 10-15 years at the study area***	**Elders (40 and above)** ***With a stay of 20 years and above at the study area***	**Male**	**Female**
Ngerengere	18	8	12	14	4
Kidugalo	15	6	9	12	3
Tununguo	15	6	9	12	3
Mkulazi	12	5	5	10	2
Total	**60**	**25**	**35**	**48**	**12**

Source: Field data (2018)

The study employed interviews because they allow face-to-face communication with respondents. Both structured and unstructured interviews were conducted as they promote an active and open-ended dialogue with interviewees (Wimmer & Dominick, 2011). The study largely used intensive interviews that usually require smaller samples but obtain a wealth of detailed information (ibid.). Documentary review analysis was also used to collect data and historical information on the subject of study.

The sample size also comprised of 10 agriculture and livestock extension officers who were purposively selected from 10 villages (providing particular representative officers from each selected study wards) in Ngerengere division, thus totalling to 70 respondents. Table 3 illustrates the distribution of the sample size used in the study.

Table 3: Distribution of Sample Size

Respondents	Number of Respondents
Farmers and/or pastoralists	60
Agriculture and/or livestock extension Officers	10
Total	**70**

2.2.3 Data Analysis and Presentation of the Results

The results from qualitative data are discussed alongside the quantitative data to confirm the findings on the perceptions of climate change among the Maasai of Ngerengere division. Qualitative data, which form the largest components of this study, were analysed using NVivo 11, and are presented in a description form (texts and tables); whereas emerging themes and patterns were clustered in accordance with the objective of the study. Quantitative data were summarized and then analysed using SPSS version 20, and presented in the form of numbers and percentages using tables. In particular, the analysis of the respondents' perceptions of climate change, and especially on their understanding of climate change, was categorised into three groups: high understanding; average understanding; and low or no understanding. These categories were based on the respondents' ability to describe clearly and sufficiently the meaning, causes, features, and impacts of climate change (IPCC, 2015).

3. Discussion of the Results

3.1 Understanding of Climate Change

Maasai pastoralists and farmers perceive climate change differently. The youth and elders in particular, perceived climate change as unsteady raining patterns and long dry seasons that affect pastoralism. In particular, their understanding and knowledge of climate change appeared to be in the three categories of: 'high understanding'; 'average understanding' and 'low or no understanding' about the subject. The findings indicate that, of the 60 respondents (pastoralists/farmers) interviewed, 78.3% had high understanding on the subject, 16.7% had average understanding, and 3.3% had no understanding; while 1.7% did had response (see Table 4).

Table 4: Ngerengere Maasai Understanding of Climate Change (CC)

Level of CC Understanding	Respondents	Percent
No responses	1	1.7
Low/No understanding	2	3.3
Average understanding	10	16.7
High understanding	47	78.3
Total	**60**	**100.0**

Source: Field Data (2018)

These findings indicate that more than 90% (57) of the 60 Maasai respondents had understanding about climate change; with 47(78.3)% having high understanding, and 10(16.7%) with average understanding on the subject. This result concurs with what Kerubo (2016) explains on the position of Maasai community on climate change: that knowledge on the environment and climate change is a subject commonly communicated and taught to the *morani* in particular, and other members of the Maasai society, as noted by one respondent:

> *"We know these things [climate changes] so well. In the previous times, we were not used to seeing insects attack [crops and animals]. The reason behind such happenings is drought. We used to receive two rain seasons but these recent years we receive only one"* (A4-male - pastoralist and farmer).

In addition, although most of the respondents had high understanding on the subject, their views were consistent with the position that climate change impacts on human use of resources, animals' heath and productivity (Tabuti et al. 2016), as noted by one paricipant: "*I do not know about climate change; but I think the change of rain seasons is due to this climate change* (A3-female - pastoralist and farmer).

Similarly, extension officers pointed out that the Maasai of Ngerengere had considerable understanding of climate change, which they used for adaptation and mitigation in the area, as one noted:

> *"People are used to seeing rains in February but because of these changes the rains may come early, late or not at all. So in other words we do tell people that let us not follow habitual experience…"* (Agriculture Extension officer1).

The respondents mentioned certain issues that are associated with climate change. Of the 60 respondents, 45% associated climate change with the change of rain seasons in various years; 33.3% associated it with long periods of drought; 13.3% associated it with fluctuation of different seasons, i.e., rain, dry, etc.; and 8.3% did not respond to the question that inquired on what they associate climate change with (Table 5).

Table 5: Issues Associated with the Understanding of Climate Change

Climate change Issue	Respondents	Percent
No responses	5	8.3
Changes in rainfall patterns	27	45.0
Drought	20	33.3
Fluctuation of seasons	8	13.3
Total	**60**	**100.0**

Source: Field Data (2018)

3.2 Climate Change Indicators

According to the UNFCCC (2007), "… climate change issues differ from place to place and not all the climate change issues equally manifest in all the countries." In the case of Tanzania, for instance, the national adaptation programme action (URT, 2007b), and the national environment statistics report (NBS, 2017) list several climate-related hazards in the country that include droughts, floods, heavy rains, strong winds, and heat waves (URT, 2007b). In this regard, the study aimed to reveal what the respondents describe as manifestations of climate change in Ngerengere. This was crucial in exploring further the respondents' understanding of climate change, in addition to exploring their perceptions of climate change issues and impacts.

In their answers, respondents mentioned particular indicators of climate change to include the alteration of the duration of seasons (e.g., long or short rainy season, dry spells, etc.); presence of new types of animals and crop diseases; changes in the patterns of human activities; and extreme fluctuations in the volume and flow of the Ngerengere river. In particular, 48.3% of the respondents mentioned the alteration of the duration of seasons as among the leading manifestations of climate change; 23.3% mentioned livestock and crops diseases; 11.7% mentioned changes in human activities (e.g., shifting from livestock as a sole activity to embracing small-scale farming); 8.3% mentioned fluctuations of the volume of the Ngerengere river; whereas 8.3% did not respond to this question (Table 6). These findings are in line with the CCCD (2008) position that in many places in general, alteration of seasons, especially changes in rainfall patterns (leading to increasingly scarce, scattered, and unpredictable pastures), are among key indicators of climate change.

Table 6: Climate Change Manifestations in Ngerengere

Climate Change Manifestations	Respondents	Percent
No responses	5	8.3
Diseases	14	23.3
River volume fluctuations	5	8.3
Changes in human activities	7	11.7
Alterations of seasons, mainly rainfall patterns	29	48.3
Total	**60**	**100.0**

Source: Field Data (2018)

According to the FAO (2009), climate changes and the duration of seasons have adversely affected crop and livestock yields, leading to increased risks of food shortages/insecurity, livestock and crop diseases, etc. In this regard, respondents had similar views:

> *" The effects of climate change include these day-to-day changes in seasons; for example, long periods of drought. As a pastoralist, these result into long dry seasons with fewer areas for animal keeping"* (A1-male - pastoralist and farmer).

In particular, respondents underscored how climate change led to drought and deforestation, in addition to affecting the flow of the Ngerengere river:

> *"I can show you various things…. For example, our river* [Ngerengere] *used to flow throughout the year. But today, in September, there is no water flowing. When the river is dry you have to dig 4 to 5 feet to get water, instead of just one foot [as before]."* (B3-male - pastoralist and farmer).

Generally, these findings indicate that drought, which is associated with adversely affecting the volume of the Ngerengere river and leads to water scarcity in the area, is viewed as the main manifestation of climate change in Ngerengere.

3.3 Perceived Causes of Climate Change

The study findings indicate that although most of the Ngerengere Maasai (56.7%) did not respond to this question, those that did so mentioned the causes of climate change to constitute mainly human activities such as nomadism, divine causes (God's will), and modernisation projects such as industrialization. In particular, 28.3% mentioned human activities as the leading cause of climate change; followed by divine or God's will (10%), and modernization projects (5%), as shown in Table 7.

Table 7: Causes of Climate Change

Causes	Respondents	Percent
No responses	34	56.7
Human activities	17	28.3
Modernization projects	3	5.0
Divine causes	6	10.0
Total	**60**	**100.0**

Source: Field Data (2018)

In addition, the Maasai's knowledge on various issues such as the environment and climate change is influenced by religious beliefs. In this regard, the respondents mentioned 'God's will' as one of the causes of climate change, as recounted in the following quote:

> *"I cannot know that all because it is God's will; I cannot put blame on someone. I cannot say to anyone that you have done so and so that is why the rains are unpredictable. If it has to do with something big as rain, who are you going to blame? It is changes we have to live with"* (Pastoralist and farmer, A16-male).

The Maasai have a group of diviners locally known as the *iloibonok*, who can predict calamities and future events, and provide remedies. The diviners are consulted for advice during major community calamities, weather changes and matters of diseases (Saitabau, 2014). However, some respondents (as Table 7 above illustrates) explained how human activities were responsible for climate change. In this regard, one of the respondents noted:

> *"Human activities are purely the causative agent behind the climatic changes. Things that used to protect us from harsh climatic conditions or that facilitated conducive climate are no longer in place. People have cut down trees; [forgetting that] forests are like shoes in the leg to facilitate good climate. Though I have not been in many places, but what I know is that animals always run to the forests. But when water level decreases, the land is depleted. Morogoro has many reserves and thus many animals. If they were protected there would be plenty of them. Morogoro used to support not just people around here but also the whole nation. Even metropolitan Dar is heavily dependent on Morogoro in many ways, leading to such actions as tree-cutting for timber and burning of charcoal. In addition to food instability due to climate chand, water is not as plenty as it used to be. If we suffer such in Morogoro, what about our friends in Dar? In the last five to six years, forests have been depleted; trees are drying especially due to drought, and the animals we keep have removed all grass cover"* (Pastoralist and farmer, C4-male).

Generally, apart from the limitation that some of the respondents were skeptical about airing their views on what causes climate change, those who did mostly identified human activities as the key causes.

3.4 Climate Change as a Problem

Exploring further the understanding of climate change among the Maasai community in Ngerengere division also entailed comprehending how they viewed climate change as problematic in their area, especially in their agricultural and pastoralist activities. The IPCC (2015) notes that observable trends of the ongoing climate change indicate how climate change is leading to severe problems that have pervasive and irreversible impacts on people and ecosystems. In this regard, the Ngerengere Maasai respondents specifically cited the following as indicators of how climate change has affected their area: inadequate pastures for their cattle, which has led to deaths of many cows and low prices when they are sold; uncertainties and unpredictability in weather; conflicts/competition over available land use for agriculture and animal pasture; and water scarcity, among others. In particular, 27(45%) of respondents said the death of animals was a sign of how climate change was a problem to them; 15(25%) mentioned water scarcity; 3(5%) said climate change was leading to low productivity in their activities; 1(1.7%) said climate change has led to conflicts over land. Another 14(23.3%) did not respond to this particular question. Table 8 presents the results.

Table 8: Problems Caused by Climate Change in Ngerengere Area

Type of Problem	Respondents	Percent
No response	14	23.3
Deaths of animals	27	45.0
Water scarcity	15	25.0
Conflicts	1	1.7
Low production	3	5.0
Total	**60**	**100.0**

Source: Field Data (2018)

The results in Table 8 were affirmed and corroborated by the views of the Ngerengere Maasai respondents and experts (agriculture/livestock extension officers). For example, one Maasai respondents said:

> *"When it reaches September, there is neither water nor grass; and that is when troubles begin. Some cows start dying, and this goes on until another rainy season….. Even when cows return home from pastures, you might find some dead the next morning. The green environment you see today in June, it will all be dry by August … These are climate changes because in the past there was good weather, fertile soil for farming, and so on. But, now, as pastoralists, we lack pastures as grasses do not grow well"* (Pastoralist and farmer, A1-male).

The agriculture and livestock extension officers also had similar views as exemplified by the following statement:

> *"For the Maasai, everything they do [economically, e.g., livestock keeping] depends on the environment, and especially on the climate [rainy season]. Thus, they are friendly with forests and rains. That is what they need. But enmity [between pastoralists and farmers] erupts in dry seasons, especially the long dry seasons we usually experience here due to climate change, when there is no grass. They will even invade protected areas during such times*" (Agriculture Extension Officer 2).

These findings and detailed views from the respondents generally list deaths of animals, water scarcity, and conflicts (between farmers and pastoralists over land) as the main problems of climate change to the Maasai of Ngerengere.

3.5 Perceived Benefits of Climate Change to Ngerengere

Climate change is mostly associated with adverse impacts on natural and human systems. Due to climate change, ecosystems face severe declines in species diversity through a combination of factors including population growth, ground water extraction for intensive agriculture, and deforestation for timber and agricultural expansion (MEA, 2005). The study findings, on the one hand, indicate that at least 99 percent of the Ngerengere Maasai respondents had views similar to the dominant narrative and position that sees climate change as largely leading to adverse impacts. Respondents strongly stated that climate change did not have any benefits to them, their livelihoods, and other related

systems, as noted by one respondent: *"Climate change does not have any benefits to us at all. It is something that has generally led to various disasters"* (Pastoralist and farmer B1-male).

As in other places, climate change has led to the diversification of economic activities among the Maasai of Ngerengere. Due to certain difficulties in pastoralism -- such as drought and death of animals -- the Maasai are now not only pastoralists, as it was the practice in the past, but also farmers (i.e., *agro-pastoralists)*, as well as traders. These are some of the perceived advantages of climate change in the area: the diversification of economic activities.

4. Results

The results suggest that the respondents perceived differently what constitutes climate change. Most of them consider climate change to imply unsteady rain patterns and long dry seasons that affect pastoralism. Also, most (78%) respondents had a deeper understanding of climate change. These results are in line with the view that the recurrence of droughts and floods in Tanzania, including Ngerengere, constitute definitive signs that climate change is impacting life in Tanzania. Moreover, farmers indicated that the late start and early cessation of the main rainy season testify to changes in rainfall regime in recent years. Thus, the change in rainy seasons is one of the main climate change indicators to many local Tanzanians (Liwenga, 2016).

The results generally indicate that most of the Maasai in Ngerengere are aware of climate change. They also understand that this change has had a significant impact in their area and livelihoods. This reality is evidenced in their struggles to find pastures, and the deployment of various land-use plans such as mixing livestock with small-scale farming, reducing the number of cattle, and other related measures. Moreover, conflicts between Maasai pastoralists and farmers from other ethnic groups over land for pastures and agricultural activities is another indicator of the impact of climate change. To the Maasai of Ngerengere, other manifestattions of climate change include droughts, which have adversely affected the volume of the Ngerengere river, leading to water scarcity in the area; and alteration of the time and duration of seasons.

The study results also show that human activities are the main cause of climate change, a view that concurs with the global position of the IPCC (2007; 2015), other organizations (e.g., UNFCCC, 2013), and scholars (e.g., Thornton et al., 2006): that humans activities are the main cause of the current climate change in general, and global warming in particular. In fact, the more human activities disrupt the climate, the greater the risks of severe, pervasive and irreversible impacts on people and ecosystems that sustain them; as well as on long-lasting changes in all components of the climate system (IPCC, 2015).

According to the respondents, main climate change problems to the Maasai of Ngerengere included deaths of animals, water scarcity, and land-use conflicts (between farmers and pastoralists). This concurs with the fact that climate change problems in Tanzania mostly come in the form of frequent droughts that lead to acute water shortage, and consequently animal losses. Droughts cause overgrazing, mass migration, and concentration around pastures and water sources (WISP, 2010). In Tanzania, in areas such as Morogoro, climate change is affecting negatively crops and forage productivity, soil fertility for agricultural production, livestock productivity, and production costs (URT, 2007b).

Although climate change is largely seen as leading to negative impacts, it has also been associated with positive changes in ecosystem structures and functions (Mung'ong'o & Yanda, 2016) that lead to new practices and activities—such as agro-pastoralism—as ways of climate change adaptation, which can be beneficial and useful to livelihoods and other needs.

5. Conclusion

This paper generally presented evidences that most Maasai in Ngerengere area have certain knowledge about climate change. In particular, they perceive that droughts, which have adversely affected the volume of the Ngerengere river and thus water scarcity in the area; and alteration of seasons as the main manifestations of climate change in their area. Moreover, most respondents perceive human activities as the key cause of climate change.

The Maasai of Ngerengere treat climate change as problematical for it leads to problems such as deaths of animals, water scarcity, and conflicts between farmers and pastoralists over land-use. This finding concurs with the dominant narrative and position that regards climate change as largely leading to adverse impacts. Generally, the study's findings show that climate change understanding exists among rural communities in Tanzania. This helps them assess past, current, and future climate change trends to develop relevant adaptation strategies and practices. Therefore, since this understanding is of such importance to rural communities in the face of adverse effects of climate change, the study recommends the deployment of mechanisms to enhance its contextual relevance to enable rural communities cease activities that lead to negative climate changes, and adapt to climate changes when necessary.

References

Abdalla, N. I. and Gaiballah, A. (2016). The impacts of climate on pastoral system in East Africa. In: Yanda, P. Z. and Mung'ong'o C. G. (eds.) *Pastoralism and climate change in East Africa*. Dar es Salaam, Mkuki na Nyota, pp.49–66.

Adger, W. N., Suraje D., Goulden, M., Hulme, M., Lorenzoni, I., Nelson, …, and Wreford., A. (2009). Are there social limits to adaptation to climate change? *Climatic Change* 93 (3): 335 –354. https://doi.org/10.1007/s10584-008-9520-z.

Baxter, P. (1994). Pastoralists are people: Why development for pastoralists and not the development of pastoralist? *Rural Extension Bulletin*, April.

Burgess, N., Doggart, N., Lovett, J. (2002). The Uluguru Mountains of Eastern Tanzania: The effect of forest loss on biodiversity. *Oryx*, 36(2), 140–152. doi:10.1017/S0030605302000212.

Churchill, G. A. (2002). Fundamentals of experimental design for edna microarrays. *Nat Genet*, 32 (1), 490–495.

Commission on Climate Change and Development (CCCD). (2008). *Climate change and drylands*. London: International Institute for Environmental Development.

Debela, N., Mohammed, C., Bridle, K., Corkrey, R., and McNeil, D. (2015). Perception of climate change and its impact by smallholders in pastoral/agropastoral systems of Borana, South Ethiopia. *SpringerPlus* 4 (1), 1–12. https://doi.org/10.1186/s40064-015-1012-9.

Egeru, A. (2016). Climate risk management information, sources and responses in a pastoral region in East Africa. *Climate Risk Management* 11 (Supplement C): 1–14 doi: https://doi.org/10.1016/j.crm.2015.12.001.

Ensor, J. and Berger, R. (2009). *Understanding climate change adaptation: Lessons from community-based approaches*. Warwickshire: Practical Action Publishing Ltd.

Food and Agriculture Organization. (2016). *Climate change and food security: Risks and responses*. Rome: FAO.

Fosu-Mensah, B.Y., P.L.G. Vlek, and D.S. MacCarthy. (2012). Farmers' perception and adaptation to climate change: A case study of Sekyedumase district in Ghana. *Environment, Development and Sustainability* 14 (4): 495–505. https:// doi.org/10.1007/s10668-012-9339-7.

Fratkin, E. (2001). East African pastoralism in transition: Maasai, Boran, and Rendille cases. *African Studies Review*, 44 (3),1–25.

Gaiballah, A. and Abdalla, N. I. (2016). Understanding the pastoral production system of East Africa. In: Yanda, P. Z. and Mung'ong'o C. G. (eds.). *Pastoralism and climate change in East Africa*. Dar es Salaam, Mkuki na Nyota, pp. 33–47.

Galvin, K. A., R. B. Boone, N. M. Smith, and S. J. Lynn. (2001). Impacts of climate variability on East African pastoralists: Linking social science and remote sensing. *Climate Research* (19 (2), 161–172.

Galvin, K.A., P.K. Thornton, R.B. Boone, and J. Sunderland. (2004). Climate variability and impacts on east African livestock herders: The Maasai of Ngorongoro conservation area, Tanzania. *African Journal of Range and Forage Science* 21 (3), 183 –189. https://doi.org/10.2989/10220110409485850.

Hesse, C. (2006. *Pastoralism: Drylands' invisible asset? Developing a framework for assessing the value of pastoralism in East Africa*. London: IIED.

Homewood, K. M., Thompson, P., Trench, S., Kiruswa, S. and Coast, E. (2009). Community- and state-based natural resource management and local livelihoods in Maasailand. *Special Issue on Community-based Natural Resource Management.* Afriche e Orienti.

Intergovernmental Panel on Climate Change (IPCC). (2007). *The science of climate change, assessment report of the intergovernmental panel on climate change*. IPCC.

Intergovernmental Panel on Climate Change (IPCC). (2018). *Global warming of 1.5°C: An ipcc special report on the impacts of global warming of 1.5°c above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty*. IPCC.

Intergovernmental Panel on Climate Change. (2015). *Climate Change 2014 Synthesis Report of the Intergovernmental Panel on Climate Change*. IPCC.

International Union for Conservation of Nature (IUCN) Eastern and Southern Africa Programme. (2010). *The Ruvu Basin: A Situation Analysis*: *Report for the Wami/Ruvu Basin Water Office Supported by IUCN*. Morogoro: IUCN.

International Work Group of Indigenous Affairs (IWGIA). (2009). *The Indigenous World 2009*. Copenhagen: IWGIA.

Juana, J. S., Zibanani, K., and Okurut, F. N. (2013). Farmers' perceptions and adaptations to climate change in sub-Sahara Africa: A synthesis of empirical studies and implications for public policy in African agriculture. *Journal of Agricultural Science* 5 (4): 121–121.

Kerubo, I. P. (2016). African indigenous education as practiced by the Maasai of Kenya. *Masters thesis*, University of Nairobi, Kenya.

Kihila, J. (2005). A Study on sedimentation rate for Mindu Dam and its implications on capacity of water supply for Morogoro Municipality. Thesis for Master of Science in Environmental Technology and Management. University College of Lands and Architectural Studies (UCLAS), University of Dar es Salaam.

Liwenga, E. T. (2016). The technical and social knowledge systems of pastoral mobility in East Africa. In: Yanda, P. Z. and Mung'ong'o C. G. (eds.). *Pastoralism and climate change in East Africa*. Dar es Salaam: Mkuki na Nyota, pp. 109–126.

Loos, T. K. and Zeller, M. (2014). To sell or not to sell – Maasai milk marketing in Ngerengere, Tanzania. *African Journal of Agricultural and Resource Economics*, 9(2):106–118.

Magita, S.Y., and Sangeda, A. Z. (2017). Effects of climate stress to pastoral communities in Tanzania: A case of Mvomero District. *Livestock Research for Rural Development* 29 (160) http://www.lrrd.org/lrrd29/8/sang29160.html.

McCabe, J. T., Perkin, S. Schofield, C. (1992). Can conservation and development be coupled among pastoral people? An examination of the Maasai of the Ngorongoro

conservation area, Tanzania. *Human Organization*. *Human Organization*, 51(4), 353–366.

Mero, R. (2011). Assessment of water quality and spatial distribution of the major pollutants in Ngerengere River Catchment, Tanzania. MSc. thesis in Integrated Water Resource Management (IWRM), University of Zimbabwe.

Millennium Ecosystem Assessment. (2005). *Ecosystems and human well-being: Synthesis*. Washington DC: Island Press.

Mung'ong'o, C.G. and Yanda, P. Z. (2016). Pastoralism for sustainable future in East Africa-An Introduction. In: Yanda, P. Z. and Mung'ong'o C. G. (eds.). *Pastoralism and climate change in East Africa*. Dar es Salaam: Mkuki na Nyota, pp. 3–8.

Ndesanjo, R. (2017). Pathways to enhance climate change resilience among pastoral households in Simanjiro District-Northern Tanzania. PhD thesis, University of Dar es Salaam. xxx

Paavola, J. (2004). Livelihoods, vulnerability and adaptation to climate change in the Morogoro Region, Tanzania. *CSERGE Working Paper EDM*, No. 04–12.

Pahl, S. S., Boomsma, C. and Groves. C. (2014). Perceptions of time in relation to climate change. *WIREs Clim. Change*, 5 (3) (2014), pp. 375–388.

Patt, A. G. and Schröter, D. (2007). Perceptions of environmental risks in Mozambique: Implications for the success of adaptation and coping strategies. *The World Bank Development Research Group Sustainable Rural and Urban Development Team Policy Research Working Paper*.

Saitabau, H. O. (2014). *Impacts of climate change on the livelihoods of Loita Maasai pastoral community and related indigenous knowledge on adaptation and mitigation*. Nairobi: National Museum of Kenya.

Sangeda, A.Z., and J.L. Malole. (2013). Tanzanian rangelands in a changing climate: Impacts, adaptations and mitigation. *Net Journal of Agricultural Science* 2 (1), 1–10.

Scholz, R. W. and Tietje, O. (2002). Types of case studies. In: Scholz R. W. and Tietje, O. (eds.). *Embedded Case Study Methods*. Thousand Oaks: Sage Publications Ltd.

Shemsanga, C., Omambia, A. N. and Gu, Y. (2010). The cost of climate change in Tanzania: Impacts and adaptations. *Journal of American Science* 6 (3), 182–196.

Skogerbo, E. (2011). *Case Studies and Comparative Analysis*. <http://www. uio.no/ studier/ emner/hf/imk/MEVIT4800/h11/undervisningsmateriale/MEVIT4800%202011_2_250811.ppt.pdf>(Accessed on23 June, (2017).

Tabuti, R. S., Egeru, A. Jakisa, E. (2016). Role of culture and gender in shaping rangeland management and adaptation. *Pastoralism and Climate Change in East Africa*. Dar es Salaam: Mkuki na Nyota, 87–105.

Thornton, P. K., Peter, G., Jones, P. G., Alagarswamy, G., Andresen, J., and Herrero, M. (2006). Adapting to climate change: agricultural system and household impacts in East Africa. *Climate and Land-use Change Processes in East Africa Paper.*

United Nations Framework Convention on Climate Change. (2007). *Climate change: impacts, vulnerabilities and adaptation in developing countries*. Bonn: Climate Change Secretariat, UNFCCC.

United Nations Population Fund (UNFPA). (2011). Population dynamics and climate change. UNFPA.

United Republic of Tanzania. (2007a). *Morogoro region – Socio-economic profile*. Dar es Salaam: National Bureau of Statistics.

United Republic of Tanzania. (2007b). *National adaptation programme of action (NAPA)*. Dar es Salaam: Vice President's Office.

United Republic of Tanzania. (2007c). *National adaptation programme of action (NAPA).* Vice president's office, division of environment. Government printers, Dar es Salaam. (2007. http://unfccc.int/resource/docs/napa/tza01.pdf.

United Republic of Tanzania. (2008). *Tanzania in figures – (2007*. Dar es Salaam: National Bureau of Statistics.

United Republic of Tanzania. (2013). *Population and housing census*. Dar es Salaam: National Bureau of Statistics.

Van Aelst, K. and Holvoet, N. (2017). Climate change adaptation in the Morogoro Region of Tanzania: Women's decision-making participation in small-scale farm households. *Journal of Climate and Development*, May (2016, 1–16.

Wimmer, R. D. and Dominick, J. (2011). *Mass media research: An introduction*. Ninth Edition, International Edition. Belmont: Wadsworth Cengage Learning.

World Initiative for Sustainable Pastoralism (WISP). (2010). Building climate change resilience for african livestock in Sub-Saharan Africa – A programme of IUCN – The International Union for Conservation of Nature. Nairobi: Eastern and Southern Africa Regional Office, March.

Yanda, P. and Munishi, P. (2007). Hydrologic and land-use/cover change analysis for the Ruvu River. *Report for WWF/CARE Tanzania*, Dar es Salaam. 2007; 87.