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1 **Climate Change Responses among the Maasai Community in Kenya**

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4

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19 **Abstract**

20  
21 The impacts of climate change to the dryland areas of East Africa are especially strong,  
22 especially if it is considered that these areas have weak institutions and governance systems.  
23 Climate change has also affected many rural communities in a severe way, reducing crop yields  
24 and sometimes causing crop failure. In Kenya and Tanzania, where drylands cover over around  
25 80% and 50% of their respective land areas, rural populations have been especially affected.  
26 Among them is the tribal group of the Maasai, legendary nomad warriors, who have been  
27 suffering from persistent droughts and the negative impacts on their cattle herds. This paper  
28 describes how climate change affects the Maasai communities in Kenya, and the changes seen in  
29 their habits and diet, in order to adapt to a changing climate.  
30

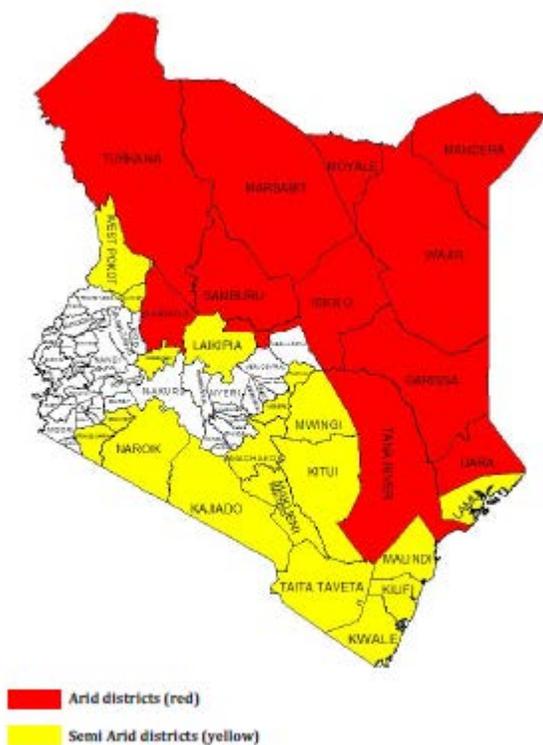
31 **Key-words: Climate change – Africa – Maasai - Adaptation**  
32

33 **Introduction and theoretical referential: climate change trends in Kenya**  
34

35 Kenya is a country located in eastern Africa, characterized by arid and semi-arid lands (ASALs)  
36 which cover more than 80% (Mwang'ombe et. al., 2011) of its total land area. Semi-arid areas are  
37 often vulnerable to climate change because they are already climatically stressed with high  
38 temperatures, low rainfall and long dry seasons (New, 2015). These zones exhibit ecological

39 constraints which set limits mainly to nomadic pastoralism. This is because the areas are  
40 characterized by low erratic rainfall, periodic droughts and different associations of vegetative  
41 cover, soils and high rate of potential evapotranspiration (Zwaagstra, 2010). Moreover, weeds  
42 grow more vigorously than cultivated crops and compete for scarce reserves of moisture. Weeds  
43 also pose a great challenge to rehabilitation programmes in the ASALs as they compete with sown  
44 grasses for the available soil nutrients and limited soil moisture in the semi-arid environment  
45 (Mganga et al., 2010). Other constraints in the region include low organic matter levels (Githae et  
46 al. 2011), except for short periods after harvesting or manure applications; and highly variable  
47 responses to fertilizer. Figure 1 shows the arid and semi arid areas of Kenya

48



49

50 Figure 1 Arid and Semi arid areas of Kenya (Source: GoK, 2012)

51 The theoretical reference of this paper bears in mind a variety of publications (e.g. IPCC 2014,  
52 Leal Filho 2015) and studies (e.g. World Bank 2013) which have shown that the African continent  
53 will be the most hit by impacts of climatic change. Kenya has not been spared with over the past  
54 decades having faced extreme climatic events especially floods and droughts. Since climate change  
55 policy-making in Kenya is slow, and its implementation is irregular (Njoroge, Ratter, Atieno,  
56 2017), the country faces a rather big challenge in coping with problems such as drought.

57 Historical data shows that major droughts occur about every 10 years with moderate droughts or  
58 floods occurring every three to four years (AEA Group, 2008a). This has led to loss of human lives  
59 as well as costing the government approximately 8.0 per cent of GDP every five years (AEA  
60 Group, 2008b). Interestingly, studies have shown that there has not been significant change in  
61 maximum and daily maximum temperatures since 1905. However, there has been significant rise  
62 in daily minimum temperatures (Christy and McNider, 2009). According to McSweeney (et al.  
63 2009) mean annual temperatures have increased by 1.0°C since 1960. This is an average rate of  
64 0.21°C per decade. It is also noted that, both the average and maximum temperatures are likely to  
65 increase in the range of 1-3 °C by 2050s (SEI, 2011), 1 °C by 2020s and 4°C by 2100 (AEA Group,  
66 2008a). Depending on the scenario, under high emissions, mean annual temperature may increase  
67 by 4.5 °C between 1990 – 2100 (WHO, 2016). In coastal region, it has become warmer with  
68 cooling near the large water bodies between the year 1961 – 1993 (Mwanga, 2015, NCCRS, 2009).  
69 This has led to depletion of glaciers in Mount Kenya (IPCC 2007, UNEP, 2009, NCCRS, 2009).  
70 However, according to Funk (et al., 2010), the projected warming will vary from one County to  
71 another.

72 The short rains have become wetter (October – December) (GoK, 2010) with overall decrease in  
73 mean annual precipitation (AEA Group, 2008a; Funk et al., 2010). Five out of seven models show  
74 an increase of rainfall from month of March to May in Wajir County in Northern Kenya (Bowden  
75 et al (2005), SEI, 2011). However, different models have mixed results for increase or decrease of  
76 precipitation between December and January, with a tendency of early rainy season in September  
77 and October (SEI, 2009). Overall, many models indicate probability of heavy rainfall and increase  
78 of flood risks (AEA Group, 2008a; SEI, 2009).Seventeen percent of Mombasa area may be  
79 submerged by 30cm sea rise by 2100 (Orindi and Adwera, 2008).

80  
81 Indigenous peoples of Kajiado County have lived within these constraints for centuries. Just like  
82  
83 other indigenous peoples in Kenya Masaai community are mainly pastoralists who are mostly  
84  
85 confined predominantly in the arid and semi-arid regions of the country (Hughes,2006). They  
86  
87 have existed on the productivity provided locally and have used their knowledge to devise  
88  
89 coping and adaptive strategies. One of these coping strategies is use of sand dams (Opiyo et. al.,  
90  
91 2011).  
92

93 Keeping large herds of cattle has been the culture of the Maasai community as it associated with  
94 wealth (GoK, 2007b). However, with diminishing grazing land, Maasai have adjusted the number  
95 of their herds (Butt et al. 2009) while embracing the expansion of grazing land. Expansion of  
96 grazing land is accompanied by conflicts as well as instances of violence among the grazing groups

97 (Maasai Chief 2011; Maasai Elder 2011). In extreme occasion, the community practice regional  
98 raiding in order to secure watering and pasture points, as well as slaughtering their animals when  
99 there is no folder (Schilling and Remlinga, 2014).

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

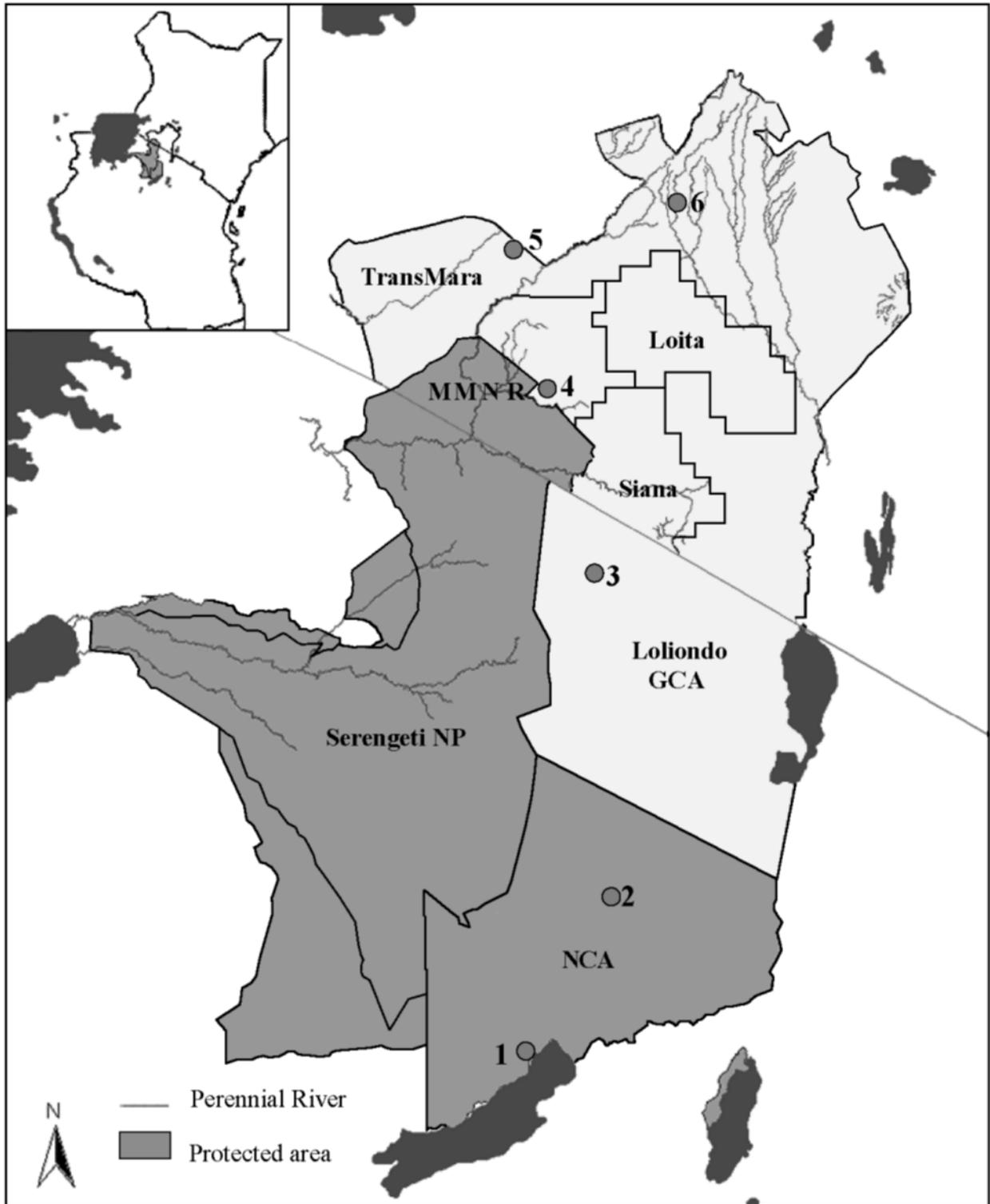
102

### 103 **Approaches used amongst Maasai agro-pastoralists in East Africa**

104 The Maasai are a Nilotic ethnic group, whose population is estimated to be about 15 million.  
105 They have traditionally inhabited the rangelands that straddle across the southern part of Kenya  
106 and northern part of Tanzania (see Figure 2) (Galvin et al., 2004; Homewood, 2004 ), along the  
107 Great Rift Valley, distributed over a total of 16.000 km<sup>2</sup> of semi-arid and arid lands. The Maasai  
108 society is comprised of sixteen sections (known in Maasai as Iloshon): Ildamat, Ipurko,  
109 Ilkeekonyokie, Iloitai, Ilkaputiei, Ilkankere, Isiria, Ilmoitanik, Iloodokilani, Iloitokitoki, Iarusa,  
110 Iimatatapato, Ilwuasinkishu, Kore, Parakuyu, and Ilkisonko, also known as Isikirari (Tanzania's  
111 Maasai) (Maasai Association 2017). The majority of the Maasai populaton lives in Kenya.

112 Maasai agro-pastoralists have in the past been able to successfully discern and track climate  
113 variability and employed a diversity of adaptation strategies to secure their livelihoods. The  
114 strategies included, for example, transhumance and migration; herd splitting and keeping species  
115 specific herds. These activities were interspersed with minimal cultivation (Galvin, 2001;  
116 Homewood et al., 2009). Increasingly, most of these adaptation strategies have become  
117 untenable due to major demographic, economic and environmental changes that have taken or  
118 are taking place within the ecosystem (Ekaya, 2005; Homewood et al., 2009; Musimba and  
119 Nyariki, 2003; Wangui, 2008). A rapid expansion of human population, shift in livelihoods from  
120 agro-pastoralism to more sedentary mixed crop-livestock production, change in land tenure from  
121 communal to individual, destruction of natural vegetation and soil degradation, are some of the  
122 changes that seriously threaten the ability of Maasai agro-pastoralists to cope and adjust to  
123 climate change. Furthermore, the nature of climate variability currently being experienced has  
124 changed. The magnitude of variability, frequency of extreme weather events (floods and  
125 drought) and rate of change within climate systems has exacerbated the situation. (Dessai and  
126 Hulme 2003; Hulme 2003).

127 Maasai agro-pastoralists like other smallholder farmers across sub-Sahara Africa are highly  
128 diverse and heterogeneous (Tittonell et al, 2011). Much of the heterogeneity is caused by spatial  
129 variability in climate, soils, landscape and their interactions with complex socio-economic and  
130 environmental conditions. This heterogeneity influences farmers' decisions and choice of  
131 adaptation options to climate variability and change. A wide array of coping and adaptation  
132 strategies have been reported across sites within the Maasai ecosystem. Change in crop variety in  
133 favor of drought tolerant and disease resistant types, early land preparation, early and staggered  
134 planting, crop rotation, destocking, breed improvement and diversification of livestock to include



135

136 Source: Homewood et al., 2004.

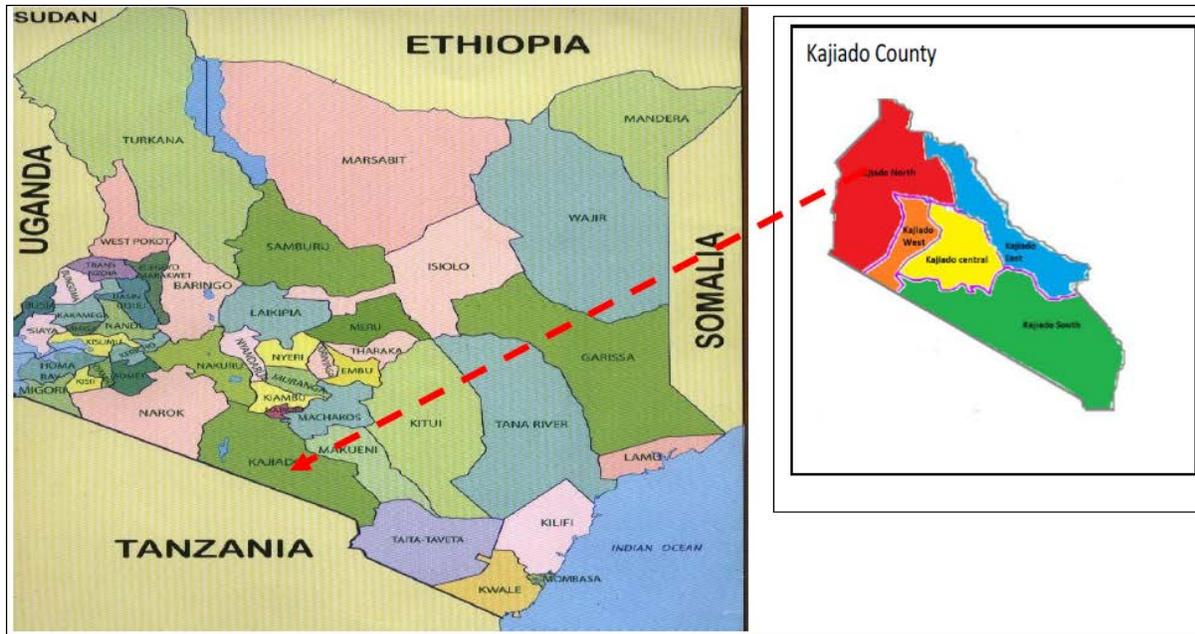
137 Figure 2: The Tanzania/Kenya border showing the East African rangelands

138 non-traditional livestock species has been documented (Bobadoye et al., 2016; Chemuliti et al.,  
139 2015). For example, in Kajiado County in Kenya, camels were introduced as a means of  
140 mitigating the devastating impacts of prolonged drought (Bukachi et al., 2003). Migration and  
141 diversification of livelihoods has also been used to spread the risk of climate-induced  
142 catastrophes on livelihoods (Yanda and Williams, 2010; McCabe et al., 2014, Rufino et al,  
143 2013).

144 In many parts within of Maasai land, farmers have diversified from traditional livelihood  
145 activities of livestock keeping and crop cultivation into various income generating enterprises  
146 including for example, bee-keeping, farm forestry (exotic fast-growing species), artisanal  
147 mining, off-farm wage employment mainly in the informal sector and small business. Most of  
148 these adaptations are occurring autonomously with very minimal support from government and  
149 policies but clearly transcend the climate dimension (Vermuelen et al., 2008; Ziervogel et al.,  
150 2008; Berrang-Ford et al., 2011). For example, the reduction in herd size may be correlated to  
151 subdivision of the previously communal land or breed improvement may be profit- driven rather  
152 than a response to the changing weather pattern. The entwined nature of disturbances and  
153 change-inducing factors in livelihoods cannot be ignored and is widely recognized in the  
154 literature (Campbell, 1999), including attempts to disaggregate the effects and show their  
155 linkages (Blaikie and Brookfield, 1987). Adaptation to climate change occurs alongside other  
156 livelihood pressures and therefore cannot be easily disaggregated. However, it is important for  
157 climate change to be recognized as a significant factor, and for the subtle dimensions of climate  
158 parameter change, which are the experienced realities, to be understood and reacted to.

## 159 **Methodology**

160  
161 The study was carried out in selected villages in Kajiado County in Kenya. Kajiado County borders  
162 Nairobi County to the North and Tanzania to the South. The county is also predominantly inhabited  
163 by Maasai whose main source of livelihood is pastoral with few being agro-pastoral (GoK 2007b;  
164 Maasai Chief 2011; Maasai Elder 2011, Nyariki et al. 2009). The County is located between  
165 longitudes 36°5 and 37°5 and latitudes 100 and 300 South (Amwata, 2013). Figure 3 shows the  
166 map of Kajiado County.  
167  
168



169  
170 Figure 3 Location of Kajiado County in Kenya.

171  
172 Data in the study area was collected primarily through 50 randomly selected respondents. Thus  
173 fifty (50) household questionnaires were administered between January 2017 and March 2017.  
174 The households selected were of Masaai community involved majority in pastoralist. A two-way  
175 analysis of variance, percentage analysis and Garrett ranking technique were applied to a set of  
176 primary data collected from 50 randomly sampled farmers with the aid of questionnaires from  
177 Kajiado County.

178  
179  
180 **Results and Discussions**

181  
182 **An empirical assessment of perceptions of climate change among the Maasai**

183  
184 The Maasai people perceive climate change as one the greatest threats to the livelihood. When  
185 asked about the three top threats, a frequent response was drought and famine, inadequate  
186 pasture, inadequate rainfall and too much sun. In fact, when asked about the number one threat to  
187 Maasai livestock keeping, majority of the respondents will mention increased prevalence of  
188 droughts. These perceptions are held across men and women alike. Results of a preliminary  
189 survey with 44 randomly selected respondents comprising 34.1% females and 65.1% males,  
190 participants were asked to what extent they perceived changes in temperature. Perceptions of  
191 temperature variability consisted four items, namely, 1) daytime temperature have increased  
192 during the last twenty years; the number of hot days has increased during the last twenty years;  
193 the number of warm nights has increased during the last twenty years; and finally, the degree of  
194 coldness or cold seasons had increased during the last twenty years. The participants were asked  
195 to indicate their perceptions according to scale provided 5 = to a great extent to 1 = Not observed  
196 or experienced this at all. The mean scores of participants' responses to each item are  
197 summarized in Table 1.

198  
199 It is apparent that majority of respondents strongly perceive that the number of hot days have  
200 increased significantly during the last twenty years. Also, majority of participants strongly  
201 perceive day time temperature to have increased during the last twenty years. Perceptions related  
202 to increase in the number of warm nights and the degree of coldness of cold seasons having  
203 increased during the last 20 years seem moderate. Maasai community rely on pastoral  
204 livelihoods, thus they are likely to notice changes in day time temperatures and also increase in  
205 the number of hot days, hence the observed results. While men spent the day time looking after  
206 cattle, sheep and goats, women, on the other hand, spent the day time looking for water for  
207 drinking and cooking. Thus, both women and men are likely to perceive changes in day time  
208 temperatures and increase in the number of hot days. Participants did not seem to perceive  
209 changes in warm nights, nor changes in the degree of coldness of cold seasons during the last 15  
210 years. There are probable reasons for this. The Maasai people, especially those who live in rural  
211 villages, still rely on traditionally grass thatched mud houses. These are usually designed to  
212 insulate people from cold nights and warm from cooking traditional three stone firewood stoves  
213 is likely to remain over nights. This may be a probable reason why respondents seemed to  
214 indicate that there were not sure if there have been changes in warm nights or degree of coldness  
215 of cold seasons.

216  
217 Results of a two-way ANOVA analysis, with gender and education level as independent  
218 variables, and a composite of variability in temperature as the dependent variable, show that  
219 perceptions of changes in temperature varied significantly among participants' levels of  
220 education,  $F(2,38) = 5.64, p < 0.05$ . However, perceptions do not differ significantly between  
221 male and female respondents,  $F(1, 38) = 0.23, p > 0.05$ . Also, interactions effects between  
222 participant's gender and education level were not statistically significant,  $F(2, 38) = 0.03, p >$   
223  $0.05$ .

224  
225 Another indicator of climate change was perceptions of changes in rainfall patterns. Perceptions  
226 of rainfall variability consisted seven items, namely, the onset of rainfall has become more and  
227 more unpredictable; the cessation of rainfall has become more and more unpredictable; the  
228 frequency of occurrence of droughts has increased; the number of rainy days has decreased; the  
229 amount of rainfall has decreased; the occurrence of untimely rainfall has increased; the intensity  
230 of rainfall has increased. Recent studies on perceptions and adaption to climate variability and  
231 change amongst Maasai show an increased recognition of the changing climatic trends  
232 (Bobadoye et al., 2016; Chemuliti et al., 2015). Similar to this study, rainfall was found to be the  
233 most significant parameter through which the farmers perceived long term changes in climate.  
234 Understandably so because variations in pattern and intensity of precipitation affects crop and  
235 livestock productivity with direct implications on livelihoods, food and nutrition security.  
236 Perceived changes in rainfall have been variously described as insufficient, unpredictable, short  
237 and intense, delayed onset, poorly distributed, increased frequency of droughts and prolonged  
238 drought. Among these descriptions, unpredictability of intra-seasonal factors and frequency of  
239 occurrence of extreme weather events (especially drought) were the most common parameters  
240 that farmers associated with long-term changes in climate in the past 30 to 50 years. Farmers'  
241 observations and assessments of the weather conditions correlate with precipitation data for

242 eastern Africa which show a general decrease in rainfall) in the region during the same period.  
 243 (Williams and Funk, 2011; Funk et al., 2008).

244  
 245  
 246  
 247  
 248

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

252  
 253

Table 1: Mean Score of Respondents Perceptions of Climate Variability Indicators (n = 44)

Item	Mean Score
Perception of Temperature Variability	
Day time temperature have 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

254 Source: Author’s Survey Data, 2017

255

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

264 Results of a two-way ANOVA analysis on gender and education level, as independent  
 265 variables and a composite of variability of rainfall as the dependent variable, show that  
 266 perceptions of variability of rainfall varied significantly among levels of participant’s education,  
 267  $F(2,38) = 4.65, p < 0.05$ . However, perceptions did not differ significantly by gender,  $F(1, 38)$   
 268  $= 0.01, p > 0.05$ . Also, interactions effects between participant’s gender and education level in  
 269 relation to perceptions of variability of rainfall were not statistically significant,  $F(2, 38) = 0.12,$   
 270  $p > 0.05$ .

271

#### 272 4) Challenges to secure their livelihoods

273  
274 A common saying among the Maasai people is that “all cows belong to the Maasai people,  
275 and all grass belongs to cows”. This saying underscores the importance of cattle keeping as the  
276 backbone of Maasai sources of livelihood. The Maasai community have traditionally relied  
277 largely on pastoralism for their livelihood. The Maasai people occupy arid and semi-arid (asals)  
278 in East Africa. Traditionally the Maasai people relied on rely on migratory strategies to cope  
279 with scarcity of pasture of water and pasture for their cattle, sheep and goats. With plenty of land  
280 to roam, the Maasai were able to designate low-lying areas for grazing during high rainy seasons,  
281 and relatively wet and cold mountainous areas for grazing during dry seasons (Lesorogol, 2008).

282  
283 Unfortunately, asals have been shrinking remarkably for a variety of reasons that include:  
284 increased human population, urbanization, privatization and illegal sub-division of communal  
285 ranchers (Lesorogol, 2008; Kinyenze & Irungu 2016). For years other tribes in East Africa used  
286 to regard asals unattractive for settlement, thus with low population, Maasai people were left to  
287 roam in these lands with their cattle. Sadly, with dramatic population growth in East Africa, and  
288 the resulting shortage of land, people from other communities have moved to settle in these  
289 marginal lands. Also, asals have been targets by large scale farmers who have bought huge  
290 chunks of lands for irrigated commercial wheat and vegetable production (Galaty, 1992;  
291 Lesorogol, 2008, Galaty 2016). Consequently, the pastoral land has shrunk dramatically in the  
292 recent years.

293 Arid and semi-arid lands are ecologically fragile ecosystems (UNDP, 2013). Thus, increased  
294 moisture stress from extreme and prevalent droughts have exacerbated increased loss of  
295 vegetation cover, exposing asals to accelerated soil loss from wind and water erosion (UNDP,  
296 2013). This has set in motion a positive feedback with increasing demand for wood leading to  
297 more harvests, hence vulnerability to prevalent and extreme droughts, further leading to less and  
298 less capacity of land to support vegetation cover, further driving the pressure to harvest whatever  
299 is available for survival (UNDP, 2013). Incidentally, the Maasai population has grown  
300 remarkably over the years (KNBS, 2009)

301  
302 From a few hundred thousand of people, the population of Maasai in Kenya today is  
303 estimated to be close to 2 million people (KNBS, 2009). That has reduced remarkably the per  
304 capita acreage of land per Maasai household. Sadly, with little room to roam, it means the  
305 pressure on the land from grazing has increased loss of vegetation cover due to overgrazing. The  
306 forces of privatization of land have further accelerated increased loss of Maasai land from illegal  
307 land sub-division. Weakening cultural and traditional values among the Maasai are partly to  
308 blame for this negative trend (Molua. & Kagwanja, 2015). Land in Maasai community was  
309 traditionally held under communal tenure systems. However, with land privatization, cartels have  
310 poured money and Maasai men, unable to resist the temptation, have resulted in the sale of  
311 communal land, often without their wives and children knowledge, often leading into  
312 landlessness and squatters (Kinyenze & Irungu 2016). Corruption, poor governance of the land  
313 sector in Kenya has also contributed to this illegal land sub-division (Molua. & Kagwanja,  
314 2015).

315

316 Urbanization especially in Narok and Kajiado counties in Kenya have also driven up land  
317 prices. With little land for urban expansion, the communal land on the urban fringe has been  
318 targeted by land developers often offering amazingly huge sums of money (Mwangi, 2005;  
319 Kinyenze & Irungu 2016). Today, much of the run-away huge Chinese enterprises and  
320 establishment in East Africa is thriving on land that was traditionally designated as Maasai  
321 communal land. Although recently, there have been claims suggesting that that climate change is  
322 forcing a shift in the sources of livelihood for the Maasai people, there seems to be little  
323 empirical evidence on this (Mutsotso, Bikuri, & Mutsotso, 2015). In one of the leading print  
324 media paper, Muiruri (2017) featured an article titled “livestock giving way to crop farming in  
325 Maasailand: vanishing pastures, caused by severe drought forced this pastoralist community to  
326 rethink its options in the face of dwindling fortunes”, the author claimed that Maasai people were  
327 shifting to crop farming to cope with the effects of climate change. However, findings from  
328 interviews with 50 randomly selected respondents summarized in table 2 do not suggest crop  
329 farming to be an attractive way of coping with droughts among the Maasai.  
330 Data for Table 2 was obtained by asking Maasai rural households to what extent households had  
331 considered the measures mentioned as ways of coping with prevalent and extreme droughts.  
332 Responses were ranked according to scale: 5 = To a great extent to 1 = Not considered this at all  
333  
334

335 Table 2: Maasai households' coping strategies with prevalent and extreme droughts (n = 44)  
 336

Item	Mean Score
Strategy for coping with prevalent and extreme droughts	
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 bee keeping	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

337  
 338 Source: Authors' survey, 2017

339  
 340 Keeping camels and donkeys are ranked lowest among the options that the Maasai people are  
 341 pursuing to cope with droughts. Interestingly, water harvesting, reducing number of cattle,  
 342 adopting fodder and hay are still ranked highly among the ways of coping with drought. Pursuing  
 343 small business is ranked fourthly among coping strategies.

344  
 345  
 346 **Conclusions**

347  
 348 This paper describes trends on climate change in the drylands of Kenya and focused on a case  
 349 study from the Maasai. There were various financial (e.g. limited funding for the study and for  
 350 the stays in the field), logistical (problems related to travel and access to the Maasai areas) and  
 351 cultural differences seen in the undertaking of study, which reflect the difficulties seen in  
 352 performing climate-related field research in Africa. Nonetheless, the information gathered and  
 353 presented on this paper provides a welcome addition to the knowledge on the impacts of climate  
 354 change on indigenous groups in Africa, and offers valuable insights into the mechanisms they  
 355 use to adapt.

356  
 357 As this paper, has tried to illustrate, the studied problem, namely the impacts of climate change  
 358 to the dryland areas of Eastern Africa are strong, and many rural populations have been  
 359 especially affected. Among them, the Maasai have been suffering from persistent droughts and  
 360 the negative impacts on their cattle herds, and have implemented a variety of changes in their  
 361 traditional pastoral migration patterns, which have been partly disrupted. The respondents clearly  
 362 indicated that they had perceived that temperatures had increased with rainfall becoming more

363 and more unpredictable. As a result, they have been compelled to use smaller areas of land for  
364 their cattle, and overgrazing has become a real problem.

365  
366 The consequences of this trend are manifold. One of them is the loss of traditional cultures,  
367 since the Maasai's way of life and traditional farming methods have been changing. In addition,  
368 disruptions in water cycles and intensive use of water reserves (e.g. by the diversion of scarce  
369 water resources for tourists), has been leaving the Maasai and other local people short of water.  
370 In order to alleviate the impacts of climate change water harvesting and storage for livestock use  
371 as well as making arrangements for fodder / hay is ranked as the most appropriate measures to deal  
372 with these impacts. Finally, as a result of the pressures posed by climate change crop growing  
373 which could allow them to capitalize on the market for grain and hence diversify their income, is  
374 made very difficult.

375  
376 In terms of future perspectives, one of the means to address the problem may include the provision  
377 of climate services to reach the Maasai and warn them of forthcoming periods of dry spell, so they  
378 may plan. Also, a diversification of livestock as a mean to ensure food and economic security  
379 could be useful, as a way for the Maasai to confront frequent droughts. By doing so, some degree  
380 of resilience may be achieved, consequently reducing their vulnerability.

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