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Climate change responses among the Maasai Community in Kenya

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Abstract The impacts of climate change to the dryland areas of East Africa are especially strong, especially if it is considered that these areas have weak institutions and governance systems. Climate change has also affected many rural communities in a severe way, reducing crop yields and sometimes causing crop failure. In Kenya and Tanzania, where drylands cover over around 80 and 50% of their respective land areas, rural populations have been especially affected. Among them is the tribal group of the Maasai, legendary nomad warriors, who have been suffering from persistent droughts and the negative impacts on their cattle herds. This paper describes how climate change affects the Maasai communities in Kenya and the changes seen in their habits and diet, in order to adapt to a changing climate.

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1 Introduction and theoretical referential: climate change trends in Kenya

Kenya is a country located in eastern Africa, characterized by arid and semi-arid lands (ASALs) which cover more than 80% (Mwang'ombe et al. 2011) of its total land area. Semi-arid areas are often vulnerable to climate change because they are already climatically stressed with high temperatures, low rainfall, and long dry seasons (New 2015). These zones exhibit ecological constraints which set limits mainly to nomadic pastoralism. This is because the areas are characterized by low erratic rainfall, periodic droughts, and different associations of vegetative cover, soils, and high rate of potential evapotranspiration (Zwaagstra et al. 2010). Moreover, weeds grow more vigorously than cultivated crops and compete for scarce reserves of moisture. Weeds also pose a great challenge to rehabilitation programs in the ASALs as they compete with sown grasses for the available soil nutrients and limited soil moisture in the semi-arid environment (Mganga et al. 2010). Other constraints in the region include low organic matter levels, except for short periods after harvesting or manure applications and highly variable responses to fertilizer. Figure 1 shows the arid and semi-arid areas of Kenya.

The theoretical reference of this paper bears in mind a variety of publications (e.g., IPCC 2014, Leal Filho 2015) and studies (e.g., World Bank 2013) which have shown that the African continent will be the most hit by impacts of climatic change. Kenya has not been spared with over the past decades having faced extreme climatic events especially floods and droughts. Since climate change policy-making in Kenya is slow, and its implementation is irregular (Njoroge et al. 2017), the country faces a rather big challenge in coping with problems such as drought.

Historical data shows that major droughts occur about every 10 years with moderate droughts or floods occurring every 3 to 4 years (AEA Group 2008a). This has led to loss of human lives as well as costing the government approximately 8.0% of GDP every 5 years (AEA Group 2008b). Interestingly, studies have shown that there has not been significant change in maximum and daily maximum temperatures since 1905. However, there has been significant rise in daily minimum temperatures (Christy et al. 2009). According to McSweeney et al. 2009, mean annual temperatures have increased by 1.0 °C since 1960. This is an average rate of 0.21 °C per decade. It is also noted that both the average and maximum temperatures are likely to increase in the range of 1–3 °C by 2050s (Stockholm Environment Institute (SEI) 2009), 1 °C by 2020s, and 4 °C by 2100 (AEA Group 2008a). Depending on the scenario, under high emissions, mean annual temperature may increase by 4.5 °C between 1990 and 2100. In coastal region, it has become warmer with cooling near the large water bodies between the year 1961–1993 (Mwanga 2015, NCCRS 2009). This has led to depletion of glaciers in Mount Kenya (IPCC 2007, UNEP 2009, NCCRS 2009). However, according to Funk et al., 2010, the projected warming will vary from one county to another.

The short rains have become wetter (October–December) (GoK 2007) with overall decrease in mean annual precipitation (AEA Group 2008a; Funk et al. 2010). Five out of seven models show an increase of rainfall from the month of March to May in Wajir County in Northern Kenya (Bowden et al. (2005), Stockholm Environment Institute (SEI) 2009). However, different models have mixed results for increase or decrease of precipitation between December and January, with a tendency of early rainy season in September and October (SEI

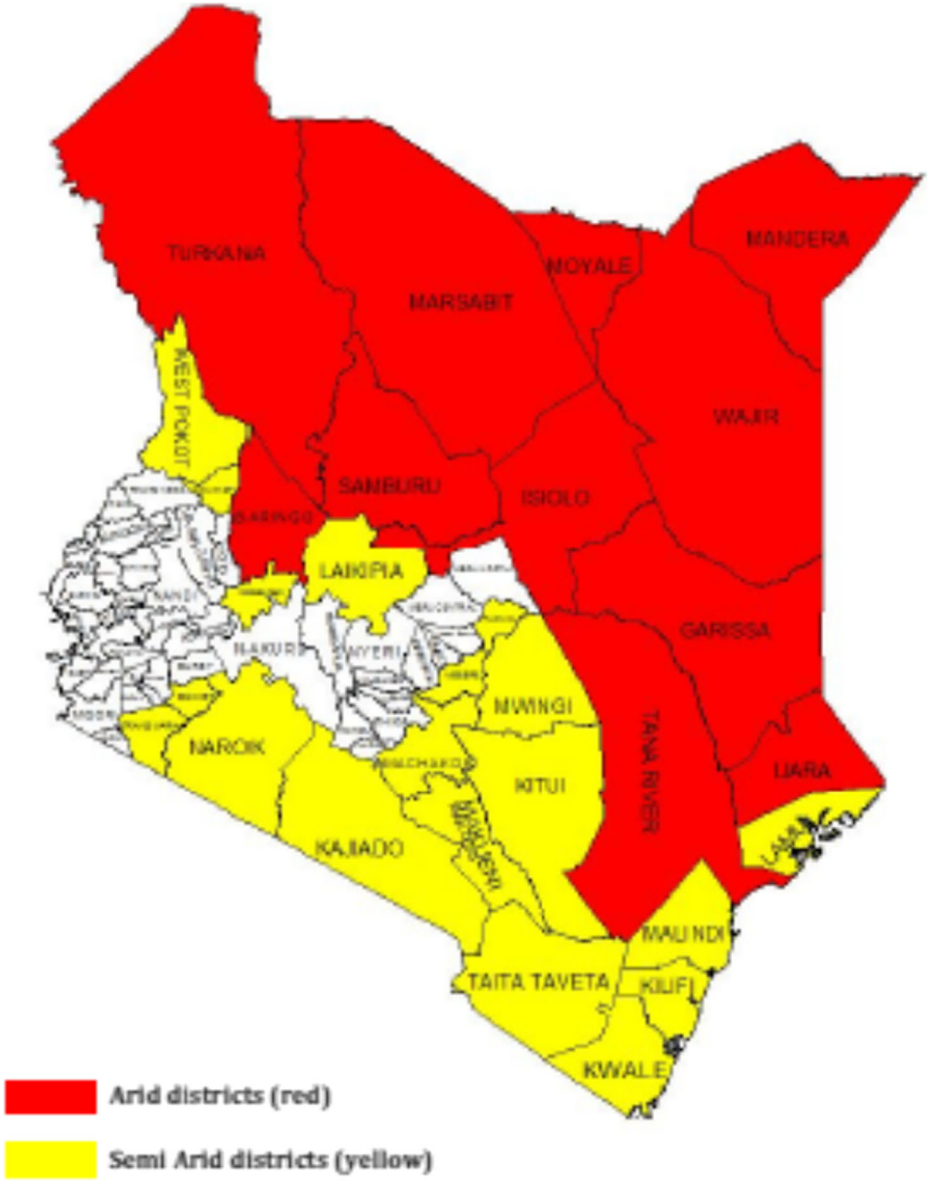


Fig. 1 Arid and semi-arid areas of Kenya (Source: GoK 2012)

2009). Overall, many models indicate probability of heavy rainfall and increase of flood risks (AEA Group 2008a; SEI 2009).Seventeen percent of Mombasa area may be submerged by 30 cm sea rise by 2100.

Indigenous people of Kajiado County have lived within these constraints for centuries. Just like other indigenous peoples in Kenya, Masaai community are mainly pastoralists who are mostly confined predominantly in the arid and semi-arid regions of the country. They have existed on the productivity provided locally and have used their

knowledge to devise coping and adaptive strategies. One of these coping strategies is the use of sand dams (Opiyo et al. 2011).

Keeping large herds of cattle has been the culture of the Maasai community as it is associated with wealth (GoK 2007). However, with diminishing grazing land, Maasai have adjusted the number of their herds (Butt et al. 2009) while embracing the expansion of grazing land. Expansion of grazing land is accompanied by conflicts as well as instances of violence among the grazing groups (Maasai Masai 2011a, b). In extreme occasion, the community practices regional raiding in order to secure watering and pasture points, as well as slaughtering their animals when there is no folder (Schilling and Remling 2014).

Thus, it is increasingly becoming urgent to do more to integrate community-based climate adaptation into agricultural, social, and economic developments for sustainability.

2 Approaches used among Maasai agro-pastoralists in East Africa

The Maasai are a Nilotic ethnic group, whose population is estimated to be about 15 million. They have traditionally inhabited the rangelands that straddle across the southern part of Kenya and northern part of Tanzania (see Fig. 2) (Galvin et al. 2004; Homewood et al. 2004), along the Great Rift Valley, distributed over a total of 16,000 km^2 of semi-arid and arid lands. The Maasai society is comprised of 16 sections (known in Maasai as Iloshon): Ildamat, Ilpurko, Ilkeekonyokie, Iloitai, Ilkaputiei, Ilkankere, Isiria, Ilmoitanik, Iloodokilani, Iloitokitoki, Ilarusa, Ilmatatapato, Ilwuasinkishu, Kore, Parakuyu, and Ilkisonko, also known as Isikirari (Tanzania's Maasai) (Masai 2011a). The majority of the Maasai population lives in Kenya.

Maasai agro-pastoralists have, in the past, been able to successfully discern and track climate variability and employed a diversity of adaptation strategies to secure their livelihoods. The strategies included, for example, transhumance and migration, herd splitting, and keeping species-specific herds. These activities were interspersed with minimal cultivation (Galvin et al. 2004; Homewood et al. 2009). Increasingly, most of these adaptation strategies have become untenable due to major demographic, economic, and environmental changes that have taken or are taking place within the ecosystem (Ekaya 2005; Homewood et al. 2009; Musimba and Nyariki 2003; Wangui 2008). A rapid expansion of human population, shift in livelihoods from agro-pastoralism to more sedentary mixed crop-livestock production, change in land tenure from communal to individual, destruction of natural vegetation, and soil degradation, are some of the changes that seriously threaten the ability of Maasai agro-pastoralists to cope and adjust to climate change. Furthermore, the nature of climate variability currently being experienced has changed. The magnitude of variability, frequency of extreme weather events (floods and drought), and rate of change within climate systems have exacerbated the situation. (Dessai and Hulme 2003; Hulme 2003).

Maasai agro-pastoralists like other smallholder farmers across sub-Sahara Africa are highly diverse and heterogeneous (Tittonell et al. 2011). Much of the heterogeneity is caused by spatial variability in climate, soils, landscape, and their interactions with complex socio-economic and environmental conditions. This heterogeneity influences farmers' decisions and choice of adaptation options to climate variability and change. A wide array of coping and adaptation strategies have been reported across sites within the Maasai ecosystem. Change in crop variety in favor of drought-tolerant and disease-resistant

types, early land preparation, early and staggered planting, crop rotation, destocking, breed improvement, and diversification of livestock to include non-traditional livestock species has been documented (Bobadoye et al. 2016; Chemuliti 2015). For example, in Kajiado County in Kenya, camels were introduced as a means of mitigating the devastating impacts of prolonged drought (Bukachi et al. 2003). Migration and diversification of livelihoods has also been used to spread the risk of climate-induced catastrophes on livelihoods (Yanda and William 2010; McCabe et al. 2014, Rufino et al. 2013).

In many parts within of Maasai land, farmers have diversified from traditional livelihood activities of livestock keeping and crop cultivation into various income generating enterprises

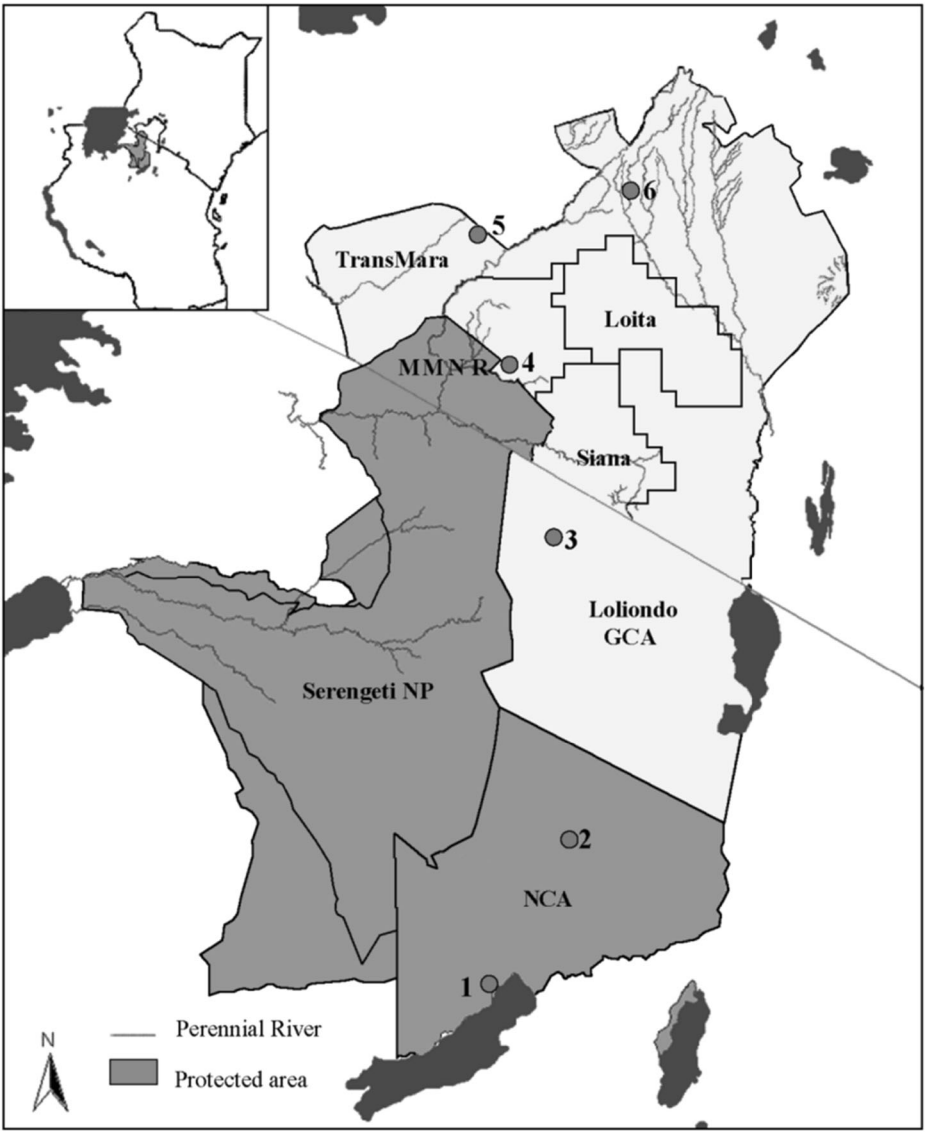


Fig. 2 Location of Kajiado County in Kenya

including, for example, beekeeping, farm forestry (exotic fast-growing species), artisanal mining, and off-farm wage employment mainly in the informal sector and small business. Most of these adaptations are occurring autonomously with very minimal support from government and policies but clearly transcend the climate dimension (Vermuelen et al. 2008; Ziervogel et al. 2008). For example, the reduction in herd size may be correlated to subdivision of the previously communal land, or breed improvement may be profit-driven rather than a response to the changing weather pattern. The entwined nature of disturbances and change-inducing factors in livelihoods cannot be ignored and is widely recognized in the literature (Campbell and Olson 1991), including attempts to disaggregate the effects and show their linkages (Blaikie and Brookfield 1987). Adaptation to climate change occurs alongside other livelihood pressures and therefore cannot be easily disaggregated. However, it is important for climate change to be recognized as a significant factor, and for the subtle dimensions of climate parameter change, which are the experienced realities, to be understood and reacted to.

2.1 Methodology

The study was carried out in selected villages in Kajiado County in Kenya. Kajiado County borders Nairobi County to the North and Tanzania to the South. The county is also predominantly inhabited by Maasai whose main source of livelihood is pastoral with few being agro-pastoral (GoK 2007; Maasai Masai 2011a, b, Nyariki et al. 2009). The county is located between longitudes 36°5 and 37°5 and latitudes 100 and 300 South (Amwata 2013). Figure 3 shows the map of Kajiado County.

Data in the study area was collected primarily through 50 randomly selected respondents. Thus 50 household questionnaires were administered between January 2017 and March 2017. The households selected were of Masaai community involved majority in pastoralist. A two-way analysis of variance, percentage analysis, and Garrett ranking technique was applied to a set of primary data collected from 50 randomly sampled farmers with the aid of questionnaires from Kajiado County.

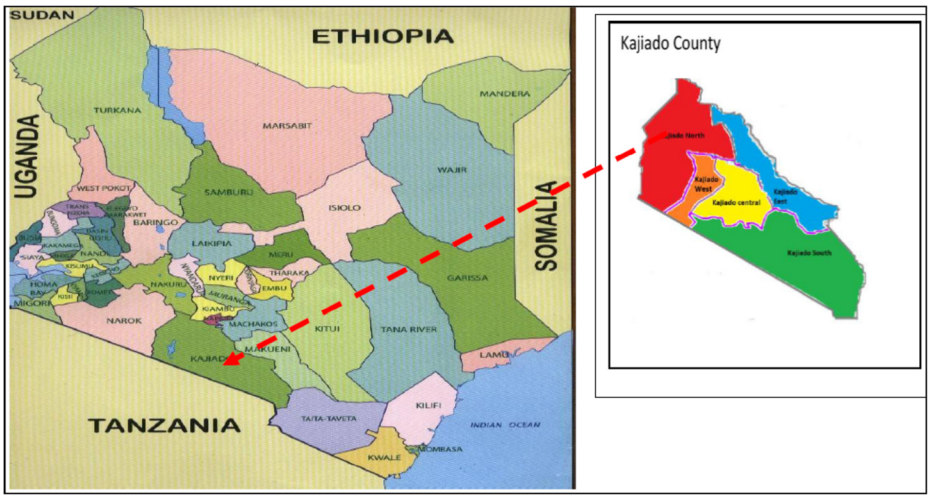


Fig. 3 The Tanzania/Kenya border showing the East African rangelands

3 Results and discussions

3.1 An empirical assessment of perceptions of climate change among the Maasai

The Maasai people perceive climate change as one the greatest threats to the livelihood. When asked about the three top threats, a frequent response was drought and famine, inadequate pasture, inadequate rainfall, and too much sun. In fact, when asked about the number one threat to Maasai livestock keeping, majority of the respondents will mention increased prevalence of droughts. These perceptions are held across men and women alike. Results of a preliminary survey with 44 randomly selected respondents comprising 34.1% females and 65.1% males, participants were asked to what extent they perceived changes in temperature. Perceptions of temperature variability consisted four items, namely, (1) daytime temperature have increased during the last 20 years, the number of hot days has increased during the last 20 years, the number of warm nights has increased during the last 20 years, and finally, the degree of coldness or cold seasons had increased during the last 20 years. The participants were asked to indicate their perceptions according to scale provided 5 = to a great extent to 1 = not observed or experienced this at all. The mean scores of participants' responses to each item are summarized in Table 1.

It is apparent that majority of respondents strongly perceive that the number of hot days has increased significantly during the last 20 years. Also, the majority of participants strongly perceive daytime temperature to have increased during the last 20 years. Perceptions related to increase in the number of warm nights and the degree of coldness of cold seasons having increased during the last 20 years seem moderate. The Maasai community relies on pastoral livelihoods; thus, they are likely to notice changes in daytime temperatures and also increase in the number of hot days, hence the observed results. While men spent the daytime looking after cattle, sheep, and goats, women, on the other hand, spent the daytime looking for water for drinking and cooking. Thus, both women and men are likely to perceive changes in daytime temperatures and increase in the number of hot days. Participants did not seem to perceive changes in warm nights nor changes in the degree of coldness of cold seasons during the last 15 years. There are probable reasons for this. The Maasai people, especially those who live in rural villages, still rely on traditionally grass-thatched mud houses. These are usually designed

Table 1 Mean score of respondents perceptions of climate variability indicators (n = 44)

Item	Mean score
Perception of temperature variability	
Daytime temperature has increased	4.80
Number of hot days has increased	4.68
The degree of coldness of cold seasons has increased	3.60
The number of warm nights has increased	2.93
Perception of rainfall variability indicators	
The onset of rainfall has become more and more unpredictable	4.80
The cessation of rainfall has become more and more unpredictable	4.68
The frequency of occurrence of droughts has increased	4.66
The number of rainy days has decreased	4.57
The amount of rainfall has decreased	4.30
The occurrence of untimely rainfall has increased	3.75
The intensity of rainfall has increased	2.36

Source: Author's Survey Data, 2017

to insulate people from cold nights, and warm from cooking traditional three-stone firewood stoves is likely to remain over nights. This may be a probable reason why respondents seemed to indicate that they were not sure if there have been changes in warm nights or degree of coldness of cold seasons.

Results of a two-way ANOVA analysis, with gender and education level as independent variables and a composite of variability in temperature as the dependent variable, show that perceptions of changes in temperature varied significantly among participants' levels of education, $F(2, 38) = 5.64$, $p < 0.05$. However, perceptions do not differ significantly between male and female respondents, $F(1, 38) = 0.23$, $p > 0.05$. Also, interactions effects between participant's gender and education level were not statistically significant, $F(2, 38) = 0.03$, $p > 0.05$.

Another indicator of climate change was perceptions of changes in rainfall patterns. Perceptions of rainfall variability consisted seven items, namely, the onset of rainfall has become more and more unpredictable, the cessation of rainfall has become more and more unpredictable, the frequency of occurrence of droughts has increased, the number of rainy days has decreased, the amount of rainfall has decreased, the occurrence of untimely rainfall has increased, and the intensity of rainfall has increased. Recent studies on perceptions and adaption to climate variability and change among Maasai show an increased recognition of the changing climatic trends (Bobadoye et al. 2016; Chemuliti 2015). Similar to this study, rainfall was found to be the most significant parameter through which the farmers perceived long-term changes in climate. Understandably so, because variations in pattern and intensity of precipitation affect crop and livestock productivity with direct implications on livelihoods, food, and nutrition security, perceived changes in rainfall have been variously described as insufficient, unpredictable, short and intense, delayed onset, poorly distributed, increased frequency of droughts, and prolonged drought. Among these descriptions, unpredictability of intra-seasonal factors and frequency of occurrence of extreme weather events (especially drought) were the most common parameters that farmers associated with long-term changes in climate in the past 30 to 50 years. Farmers' observations and assessments of the weather conditions correlate with precipitation data for eastern Africa which show a general decrease in rainfall in the region during the same period. (Williams and Funk 2011; Funk et al. 2010).

For each item, the respondents were asked to indicate their perceptions according to scale provided, 5 = to a great extent to 1 = not observed or experienced this at all. The mean scores of the responses are summarized in Table 1.

According to the results obtained, it is evident that Maasai people perceive that there have been changes in rainfall during the last 15 years. However, perceptions relating the specific indicator, *increases in the intensity of rainfall*, seem low. There are probable reasons to this. Intensity of rainfall generally refers to the increasing incidences of increased intensity in rainfall often over a short period of time, usually generating to huge amounts of run-offs and floods. However, while this phenomenon is readily observable using meteorological instruments, this may not register in the memory of ordinary people who may not be paying attention to the duration of outpours and intensity.

Results of a two-way ANOVA analysis on gender and education level, as independent variables and a composite of variability of rainfall as the dependent variable, show that perceptions of variability of rainfall varied significantly among levels of participant's education, $F(2, 38) = 4.65$, $p < 0.05$. However, perceptions did not differ significantly by gender, $F(1, 38) = 0.01$, $p > 0.05$. Also, interactions effects between participant's gender and education level in relation to perceptions of variability of rainfall were not statistically significant, $F(2, 38) = 0.12$, $p > 0.05$.

4 Challenges to secure their livelihoods

A common saying among the Maasai people is that "all cows belong to the Maasai people, and all grass belongs to cows". This saying underscores the importance of cattle keeping as the backbone of Maasai sources of livelihood. The Maasai community has traditionally relied largely on pastoralism for their livelihood. The Maasai people occupy arid and semi-arid (ASALs) in East Africa. Traditionally the Maasai people relied on rely on migratory strategies to cope with scarcity of pasture of water and pasture for their cattle, sheep, and goats. With plenty of lands to roam, the Maasai were able to designate low-lying areas for grazing during high rainy seasons, and relatively wet and cold mountainous areas for grazing during dry seasons (Lesorogol 2008).

Unfortunately, ASALs have been shrinking remarkably for a variety of reasons that include increased human population, urbanization, privatization, and illegal sub-division of communal ranchers (Lesorogol 2008; Kinyenze and Irungu 2016). For years, other tribes in East Africa used to regard ASALs unattractive for settlement; thus with low population, Maasai people were left to roam in these lands with their cattle. Sadly, with dramatic population growth in East Africa, and the resulting shortage of land, people from other communities have moved to settle in these marginal lands. Also, ASALs have been targets by large-scale farmers who have bought huge chunks of lands for irrigated commercial wheat and vegetable production (Galaty 1992; Lesorogol 2008, Galaty John 2016). Consequently, the pastoral land has shrunk dramatically in the recent years.

Arid and semi-arid lands are ecologically fragile ecosystems (UNDP 2013). Thus, increased moisture stress from extreme and prevalent droughts have exacerbated increased loss of vegetation cover, exposing ASALs to accelerated soil loss from wind and water erosion (UNDP 2013). This has set in motion a positive feedback with increasing demand for wood leading to more harvests, hence vulnerability to prevalent and extreme droughts, further leading to less and less capacity of land to support vegetation cover, further driving the pressure to harvest whatever is available for survival (UNDP 2013). Incidentally, the Maasai population has grown remarkably over the years ((KNBS) 2009).

From a few hundred thousand of people, the population of Maasai in Kenya today is estimated to be close to 2 million people ((KNBS) 2009). That has reduced remarkably the per capita acreage of land per Maasai household. Sadly, with little room to roam, it means the pressure on the land from grazing has increased loss of vegetation cover due to overgrazing. The forces of privatization of land have further accelerated increased loss of Maasai land from illegal land sub-division. Weakening cultural and traditional values among the Maasai are partly to blame for this negative trend (Molua and Kagwanja 2015). Land in Maasai community was traditionally held under communal tenure systems. However, with land privatization, cartels have poured money, and Maasai men, unable to resist the temptation, have resulted in the sale of communal land, often without their wives' and children's knowledge, often leading into landlessness and squatters (Kinyenze and Irungu 2016). Corruption and poor governance of the land sector in Kenya have also contributed to this illegal land sub-division (Molua and Kagwanja 2015).

Urbanization especially in Narok and Kajiado counties in Kenya has also driven up land prices. With little land for urban expansion, the communal land on the urban fringe has been targeted by land developers often offering amazingly huge sums of money (Mwangi 2005; Kinyenze and Irungu 2016). Today, much of the runaway huge Chinese enterprises and establishment in East Africa is thriving on land that was traditionally designated as Maasai

communal land. Although recently, there have been claims suggesting that that climate change is forcing a shift in the sources of livelihood for the Maasai people, there seems to be little empirical evidence on this (Mutsotso et al. 2015). In one of the leading print media paper, Muiruri (2017) featured an article titled "livestock giving way to crop farming in Maasailand: vanishing pastures, caused by severe drought forced this pastoralist community to rethink its options in the face of dwindling fortunes"; the author claimed that Maasai people were shifting to crop farming to cope with the effects of climate change. However, findings from interviews with 50 randomly selected respondents summarized in Table 2 do not suggest crop farming to be an attractive way of coping with droughts among the Maasai.

Data for Table 2 was obtained by asking Maasai rural households to what extent households had considered the measures mentioned as ways of coping with prevalent and extreme droughts. Responses were ranked according to scale 5 = to a great extent to 1 = not considered this at all.

Keeping camels and donkeys are ranked lowest among the options that the Maasai people are pursuing to cope with droughts. Interestingly, water harvesting, reducing number of cattle, and adopting fodder and hay are still ranked highly among the ways of coping with drought. Pursuing small business is ranked fourthly among coping strategies.

5 Conclusions

This paper describes trends on climate change in the drylands of Kenya and focused on a case study from the Maasai. There were various financial (e.g., limited funding for the study and for the stays in the field), logistical (problems related to travel and access to the Maasai areas), and cultural differences seen in the undertaking of study, which reflect the difficulties seen in performing climate-related field research in Africa. Nonetheless, the information gathered and presented on this paper provides a welcome addition to the knowledge on the impacts of climate change on indigenous groups in Africa and offers valuable insights into the mechanisms they use to adapt.

As this paper has tried to illustrate, the studied problem, namely the impacts of climate change to the dryland areas of Eastern Africa are strong, and many rural populations have been

Table 2 Maasai households' coping strategies with prevalent and extreme droughts (n = 44)

Item strategy for coping with prevalent and extreme droughts	Mean score
Start water harvesting and storage for livestock	4.61
Make arrangements for fodder/hay	4.11
Reduce the number of cattle	3.89
Shift from keeping cattle to small businesses	3.60
Shift from cattle keeping to crop farming	2.93
Shift from cattle keeping to irrigated farming	2.73
Shift from cattle keeping to growing fruits/vegetables	2.48
Shift from cattle keeping to keeping goats and sheep	2.57
Shift from cattle keeping to keeping poultry	2.30
Shift from cattle keeping to beekeeping	2.00
Shift from cattle keeping to keeping camels	1.50
Shift from cattle keeping to keeping donkeys	1.41
Shift from cattle keeping to keeping pigs	1.25

Source: Authors' survey, 2017

especially affected. Among them, the Maasai have been suffering from persistent droughts and the negative impacts on their cattle herds and have implemented a variety of changes in their traditional pastoral migration patterns, which have been partly disrupted. The respondents clearly indicated that they had perceived that temperatures had increased with rainfall becoming more and more unpredictable. As a result, they have been compelled to use smaller areas of land for their cattle, and overgrazing has become a real problem.

The consequences of this trend are manyfold. One of them is the loss of traditional cultures, since the Maasai's way of life and traditional farming methods have been changing. In addition, disruptions in water cycles and intensive use of water reserves (e.g., by the diversion of scarce water resources for tourists) have been leaving the Maasai and other local people short of water.

In order to alleviate the impacts of climate change, water harvesting and storage for livestock use as well as making arrangements for fodder/hay is ranked as the most appropriate measures to deal with these impacts. Finally, as a result of the pressures posed by climate change, crop growing which could allow them to capitalize on the market for grain, and hence diversify their income, is made very difficult.

In terms of future perspectives, one of the means to address the problem may include the provision of climate services to reach the Maasai and warn them of forthcoming periods of dry spell, so they may plan. Also, a diversification of livestock as a means to ensure food and economic security could be useful, as a way for the Maasai to confront frequent droughts. By doing so, some degree of resilience may be achieved, consequently reducing their vulnerability.

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