INDIGENOUS KNOWLEDGE ON DROUGHT PATTERN AND COPING STRATEGY AMONG THE MAASAI PASTORALISTS IN KAJIADO COUNTY, KENYA

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Abstract
Maasai pastoralists have used indigenous weather forecasting as tool for decision making, a knowledge passed down through generation. For instance, local knowledge indicators are used to determine onset of rainfall, predict drought and dry spells. It is important to understand the use of traditional weather forecasting among the Maasai pastoralist for effective climate change adaptation planning among pastoralist in Kenya. This study describes the traditional weather forecasting methods that Maasai pastoralists in Kajiado county Kenya use for pastoral planning and developing indigenous coping strategies to climate extremes. The study identified coping strategies to drought in semi-arid region of Kajiado Kenya. Data were collected through household interviews using questionnaire and focus group discussion. A total of 305 households were interviewed for the study, including four focus group discussions (FGDs) conducted separately with gender parity (of eight men and eight women) from the sampled villages. This study shows that Maasai communities keep adequate mental records of extreme climatic events and they have names for years of extreme drought for easy remembrance. The result shows that Maasai pastoralists have useful information on climatic trends, rainfall pattern and drought prediction. The various signs used by Maasai communities in Kajiado to forecast rainfall include the phenological stage of plants, movement of ants, Pattern of stars in the night and the shape of the moon, animal intestine and restlessness of animals. This study indicates that Maasai communities possess a good understanding of weather pattern of the region and they have developed coping strategies against extreme weather conditions. The communities are important stakeholders in adaptation planning and understanding their perception about extreme weather event is key in climate adaptation planning.

Keywords: *Maasai pastoralist, Indigenous knowledge, Drought, Climate extremes, Coping strategies*

Introduction

The arid and semi-arid lands (ASALs) of Kenya are most affected by climate change and its extremes (Opiyo, 2014). These areas constitute 80% of Kenya's land mass and support 70% and 25% of the nation's livestock and human populations respectively (Amwata, 2013). These regions receive an annual rainfall of around 500mm and its distribution within the seasons is usually erratic. Pastoralism is the major source of livelihood of those

living in the ASALs of Kenya. As climate change looms globally, extreme weather events have already impacted on the livelihoods of pastoralist living in ASALs of Kenya.

Maasai pastoralists in Kenya have sustained their pastoral livelihoods in the rangeland ecosystems for centuries with the help of indigenous knowledge (Kagunyu *et al*., 2016). Recent studies show that rangeland ecosystems are undergoing many changes including increased drought and rainfall variation due to climate change, higher temperatures and land use change. (Butt 2015; Archambault 2016; Bobadoye *et al*., 2019 and Boas 2022).

Maasai pastoralists have devised coping mechanisms to build the resilience of pastoral systems against these climate-related shocks and anthropogenic factors by using their indigenous knowledge. Mastering rainfall pattern is one of the adaptation strategies of Maasai pastoralist in the arid and semi-arid regions of Kenya.

Indigenous knowledge of rainfall variability and drought pattern among Maasai pastoralist is based on long term experience and familiarity with seasonal rainfall pattern in an area. Traditional weather forecasting represents an accumulation of explicit or implicit knowledge, practices and beliefs that have evolved from observation of past climatic events and environmental changes (Masango, 2010; Mosime, 2018). Individuals with traditional weather forecasting knowledge often observe changes in the environment, such as flowering and fruiting of plants, the lunar cycle, and insect behaviour, to generate early warning signs of drought and flood events and provide weather information such as rainfall patterns.

Most studies on pastoralism indicate that traditional weather forecasting is practically used for planning animal movement and farming activities (Orlove et al., 2010; Bobadoye *et al*., 2018). Studies indicate that in Kenya, traditional weather forecasting has been and is currently being used, to influence making decisions about planting dates, mating livestock, harvesting dates, etc. (Thornton *et al*., 2009; Herrero *et al*., 2016).

Studies on climate change awareness and local knowledge at the household and community levels can provide the basis for concepts and methods for assessing climate change vulnerability and adaptation strategies for pastoral livelihoods. Planning adaptation strategies for climate change requires adequate understanding of climate parameters by all stakeholders including researchers, pastoralist communities, policy makers, extension agents and the private sector.

This study therefore seeks to understand the indigenous knowledge used by the Maasai in Kajiado county, Kenya to predict and adapt to extreme climatic events. These findings will be useful for the government and policy makers for climate change adaptation planning in Kajiado County.

Study Area

The study was carried out in selected villages in Kajiado County in Kenya. Kajiado County is located in the southern tip of the former Rift valley province between longitudes 36o5 and 37o5 and latitudes 100 and 300 South (Amwata, 2013). It covers an area of 19,600Km^2 (CBS, 1981). Kajiado County is bordered by Tanzania to the south, Taita Taveta County to the east, Narok County to the west and Nakuru, Kiambu, Nairobi and Makueni Counties to the north. The county is divided into five administrative

sub counties: Kajiado West, Kajiado North, Kajiado South, Kajiado East and Kajiado Central. It is also divided into four eco-zones: the Rift valley, the upland Athi Kapiti Plains, the Central Hills and Amboseli Plains. Field study was conducted with communities in Kajiado East sub-County. The sub-County has five administrative wards (Oloosirkon/Sholinke, Kitengela, Kapetui North, Kenyawa-Poka and Ilmaroro). Kajiado East has a land size of 2,610.30sq.km and the major towns include: Kitengela, Isinya, Emali and Imaroro.
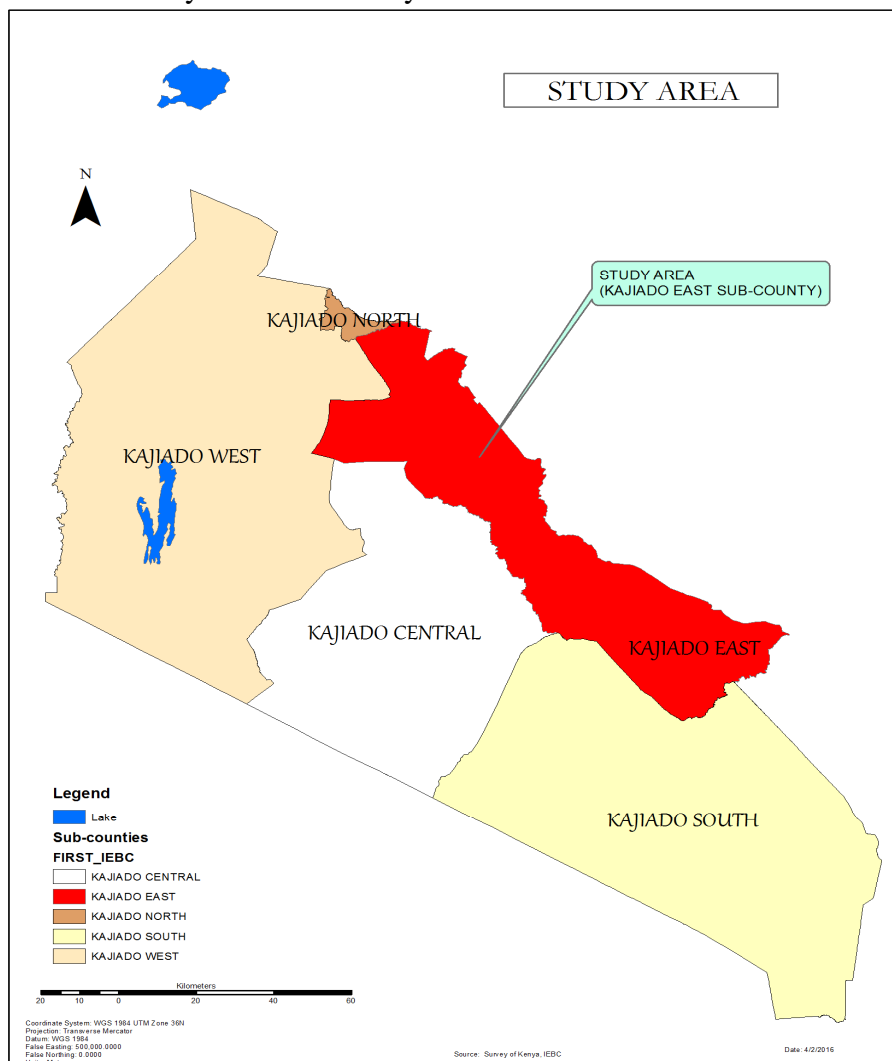

Fig. 1: Map of Kajiado County in Kenya showing the five sub counties

Data Collection

The field study was conducted in selected villages in Kajiado County. Kajiado County was purposively selected because it is one of the arid and semi-arid lands in Kenya which is prone to extreme climatic events especially drought and dry spells. It also has high population of Maasai who practice pastoralism as their main source of livelihood and are affected

by the negative impact of climate change and its extremes.

Data were collected through household interviews using questionnaire and focus group discussion. A total of 305 households (table 1) were interviewed for the study. A total of four (4) focus group discussions (FGDs) were conducted separately with a gender parity (of eight men and eight women) from the sampled villages. The pastoralists that participated in the FGD were selected with the help of the local leaders. Participants in the focus group discussions were household heads selected based on the number of years they have spent in the location and their main source of livelihood which is pastoralism.

Table 1: Distribution of sampled villages in each ward in Kajiado East

Wards	Villages sampled and number of questionnaires sampled per village	Total number of household sampled per ward
Kaputie North	Emampariswai (4), Enkileele (3), Enkirgirri (3), Ilkiushin (3), Ilpolosat (5), Isinya (8), Kekayaya (5), Kisaju, (8), Lenihani (3), Noosuyian (3), Ntipilikuani (3), Olepolos (3), Olkinos (3), Olmerui (5), Oloshaiki (2), Olturoto, (6), Ormoyi, (4).	69
Kitengela	Embakasi (8), Enkasiti (8), Kepiro (6), Kitengela (8), Korrompoi (7), Mbuni (7), Nado Enterit (5), Naserian (8), Nkukuon (5), Olooloitikoshi (5)	67
Sholinke	Embakasi (6), Enkutoto o mbaa (9), Kware (8), Nkukuon (6), Olooloitikoshi (9), Oloosirikon (8), Sholinke (6)	56
Kenyawa Poka	Arroi (8), Esilanke (5), Kenyawa (6), Kibini (4), Mashuuru (5), Noompaai, (6), Olgulului (5), Oltepesi (8), Poka (4), Sultan (5)	55
Imaroro	Arroi (4), Imaroro (4), Konza (6), Mbilin (6), Oibor Ajijik (4), Olekaitoriori (10), Olgulului (8), Oloibor Ajijik (7), Oltepesi (7), Wulu (8).	57`

Data Analysis

The data obtained from this study was analyzed using both qualitative and quantitative approaches. Data collected from household survey on household characteristics, perception and adaptation strategies of Maasai pastoralist to extreme weather events were also analyzed using descriptive statistics and presented in tables. Qualitative data analysis involves the ability to construct a coherent and explanatory account from data. This requires the ability to turn raw data into something that promotes understanding and increase knowledge that can be viable basis for transformation. Qualitative data collected in this study from focus group discussions on perception of Maasai pastoralist on climate change and timeline analysis of climate events were coded and analyzed using NVIVO statistical packages.

Results and Discussion
Demographic Characteristics of Respondents in Each Ward

The demographic characteristics of each administrative ward in Kajiado east is presented in Table 2. Average age of household head ranges from 53years in

Imaroro to 56.8 years in Kenyawa-Poka. The table shows that the wards have similar average household size with Kitengela having the highest household size of 8, followed by Imaroro 8, Kaputei North has 7 members, Kenyawa-Poka has 7 and Sholinke has the least with 7 members. Amwata (2013) reported an average household size of 5 members in a study conducted in Kajiado County. Kenyawa-Poka ward had the highest average land size of 180.3Ha; Imaroro had an average land size of 127.4Ha; Sholinke

had an average of 88.5Ha; Kaputei North 84.5Ha and Kitengela had the least average land size of 60.3Ha. This concurs with the findings of Amwata (2013) that land subdivision and increased sales of land around Kitengela have reduced land available for pastoralism and agro-pastoralism. GOK (2013) also reported that Kenyawa-Poka has the largest land size of 1,340.4sq.km, followed by Imaroro 790.90sq.km and least for Kaputei North 88.70sq.km.

Table 2: Demographic characteristics of respondent in each ward

Ward	Average Age of HH (years)	Average Household size	Average Land owned (Ha)
Kaputie North	55.9	7	84.5
Kitengela	55.5	8	60.3
Sholinke	53.8	8	88.5
Kenyawa-poka	56.8	9	180.3
Imaroro	53	7	127.4

Perceptions on Extreme Climatic Occurrence in Kajiado County

Local knowledge of rainfall variability is based on long term experience and familiarity with seasonal rainfall pattern in an area. Pastoralists living in arid and semi-arid lands of Kenya are particularly vulnerable to climate induced stress due to over dependence on climate sensitive livelihood activities.

Focus group discussion participant agreed that rainfall is reducing and there is an increase in drought and dry spell occurrence in Kajiado county. They agreed with one of them who said that:

> "Although Maasai are known worldwide as pastoralists, however, the rate at which drought and dry spell is increasing and also the continuous selling and fencing of land will most likely lead to the end of pastoralism in Kajiado County within the next 20years."

The perception of Masaai pastoralist on years of extreme climatic occurrence shows that drought and dry spell is the major climatic challenge faced by pastoralist in Kajiado County. The results in table 3 revealed that the Maasai observed extreme drought in ten (10) years (2014, 2011, 2009, 2005, 2000, 1994-1996, 1990-1991, 1984, 1981-1980, 1976) from 1976 and 2013. The result showed that drought occurrence is increasing in Kajiado County in recent years. This concurs with the findings of Opiyo (2014) who reported that drought occurrence has changed from every 8-10 years to every 2-3 years in ASALs of Kenya. Amwata (2013) also reported similar years of drought in a study conducted in the ASALs of Southern Kenya. The Findings of this study also corroborate previous observations by Hastenrath *et al*. (2011); Cook and Vizy (2013); Omondi *et al*. (2013) conducted in

arid and semi-arid lands in eastern Africa. The result also shows heavy rainfall occurred in Kajiado in 1988 and 1997 causing bumper harvest of crops and also flood in the study area. This agrees with several studies (Serigne and Verchot, 2006; SEI, 2009 and Amwata 2013) which reported occurrence of El Nino rains in 1988, 1997-1998 and 2008 which caused floods in most parts of Kenya. This finding shows the importance of indigenous knowledge in climate observation. It shows that the Maasai communities keep adequate mental records of extreme climatic events and they have names for years of extreme drought for easy remembrance. It can be deduced that rural dwellers especially farmers and pastoralists who depends on rainfall for their livelihood sustenance have useful information on climatic trends and they should be actively involved in decision making in their communities.

Table 3: Perceptions of the Maasai pastoralist on extreme climate events in Kajiado East sub-County

Year	Events	Local name of drought	Impact on people
2014	Drought		Death of livestock and starvation
2011	Drought		Loss of animals and migration of animals to national park Ambroseli and Loitokitok
2009	Drought		Death of livestock and wild animals. People moved their livestock as far as Tanzania
2005	Drought and famine	*Emperi*	Death of livestock and wildlife. Lack of grains for human
2000	Drought		Maasai were given yellow maize for food aid. Loss of animals
1997	Heavy rains (El Niño)		Bumper harvest of maize. Livestock suffered from bloat
1994-1996	Drought	*Emperi*	Livestock taken to Nairobi in search of pasture for the first time
1990-1991	Drought		Not enough grazing for livestock, Maasai women started diversifying sources of income in bead making
1988	Heavy rains		Sufficient pasture for animals and flood
1984	Drought	*Engunememasi Kiroi*	East Coast fever (*Oldikana*) outbreak. Maasai were given yellow maize for the first time as food aid. The drought was called the drought of the yellow maize
1980 -1981	Drought		People starved and livestock died
1976	Drought	*Oloik*	Starvation and death of animals

Traditional Rain Forecasting among Maasai Pastoralists

Communities have over the decades used various signs to predict the onset of rainfall. According to Amwata (2013), rural communities in Kenya forecast rain using traditional indicators such as wind, moon, stars, birds, insect, animals, plant clouds and lightning patterns. The ability of Luo communities of former Nyanza

province to predict rainfall was also reported by Ogallo (2004). He noted that these communities use plant phenological stages, position and direction of wind, movement of rain cloud and frequency of a westerly driven swarm of insect as indicators to predict onset of rainfall.

Various signs have also been used by Maasai communities in Kajiado to forecast rainfall. The phenological stage of plants is one of the most commonly used signs by Maasai communities to forecast rainfall. The Maasai communities also use their closeness to wild animals to predict rainfall. They observe migratory pattern of some animals to forecast onset of rainfall. They also use sounds from animals such as Lion and Ostrich to predict rainfall. Other indicators used by Maasai pastoralist to forecast rains are as reported in the focus group discussion include:

1. Movement of safari ants: The Maasai especially the women use the direction of movement of safari ants to predict rain.
2. Animal intestine: The Maasai elders can use the shape and colour of the intestine of a slaughtered cow or goat to predict rain or drought for that season. If the colour of the intestine is black, it means there will be drought.
3. High temperature: intense heat especially in the night is a sign that the rainy season will start in a few days.
4. Pattern of stars in the night and the shape of the moon: The Maasai elders also use pattern of stars and the shape of the moon to predict onset of the raining season.
5. Restlessness of animals: The Maasai use restlessness of animals such as giraffes and Zebras to forecast rainfall.

Coping Strategies to Climate Change and Variability

Maasai pastoralist communities in Kajiado County over the years have developed strategies of coping and adapting to climate change and it's extreme. Several research has provided critically important insights into pastoralist adaptation strategies (Napogbong *et al*., 2021; Volpato and King 2019; Opiyo *et al*., 2015 in ASAL in Kenya. Respondents in this study agreed that increase in frequency and magnitude of extreme climatic events is increasing their vulnerability to these extreme climatic events. This study revealed the different strategies used by Maasai pastoralist to adapt to climate change and its extremes. Table 4 summarizes the coping strategies and the percentage of household using the adaptation strategies in the study area. Migration in search of pasture (79%), Destocking (68%), buying of hay (60%), livelihood diversification (74%), table banking and self held group (55%) were some of the strategies identified by respondent. Other strategies identified by the households include Harvesting of wild fruit, slaughtering of weak animals, diversification of herds, sending children to school and rain harvesting.

Table 4: Coping Strategies to Climate Change

S/N	Coping strategy	% of household
1	Migration	79
2	Destocking	68
3	Buying hay	60
4	Paddock grazing	55
5	Diversify livelihood (employment, bead making, tourist guide)	74
6	Table banking and self-help group	55
7	Irrigated farming using borehole	25
8	Selling of land	27
9	Rain harvesting	35
10	Sending children to school	63
11	Tree planting	39
12	Building dams	23
13	Greenhouse farming	8
14	Diversification of herds	58
15	Animal health training	54
16	Food aid	38
17	Slaughtering of weak animals	45
18	Harvesting of wild fruit	59

The coping strategies reported in this study aligns with several studies, Agrawal and Perrin 2009; Thornton and Manasfi 2010; Wang et al. 2013 conducted in ASAL in Kenya. Adaptation strategies reported in these studies include (i) mobility, e.g. movement of livestock and/or people; (ii) diversification, e.g. diversifying subsistence- and income opportunities, or livestock and crop types; (iii) storage, e.g. storage of food, water, and seeds; (iv) communal pooling, e.g. shared access to resources across households; and (v) market exchange, e.g. increased use of market mechanisms to exchange products and services.

Conclusion

Understanding knowledge of Maasai Pastoralist to climate change and their coping strategies is important in planning effective adaptation strategies to minimize the effect of extreme climatic conditions and maximize the available opportunities. Rural communities over the years have developed indigenous methods of predicting climate trends. They also have useful information about climatic trends and occurrence of extreme climatic events such as drought in their communities. This study shows that Maasai communities perceived increase in frequency of drought in recent years and are developing coping strategies to reduce the impact of extreme weather conditions. The communities are very important stakeholders in adaptation planning and understanding their perception about climate change and variability is important in climate adaptation planning.

References

Agrawal, A. and Nicolas, P. (2009). Climate adaptation, local institutions and rural livelihoods. Adapting to climate change: Thresholds, values, govern- ance, 350–367. New York: Cambridge University Press.

Amwata, D.A. (2013). The influence of climate variability and change on Land–use and Livelihoods in Kenya's Southern rangelands. A PhD thesis submitted to the Department of Land Resource Management and Agricultural Technology, University of Nairobi.

Archambault, E. (2016). Scientific Output and Collaboration of African Countries: A Bibliometric Analysis. Montreal: Science-Metrix Inc.

Boas, M. (2022). Biosecurity in Fragile States: Challenges and Governance in Sub-Saharan Africa. *African Security Review*, 31(2): 129–145. https://doi.org/10.1080/10246029.2022.2053040

Bobadoye, A.O., Ogara, W.O., Ouma, G.O. and Onono, J.O. (2018). Assessing vulnerability of Maasai Pastoralist in Kenya to climate change and Variability. *International Journal of Agricultural and Environmental Science*, 3(6): 97-107.

Bobadoye A.O., Bobadoye B.O., Adio. A.F. and Adewoye, R. (2019). Assessment of Meteorological drought using Standardized Precipitation Index (SPI) in Kajiado County, Kenya. *Journal of Forestry Research and Management*, 16(1): 154-16.

Butt, R.H. (2015). Biosecurity in Africa: Challenges and Opportunities. *Journal of Health Security*, 13(3): 161–167. https://doi.org/10.1089/hs.2015.0016

CBS (1981). The 1979 population census. Ministry of Finance and Planning, Nairobi, Kenya.

Cook, K.H. and Vizy, E.K. (2013). Projected Changes in East African Rainy Seasons. *Journal of Climate,* 26(16): 5931-5948.

Hastenrath, S., Polzin, D. and Mutai, C. (2011). Circulation Mechanisms of Kenya Rainfall Anomalies. *Journal of Climate,* 24(2): 404-412.

Herrero, M., Thornton, P.K., Power, B., Bogard, J.R., Remans, R., Fritz, S., Gerber, J.S., Nelson, G., See, L., Waha, K., Watson, R.A., West, P.C., Samberg, L.H., van de Steeg, J., Stephenson, E., van Wijk, M. and Havlík, P. (2016). A review of the global consequences of climate change for biodiversity, agriculture, and ecosystems. *Environmental Science and Policy*, 61: 1–15. https://doi.org/10.1016/j.envsci.2016.02.003

Intergovernmental Panel on Climate Change (IPCC) (2022). Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press. https://doi.org/10.1017/9781009325844

Kagunyu, A., Wandibba, S., & Wanjohi, J. G. (2016). The use of indigenous climate forecasting methods by the pastoralists of Northern Kenya. *Pastoralism: Research, Policy and Practice*, 6(1): 7. https://doi.org/10.1186/s13570-016-0054-0

Masango, C.A. (2010). Biosecurity and biosafety: A neglected public health issue in Africa. *South*

African Medical Journal, 100(9): 555–556.

Mosime, F.M. (2018). Biosafety and biosecurity capacity-building in Africa: Gaps, priorities, and policy implications. In S. Enemark (Ed.), Biosecurity and Bioterrorism: Controlling Dual-Use Research (pp. 85–104).

Napogbong, L.A., Abubakari, A. and Emmanuel, K.D. (2021). Fulani herders and indigenous strategies of climate change adaptation in Kpongu community, North-Western Ghana: Implications for adaptation planning. *Climate and Development* 13(3): 201–214.

Ogallo, L.A. (2004). Traditional indicators used for climate monitoring and prediction by some rural communities in Kenya. ICPAC, Nairobi, Kenya.

Omondi, P., Ogallo, L.A., Anyah, R., Muthama, J.M. and Ininda, J. (2013). Linkages between global sea surface temperatures and decadal rainfall variability over Eastern Africa region. *International Journal of Climatology*, 33: 2082–2104.

Orlove, B., Lazrus, H., Hovelsrud, G.K. and Giannini, A. (2010). Recognitions and Responsibilities: On the Origins and Consequences of the Uneven Attention to Climate Change around the World. *Current Anthropology*, 51(3): 275–284. https://doi.org/10.1086/651242

GOK (2013). Government of Kenya. County Government of Kajiado, County Integrated Development Plan 2013-2017.

SEI (Stockholm Environment Institute) (2009). The economics of climate change in Kenya. SEI, Oxford. SEI project report. www.sei-international.org.

Serigne, T. and Verchot, L. (2006). Impacts of Adaptation to Climate Variability and Climate Change in the East African Community: A Focus on the Agricultural Sector. Nairobi: World Agro-forestry Centre (ICRAF).

Thornton, P.K., Jones, P.G., Owiyo, T., Kruska, R.L., Herrero, M., Kristjanson, P., Notenbaert, A., Bekele, N. and Omolo, A. (2009). Climate change and poverty in Africa: Mapping hotspots of vulnerability. International Livestock Research Institute (ILRI). https://hdl.handle.net/10568/2037.

Thornton, T. F. and Nadia M. (2010). Adaptation--genuine and spurious: Demystifying adaptation processes in relation to climate change. *Environment and Society,* 1(1): 132–155.

Volpato, G. and King, E.G. (2019). From cattle to camels: Trajectories of livelihood adaptation and social-ecological resilience in a Kenyan pastoralist community. *Regional Environmental Change*, 19(3): 849–865.

Wang, J., Daniel, G.B. and Agrawal, A. (2013). Climate adaptation, local institutions, and rural livelihoods: A comparative study of herder com- munities in Mongolia and Inner Mongolia, China. *Global Environmental Change*, 23(6): 1673–1683.