ASSESSING THE FLUXES AND IMPACTS OF DROUGHT-INDUCED MIGRATION OF PASTORALIST COMMUNITIES INTO URBAN AREAS: A CASE OF MARSABIT TOWN, NORTHERN KENYA

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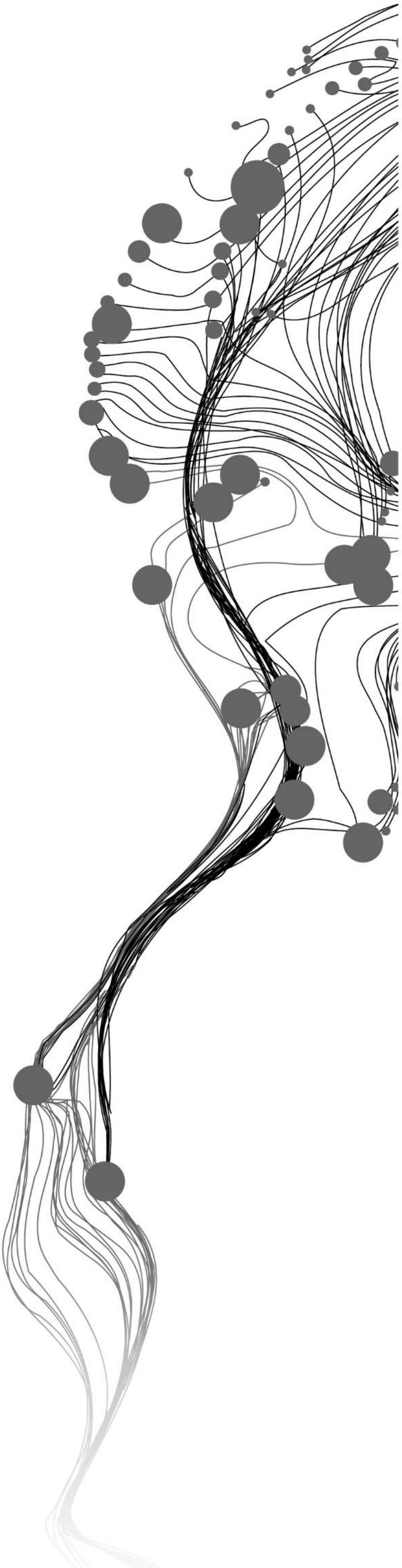

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ABSTRACT

Mass population movements into urban areas are among the key drivers of population growth and urbanization. The choice and reasons for migration are multi-casual in nature and are often voluntary. However, there is a significant number of flows which are involuntary. Environmental change, especially drought in Arid-and Semi-Arid areas, is one such factor that may perpetuate forced displacement of pastoralist communities who predominantly reside in these areas and are predisposed to erratic conditions. Persistent and more intense drought conditions cause hunger, poverty, conflict and even death which pervade their survival. These adverse impacts, coupled with other socio-economic factors push these communities out of the rural drylands into urban areas to seek alternative means of survival.

The main objective of this research was to determine whether droughts contributes to the migration of pastoralists from rural to urban areas and how their livelihood dynamics are affected in Northern Kenya. Key objectives that guided the study were; to understand the dynamics, i.e., timing, source areas and causes of rural-to-urban migration by pastoralist-drop outs who reside in Marsabit Town; to evaluate to what extent satellite-derived drought assessments may explain the dominant timings of migration of pastoralists and to understand the effects of migration on the livelihoods of migrants'. The thesis is structured as follows: Introduction; literature review; research methodology; results and discussion; conclusion and recommendations.

A combination of qualitative and quantitative methods and research instruments were designed and employed to answer the research questions. The study utilized a longitudinal and case study approach to empirically determine the pattern of change between drought (seasonal forage scarcity index) and pastoralist migration into urban areas. Firstly, primary data collection (fieldwork) in the case study area of Marsabit Town was undertaken. Semi-structured household questionnaire; gender-separate Focus Group Discussions (participatory mapping) and Key Informant Interviews were done. Second, forage scarcity index of an Index Based Livestock Insurance (IBLI) scheme was used to compare drought and migration data. To this end, an approach termed as comparative cumulative percentage analysis for migration against the current season of zcNDVI, was utilized to compare satellite-derived seasonal forage scarcity proxies and empirically derived migration data. Three z-scored cumulative NDVI (zcNDVI) time series data of GIMMS (1981-2015), GIMMS (2001-2015) and eMODIS (2001-2016) were used.

Results of this study show that there is a relationship between temporal seasonal forage scarcity indices derived from satellite time series and pastoral out-migration patterns. This study used plots of zcNDVI against cumulated migrations to test a potential relationship. Assuming normal distribution, the results revealed that more than 50 % of cumulated migrations was observed at zcNDVI below 0. i.e. for slight drought conditions, particularly when looking at the more recent time period, i.e. the more recent time-step of (GIMMS 2001-2015=52% and eMODIS 2001-2016=50%). Also, cumulative migrations for zcNDVI of current season at below -1 threshold, i.e. for serious drought conditions, results reveal the migration data to be above the expected 15.9% (GIMMS 1981-2015=18%, GIMMS 2001-2015=28% and eMODIS 2001-2016=25%). In both cases, it could be inferred that migration to urban areas was probably as a result of drought conditions. Study recommends investment in drought adaption and resilience strategies for pastoralists in rural drylands; management of migration data; protection of rights of displaced migrants.

Future research should focus on the multi-causal relationship of environmental change and migration with an increase in an interdisciplinary approach to aid in understanding of other drivers of migration, for better adaptation planning.

Key words: Drought, Fluxes, Pastoralists, Rural to Urban Migration

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1. INTRODUCTION

1.1. Background and Justification

Rural to urban migration is one of the main reasons of rapid urbanisation. Urbanization is considered by the United Nations Human Settlements Programme (2015) as a way of life-based on a process of change from rural to urban ways of living, in physical-spatial, social and economic terms. Urbanization is "the increasing share of the population living in urban areas" (Poston & Bouvier, 2010, p. 307). The New Urban Agenda acknowledges population movements into towns and cities as a critical driver of urbanisation, particularly in developing countries (UN-Habitat III, 2017). These movements are caused by a complex interplay of push factors -driving people away from the rural areas—and pull factors, attracting people to relocate to urban areas. The choice and reasons for migration are often multi-causal in nature and voluntary, although a substantial number of cases are also involuntary.

Different factors influence peoples' decision to remain or relocate from rural to urban areas. These factors range from economic to social; political to demographics; and environmental (European Union, 2015). The main environmental factors of migration identified are exposure to hazards, reduction of land productivity and inhabitability. However, existing complex interactions between economic, political and social elements are still likely to continue to cause migration regardless of environmental factors (Foresight, 2011). Environmental change may influence migration when in interaction with the economic, social and political drivers, leading to inevitably displacement and increased migration (Foresight, 2011). Consequently, migration has become a response to environmental changes mainly linked to disaster risk (European Union, 2015). Several factors may define disaster risk; the hazard event (e.g., sudden hazards such as cyclones, earthquakes or slow on-set hazards such as drought, slow-moving landslides) and the level of exposure of a large number of people located in a dangerous places and their underlying vulnerabilities (social, economic and physical state of resources) (UNISDR, 2015; Gaillard et al., 2017). Disaster risk is also influenced by specific historical contexts that are unique to a given spatial location and which inevitably shape the adaptive capacities based on unequal distribution of risk and vulnerabilities of the societies in which they occur (Fratkin, Roth, & Nathan, 2004). The Intergovernmental Panel on Climate Change (IPCC) in IPCC (2012) explains that erratic variations in the intensity and frequency of rainfall, extreme drought and flooding events, are some of the salient impacts that threaten livelihoods and may cause migration.

Climate change escalates the severity, intensity and frequency of drought. Dai (2013) noted that the recent significant increase in global surface air temperatures caused by global climate change due to increased greenhouse gas emissions are expected to aggravate future drought events. The IPCC, in the 4th and 5th assessment reports, predicted an increase in global surface temperatures of 0.3 to 4.8 degrees Celsius and associated changes in the spatial pattern of global precipitation in the 21st century (IPCC, 2014; IPCC, 2007). Thus, if global temperature continues to rise, the areal extent, severity and frequency of drought may change dramatically (Wang et al., 2018).

Drought poses a major environmental risk in many regions of the world. As revealed by data from the Emergency Event Database (www.em-dat.net), the number of drought disasters accounts for only 5% of total global disasters, but the losses can amount to 30% of the losses from all natural disasters with the agricultural sector being most affected (Wang et al., 2014). The frequency and intensity of drought events across the world have increased in the past 1000 years (Dai, 2013; Wilhite & Glantz, 1985). Historically, more extensive global climatological studies indicate an exacerbated rise of drought intensity and frequency in different parts of the world including North America, Mexico, Asia, Australia and Africa (Dai, 2011). For example, in northwest Africa and western Africa, severe and widespread droughts of the 1970s and 1980s in the Sahelian region devastated the local population, economy and the environment, mainly due to the drought being long lasting and spatially extensive (Dai, 2011).

Africa's land mass constitutes about 43 percent of drylands, and it is inhabited by about 50 percent of the population. Moreover, about 75 percent of the area is used for agriculture (Cervigni & Morris, 2016). This characteristic predisposes drought-prone Africa to experience successive unprecedented drought and exposes its population to greater drought-related vulnerabilities. Furthermore, these vulnerabilities often result in effects such as crop yield losses and damage, increase forest fires, exacerbated land degradation and desertification as well as increased competition and conflict for scarce resources (IPCC, 2007a). Between 1900-2013, Africa recorded a high number of drought events at 291: drought in eastern Africa (Horn of Africa) in 2010–2012; and in southern and southeastern Africa in 2001–2003 were recorded (Masih, Maskey, Mussá, & Trambauer, 2014). These droughts were estimated to have resulted in over 800,000 deaths, about 360 million people affected, and approximately three billion USD of economic damages (Masih et al., 2014). In addition, the International Disaster Database of the Centre for Research on Epidemiology of Disasters (CRED) reported that in Africa, over 500,000 deaths and 253 million people were affected by drought during the last 30 years (1981-2010) (Rojas, Vrieling, & Rembold, 2011; EM-DAT, 2010). More recently, in July 2011, a severe drought hit the Horn of Africa and resulted in devastating consequences. By September 2012, nearly a million people had fled Somalia to camps in Kenya and Ethiopia (UK Climate Change and Migration Coalition, 2015).

Pastoralist communities predominantly reside in dryland areas with pastoralism as the dominant land use. These communities are therefore highly exposed to drought-related risks (Epule, Ford, Lwasa, & Lepage, 2017). Livestock keeping is the primary source of livelihood and income generating activity, and as a result, drought has a negative impact on their livelihoods. Due to the increase of drought intensity and occurrences, pastoral lands are deprived of forage, leading to a reduction in water points. The absence of water exacerbates the effects of drought on forage and pasture which leads to a decline in livestock production (Adow, 2008). Subsequently, livestock herds are decimated and the remaining stock, plagued by disease and even death. For the community, negative impacts like social dislocation; lack of access to potable water; famine, malnutrition and even loss of life of pastoralists manifest (Rain et al., 2011). Additionally, food insecurity, resource conflict, water scarcity, and environmental degradation also occur (Middleton & Sternberg, 2013).

Notably, adverse impacts of climate change have led pastoral households to establish coping strategies for survival in both the long and short terms (Fratkin, 2001; Mwang'ombe et al. 2011). An essential coping strategy employed is mobility, particularly, seasonal migration whereby pastoralists go after forage and water for their livestock (Perch-Nielsen et al., 2008). Traditionally, mobility and migration have always been the prime strategy for pastoralists to adapt to drought (de Bruijn & van Dijk, 2003). Previously, pastoral communities responded to drought through not only movement, but also temporary adoption of hunting and gathering (Fratkin, 2001). They also engaged in herd splitting or merging, sale of livestock, livelihood diversification such as trade and planting of drought-tolerant crops and water harvesting (Barton, Morton, & Hendy, 2001; Fratkin, 2001). Today, increase in population, land pressure and increased frequency and intensity of droughts render traditional coping strategies ineffective. Consequently forcing pastoralist to change adaptation regimes such as migration into towns (Fratkin et al., 2004). For this reason, migration is now perceived as a coping strategy to diversify increased risk from environmental hazards.

Severe and intense drought is pushing pastoralist communities into urban areas. The destruction of pastoralists coping mechanisms has resulted in increased out-migration into cities. Fratkin et al. (2004) note that on arrival in towns, pastoralists undertake menial labour and migrate to famine relief camps. Henderson, Storeygard and Deichmann (2017) also explained that pastoral households abandon pastoralism and seek more non-pastoral trade activities in the towns. Several studies have identified a growing trend in which the increased occurrence of drought is resulting in increased adverse impacts which are changing pastoralist mobility and migration patterns. For example, in Niger, because of severe drought, the number of adult males who participated in out-migration to large West African towns rose from 35 percent in 1969-70 to 75 percent in 1973-74 (Faulkingham & Thorbahn, 1975). Also in Niger, during consistently poor drought conditions, the high level of degradation causes people to migrate for both long and short distances, some leave rural-dry lands and stop-over in surrounding local market centres with seemingly better conditions (Vag, 2009). Some leave for urban centres within the country while other are noted to leave for neighbouring countries like Libya, Mali, Chad, Cameroon and Benin in search of opportunities (Vag, 2009). According to Grolle's, (2015) study of drought in Sahelian region, he noted that in Dakar, Senegal, increased drought resulting from climate change had pushed pastoral communities towards the city. Similarly, in Kenya when frequent and extreme drought hits the drylands of Samburu County, the livelihoods of herders are affected, migration to nearby urban centres of Meru, Isiolo, Nanyuki, Nyeri, Karatina, Thika, and Nakuru follows. Further, Suckall et al. (2015) substantiate evidence of migration induced by persistent drought and slow environmental changes.

Migration is often not only a risk reducer but may also play a critical role as a risk creator (Gaillard et al., 2017). In a report by Schrepfer and Caterina, (2014), displaced pastoralists in Northern Kenya may suffer from marginalisation that eventually traps them into a vicious cycle of poverty (Barrett et al., 2006).

1.2. Research Problem

Globally, there are little evidence-based longitudinal researches that explicitly exploring the effects of environmental factors on out-migration based on quantitative multivariate methods (Morinière & Hamza, 2012). Furthermore, there is an overwhelming concentration on the possible adverse impact of environmental change on migration, but less emphasis on migration as adaptation and possible coping mechanism. A report by UNESCO (2011) notes that insufficient empirical data of historical environmental variations and migration flows is among the challenges of determining migration caused by climate change and other environmental hazards. Further, Vag (2009) iterates that information on the relationships between the processes of environmental change and migration is barely empirically-based. One important reason for this is that the needed empirical research requires a robust interdisciplinary approach and this has been missing (Vag, 2009). This much-needed empirical evidence calls for a firm interdisciplinary approach; an empirical study that investigates the spatial-temporal changes of migration patterns of pastoralist communities directly linked to drought incidences.

In a longitudinal study of the Sahelian region, Grolle (2015) emphasis is put on the need to consider that mass migrations into urban areas from the Sahelian region will happen as a result of intense droughts. Therefore, research geared towards exploring coping mechanisms, development strategies, and other socioeconomic changes that foster resilient livelihoods at a time of increasing climatic uncertainty is needed (Thompson et al., 2009; Orindi et al., 2007). Van der Geest, Vrieling and Dietz (2010) present an analysis of how vegetation dynamics assessed from a remotely sensed data affect human mobility in Ghana. The analysis established that districts with lower vegetation cover, have a more positive trend of Normalized Difference

Vegetation Index (NDVI), and more out-migration than in-migration. Another study done in Burkina Faso by Henry, Piché, Ouédraogo, and Lambin (2004) on impacts of environmental changes on migration linked national longitudinal survey data with high-resolution rainfall and land degradation data. Results suggested that environmental factors influence the out-migration probability.

Although there are studies on how drought is having negative impacts on pastoral livelihoods across East Africa, there are little evidence-based studies on whether and how drought affects the rural to urban migration decisions of pastoralists from northern Kenya. There is limited empirical research that applies multivariate methods to understand rural-urban migration caused by environmental hardship of pastoralists. Little enquiries have however been made to quantify and empirically determine the effects of drought-induced rural to urban migration of pastoralists in northern Kenya. Therefore, this research aimed to fill this knowledge gap in the case of Marsabit Town.

1.3. Research Objectives

The main objective of this study was to assess how drought contributes to rural-urban migration and livelihood dynamics of pastoralists in Northern Kenya.

1.4. Specific Research Objectives

The following specific objectives guided this research:

1. To determine the timing, source areas and causes of rural-to-urban migration by former pastoralists who now reside in Marsabit Town.
2. To quantify the extent to which satellite-derived drought assessments may explain the dominant timings of migration of pastoralists
3. To qualitatively assess the effects of migration on the livelihood of migrants.

1.5. Research Questions

The following research questions guided the above specific objectives in *Table 1-1*:

Table 1-1: Specific Research Questions and Objectives

Research Objective	Research Questions
1. To determine the dynamics, i.e., timing, source areas and causes of rural-to-urban migration by former pastoralists who now reside in Marsabit Town.	1. What are the temporal peaks of rural-to-urban migration of pastoralist communities into Marsabit Town? 2. What are the main causes of migration? 3. Where are the origin locations from which pastoralists migrated?
2. To quantify the extent to which satellite-derived drought assessments may explain the dominant timings of migration of pastoralists.	1. Can seasonal forage scarcity proxies, derived from NDVI time series, explain the temporal peaks/dominant timings of rural-to-urban migration of pastoralists?

3. To qualitatively assess the effects of migration on the livelihood of migrants.	1. What are the current livelihoods of migrant pastoralists in urban areas? 2. What is the perceived level of satisfaction/dissatisfaction of migrants' quality of life before and after migration to urban areas? 3. To what extent do migrant pastoralists remain connected to their place of origin?

1.6. Hypothesis and Anticipated Results

The study hypothesised that:

1. H_0: There is no relationship between temporal seasonal forage scarcity indices derived from satellite time series and pastoral out-migration patterns

H_1: There is a relationship between temporal seasonal forage scarcity indices derived from satellite time series and pastoral out-migration patterns

1.7. Organisation of Study

Figure 1-1 below presents the six chapters in which the research was organised:

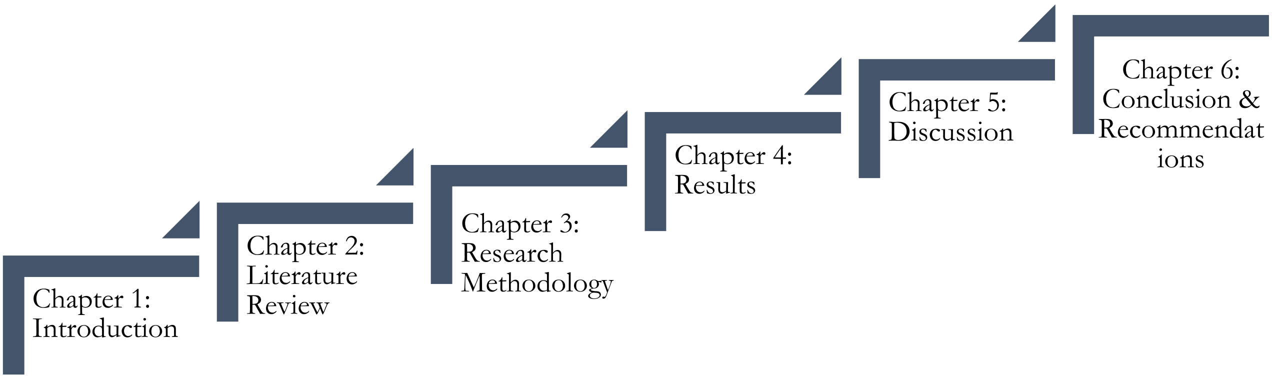


Figure 1-1: Summary of thesis structure. Source: Author.

Chapter 1: Introduction

The chapter covers; the introduction, background and justification, related studies, problem statement and research objectives and questions. It also discusses the hypothesis and anticipated results of the study, scope and organisation of the study.

Chapter 2: Literature Review

The section includes a literature review of the study which contains works on definitions, understanding and operationalisation of key concepts of the study.

Chapter 3: Research Methodology

This chapter profiles the study area, data used in the study and the research methods applied. It contextualises the case-study area and provides a detailed account of geospatial data used in this research. The section concludes with the methods designed and implemented for the research.

Chapter 4: Results

This section contains all results, including linkage of field-based migration data with the satellite-derived drought indices used. It covers aspects of research results, observations and overall field experiences and findings.

Chapter 5: Discussion

This chapter contains a reflection of the results and findings.

Chapter 6: Conclusion and Recommendations

Based on the findings from chapter two, three and four and in line with the objectives and research questions, the chapter concludes and proposes recommendations.

2. LITERATURE REVIEW

This section defines the key concepts of this research, various approaches considered. The chapter concludes with a conceptual framework.

2.1. Key concepts and definitions

2.1.1. Drought

Drought can either be distinguished between conceptual and operational definitions (Wilhite & Glantz, 1985). Conceptual definitions refer to those stated in relative terms such as a drought is a long, dry period, whereas operational drought attempt to identify the onset, severity and termination periods of drought (Mishra & Singh, 2010). Some of the commonly used definitions of drought are: i) Drought can be defined as a recurring extreme climate event over land characterised by below-normal precipitation over a period of months to years (Dai, 2011). It refers to a dry spell relative to its local normal condition (Dai, 2011). ii) According to Dalezios (2017), drought is a natural, casual and temporary state of continuous decline in precipitation and water availability in relation to normal values, spanning a considerable period and covers a wide area. iii) Drought is an extended period-a season, year or several years of deficient rainfall relative to the statistical multi-year mean for a region (Schneider, 1996). iv) It is a condition of insufficient moisture, both atmospheric and lithospheric, due to prolonged precipitation scarcity over some period (Mckee, Doesken, & Kleist, 1993). Wilhite and Glantz (1985) categorise drought as meteorological, agricultural, atmospheric, climatological, hydrologic and water management. Meteorological drought can be defined drought solely by the degree of dryness and the duration of the dry period within a given geographical location (Mckee et al., 1993). Rosenberg (1980) operationalises the definition of drought based on crop susceptible at various stages of development. Laikhtman and Rusin (1957) perceive definitions of agricultural drought in association with characteristics of meteorological drought. In this research, agricultural drought was the focus. This was based on the understanding of drought as an anomaly of poor conditions which are below-normal conditions.

2.1.2. Hazard

A hazard can be defined as "a potentially damaging physical event, phenomenon or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation. This event has a probability of occurrence within a specified period and a given area and has a given intensity" (UNISDR, 2005). Hazards can be single, sequential or combined with their origin and effects. Each hazard is characterised by its location, area affected (size or magnitude), intensity, speed of onset, duration and frequency. Dalezios (2017) provides a possible classification of hazards is natural, human-induced and human-made hazards. Further classifications of natural hazards include:

- Hydro-metrological hazards: floods, wave surges, storms, drought and related disasters such as desertification
- Geophysical hazards: Resulting from earth-surface or sub-surface, such as earthquakes, tsunamis and volcanic eruptions. Also includes geological hazards like landslides and snow avalanches.
- Biophysical hazards: extreme temperatures, frost heatwaves, forest/scrub fires as well as biological hazards related to epidemics and insect infestations.

- Human-induced hazards result from modifications of natural processes in Earth's systems caused by human activities, which accelerate or aggravate the damage potential such as landslides, soil erosion, forest fires
- Human-made hazards: Originate from industrial or technological accidents, dangerous procedures or specific human activities, which may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation, such as industrial pollution, nuclear activities and radioactivity, toxic wastes and dam failures, oil spills and fired (Dalezios, 2017)

This research focused on natural hazards and specifically, drought as a hydro-meteorological hazard.

2.1.3. Disaster

Is defined as "a severe alteration in the normal functioning of a community or society due to hazardous physical events interacting with vulnerable social conditions, resulting in widespread adverse human, material, economic or environmental effects" (Lavell et al., 2012). It is also defined as "a serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources" (UNISDR, 2009, p. 9).

2.1.4. Disaster Risk

Risk can be defined as "the probability of harmful consequences, or expected losses resulting from interactions between natural hazards and vulnerable conditions" (UNISDR, 2005). Disaster risk is "the potential disaster losses, in lives, health status, livelihoods, assets and services, which could occur to a particular community or a society over some specified future period" (UNISDR, 2009, p. 9). The interaction of physical, social, economic and environmental vulnerabilities with hazards lead to disaster risk. Disaster risk refers to as the probability of severe alterations over a specific period, of the normal functioning of a community due to hazardous physical events interacting with vulnerable social conditions, leading to widespread adverse human, material, economic or environmental effects (Lavell et al., 2012).

Disaster risk is compounded by several other factors that drive, aggravate and exacerbate hazards, which, as stated by Dalezios (2017) include: population growth; urbanisation; land pressure; climate variability and change; weak risk governance; technological innovation; global interdependence; environmental degradation and inequality. These challenges are notably higher in developing countries, threatening their sustainable development (UNISDR, 2015).

2.1.5. Drought Hazard and Disaster

Drought constitutes part of natural climatic variability that is a cumulative hazard. It develops slowly over time with several successive and long-lasting events being disastrous (Dalezios, Blanta, Spyropoulos, & Tarquis, 2014). This hazard causes loss of life (both human and animal), significant economic damage, social and physical loss and damage to property and human life. The impacts of drought concern a variety of sectors of the economy, environment and society of the affected area (Dalezios et al., 2014). Precipitation shortages affected by meteorological conditions have an impact on vegetation ability, biological characteristics, physical and biophysical properties of soil. For pastoralist communities and households who predominantly reside in drought-prone areas, these shortages related to drought hazard lead to dire consequences of which declined forage is the most prevalent. These shortages result in severe impacts on their livelihoods as they face major livestock losses, which threatens their livestock-asset base (Vrieling et al., 2016).

To monitor drought hazard, several features are usually detected through conventional and remote sensing data, methods and techniques. These are used to quantitatively distinguish the spatial and temporal variability of several features (Dalezios et al., 2014). Figure 2-1 outlines some key features of drought hazard as highlighted by Dalezios et al. (2014), mainly considered for first, understanding the concept of drought hazard and second, operationalising drought as a hazard in this research.

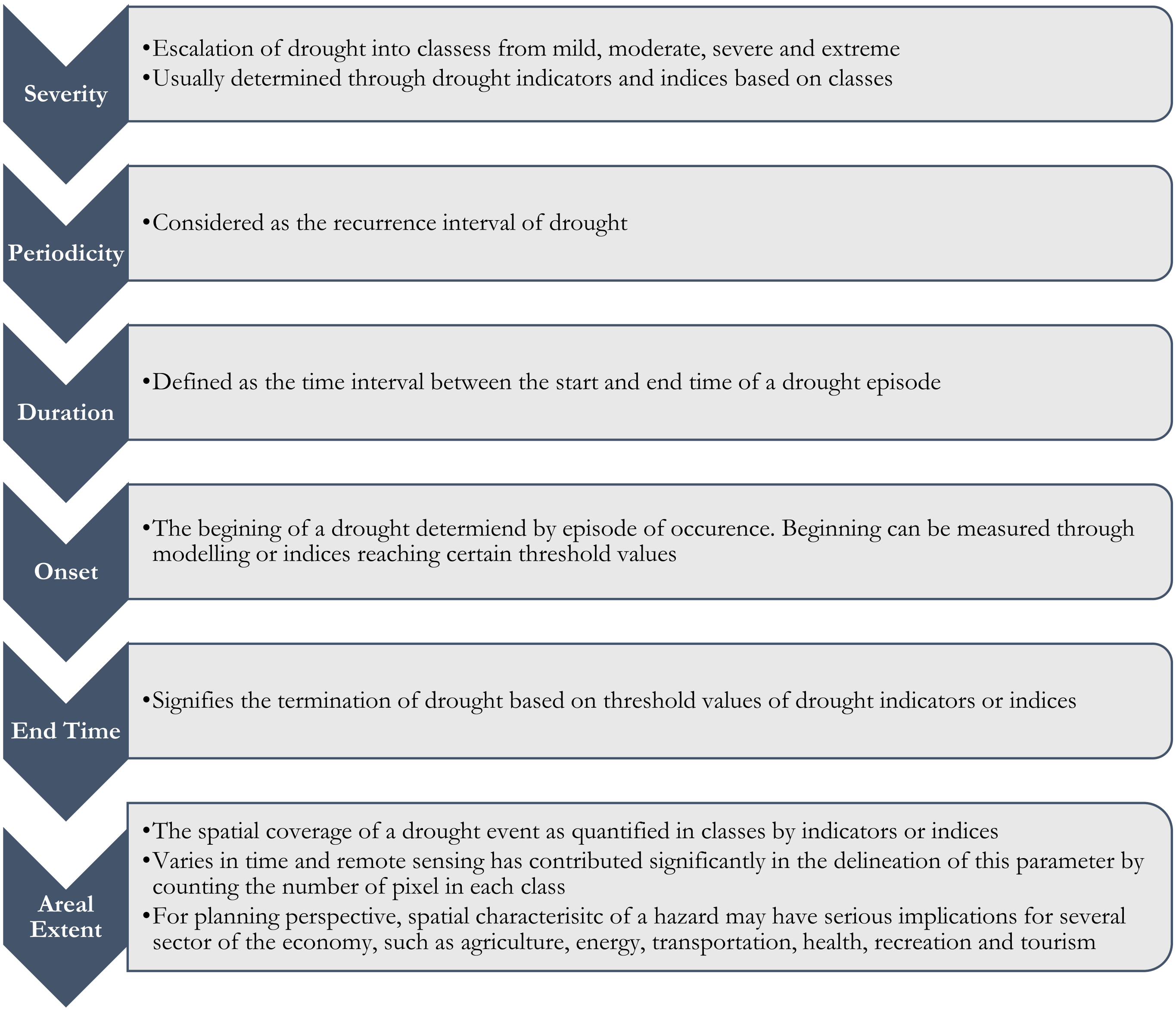


Figure 2-1: Description of some key features of drought hazard. Source: Dalezios (2017)

However, it is important to note that for this research, not all these features were used. The primary focus considered was the average severity of seasonal drought in a large areal extent, specifically, the region of Marsabit County.

2.1.6. Vulnerability

Vulnerability is among the factors that influence risk. It refers to the degree to which communities or societies are "susceptible to the damaging effects of a hazard" (UNISDR, 2009, p. 30). Vulnerability is a result of diverse historical, social, economic, political, cultural, institutional, natural resource, and environmental conditions and processes (Lavell et al., 2012). It is defined as "the propensity or predisposition to be adversely affected" (Field, Barros, Stocker, & Dahe, 2012). McLeman and Smit (2006) define vulnerability as a function of exposure and adaptive capacity in a particular time and place based on climatic stimulus. In this research, adaptive capacity was understood as espoused by Cervigni and Morris (2016) which is the ability of pastoralists communities to alleviate, through their resources or support from friends, relatives or government insitions, the impact of droughts and shocks after they occur; exposure is the degree to which people are subject to droughts and other shocks depending on where they live (Cervigni & Morris, 2016).

2.1.7. Who is a Pastoralist/Migrant?

Pastoralists

A pastoralist is a person or community engaging in economic system in which they rear, raise and herd a large number of livestock (Stidsen, 2006). "Pastoralists are the people who rely on mobile livestock rearing as the main source of their livelihood" (Nori & Gemini, 2011, p. 2). A pastoralist is also defined as "people who receive more than 50% of their income from livestock and livestock products derived from rangeland resources"(Buono et al., 2016, p. 14).

Migrant

The International Organization for Migration (IOM), in IOM (2017) defines a migrant as any person relocating or has moved across international borders or within a country away from his/her long-term place of residence irrespective of the individual's legal status regardless of; whether the relocation is voluntary or involuntary; causes of the movement; or duration of stay.

2.1.8. Environmental Migration

The Institute for the Study of International Migration (2014), identified three key types of environmental factors that could lead to different migratory responses: (a) Abruptly occurring disasters and natural hazards are the most direct causes of deaths and loss of livelihoods and can lead to mass movements of people to the nearest accommodative environment; (b) Slow occurrence of environmental degradation, especially at early stages, is habitually impermanent and can be an adaptation strategy to environmental change; (c) At progressive phases of environmental degradation, affected people usually opt for long term relocation to areas that can sustain their livelihood. Gradual and sudden changes in the environment can influence migration patterns. However, vital social, economic or political factors may also induce migration (IOM, 2007). Migration is used by human populations as an adaptive strategy to cope with adverse environmental conditions (Black et al., 2011; McLeman & Smit, 2006).

2.1.9. Environmental Migrant

The IOM proposes the following definition for environmental migrants (IOM, 2007, p. 2):

"Environmental migrants are persons or groups of persons who, for compelling reasons of sudden or progressive changes in the environment that adversely affect their lives or living conditions, are obliged to leave their habitual homes, or choose to do so, either temporarily or permanently, and who move either within their country or abroad."

Environmental displaced people are people forced to leave due to slow deteriorating environmental conditions (IOM, 2007). In this research, this definition of an environmental migrant has been understood to comprise both people who voluntarily or involuntarily choose to leave their place of residence either because of deteriorating environmental conditions or due to the occurrence of natural disasters.

2.1.10. Rural to Urban Migration

Rural to urban migration of the movement of people from the countryside to the city or urban areas. Rural to urban migration is attributed to an array of push and pull factors, however, predominantly, in a quest for improved livelihood opportunities and living conditions (Black et al., 2011). Rural-urban migration is increasing in some situations because of environmental change, and people arriving in cities are vulnerable (Foresight, 2011).

2.1.11. Pastoralist-drop out

Adow (2008) defined two forms of pastoralist-drop outs; 1) people entirely drop out of the pastoralist lifestyle and livelihood system, moving to urban centers to seek casual work or to depend on gifts from relatives; and 2) others move to the vicinity or periphery of urban centres as internally displaced people to find emergency food aid. In this study, pastoralist-drop out was operationalised to mean a pastoralist who entirely left the pastoralist way of life and livelihood system and migrated more permanently from rural drylands to urban areas in search of opportunities and better living conditions.

2.1.12. Adaptation

"The adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploit beneficial opportunities"(UNISDR, 2009, p. 4).

2.1.13. Resilience

"The ability of a system, community or society exposed to hazards to resist, absorb, accommodate and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions" (UNISDR, 2009, p. 24). Resilience can be defined as the potential of a system to remain in a particular configuration and to maintain its feedbacks and functions. The system can reorganise following disturbance-driven change when considered in a specific context (Holling & Meffe, 1996). Resilience in drylands refers to the ability of people to withstand and respond to dryland-specific shocks such as drought (Cervigni & Morris, 2016). Pastoral communities largely depend on their informal social arrangements and vibrant social networks to enhance their adaptive capacities in the face of drought (Cervigni & Morris, 2016).

2.2. Relationship between hazard, risk and vulnerability

Disaster risk is explained by an interaction of a natural weather and climate event (such as drought, fire, flood, sea level rise) with vulnerable conditions and the exposure through physical location of people, livelihoods, infrastructure socio-economic and socio-cultural assets to potential future adverse effects of harm, loss or damage (Lavell et al., 2012). In this research, this was understood as the disaster risk pastoralists face when a drought event occurs, based on their vulnerable social, economic, political, historical and human capitals leading to loss and damage of their livestock-assets, cultural way of life and even death.

Figure 2-2 illustrates the relationship between the key concepts as represented by (Lavell et al., 2012). Climate is based on natural variability as well as anthropogenic factors which are human activities that may exacerbate climate change through increase in Greenhouse Gas Emissions. The interaction of physical, social, economic and environmental vulnerabilities with hazards lead to disaster risk. Here, when weather and climate events such as drought (hazard) occur, communities such as pastoralists who reside in drylands are exposed to vulnerable conditions with the potential of losing lives, livelihoods, assets. The disaster risk turns into a disaster; it results in the spread of adverse impacts such as economic and environmental consequences which may disrupt the functioning of the affected society or community. In response to disaster risk, development planning would be required to focus on disaster risk management strategies and climate change adaptation mechanisms. The framework was used in this research for the better conceptualisation of key terms and their linkage with each other.

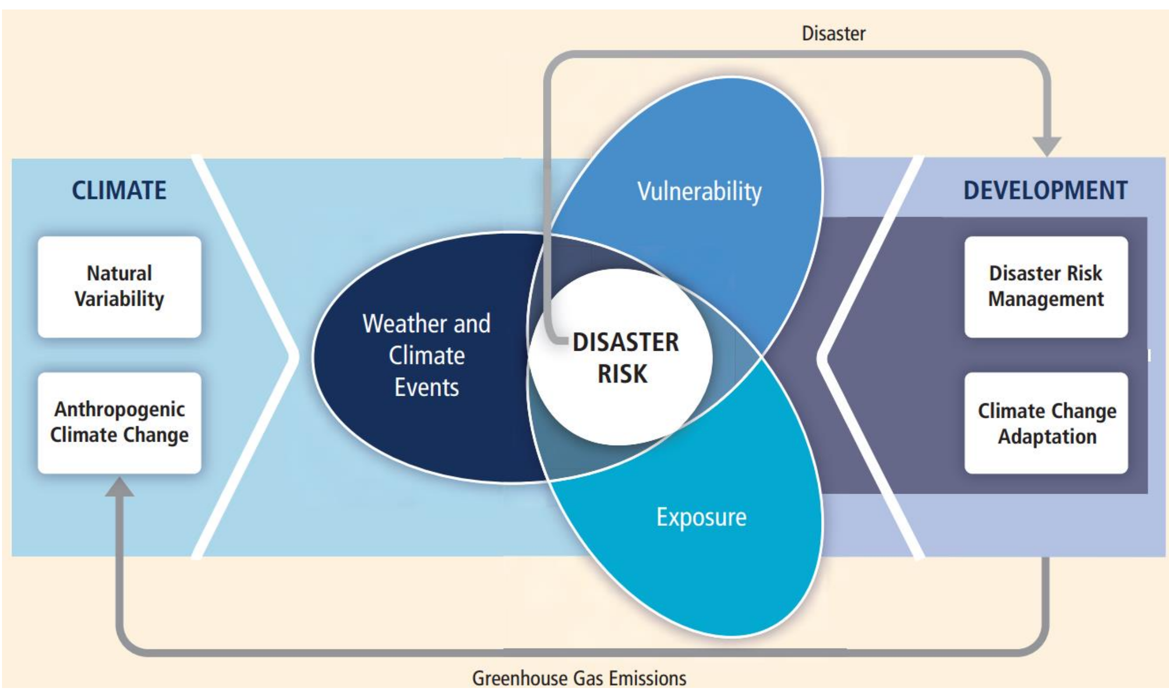


Figure 2-2: Schematic diagram of interrelationship between climate, disaster risk and development
Source: Lavell et al. (2012, p. 31)

2.3. Operationalization of Key Concepts

Based on the understanding of the main concepts discussed in *Section 2.1* above, *Table 2-1* operationalised key concepts that were used consistently in this research below:

Table 2-1: Operationalization of key research concepts. Source: Author

Concept	Element	Explanation
Drought	Drought as an anomaly. The deviations between current and past NDVI levels are used as an indication of reduced vegetation productivity as a result of drought	Seasonal forage scarcity proxies, from satellite-derived drought indices time series
Pastoralists	Community engaging in economic system in which they rear, raise and herd large number of livestock	Dominant timings of rural-to-urban migration of pastoralists
Pastoralist drop-out	People who have migrated due to poor environmental conditions	Number of rural-urban migrants who previously practised pastoralism and have since completely left the practice. They now permanently reside in urban areas
Rural to Urban Migration	Dynamics (causes, timings and locations) of rural-urban migration of pastoralist.	Number of movements of pastoralists from rural areas into urban areas based on different push and pull factors

2.4. Impacts of drought on pastoralists

Drought, especially when prolonged, may drive people beyond their coping and adapting capacity creating harmful consequences. Wilhite et al. (2007) state that disturbances in the hydrological cycle like those related to drought yield high risk to the social and economic systems of human society. Drought impacts can be understood in two-fold; Direct and indirect impacts. Direct impacts include below-normal agricultural or rangeland productivity; food insecurity; livestock mortality; reduced rural incomes/livelihoods among others. These impacts then have a ripple effect leading to indirect impacts such as poor public health, sanitation and safety, resource-based conflict, cattle rustling, migration and issues of poor quality of life (Dalezios, 2017). So as to understand how drought affects pastoral communities, it is imperative to understand their underlying livelihood systems and environmental vulnerabilities as a result of the drought-prone regions in which they reside. The scarcity of water resources and the resultant depletion of vegetation quality and quantity directly impacts on the livelihoods of pastoralists (Sommer, 1998). Livestock products of milk and meat significantly reduce causing livelihoods to eventually become insecure for these communities who largely depend on these bi-products for income. These adverse effects eventually lead to death and decimation of livestock, which leads to hunger of pastoralist and their household needs (Orindi et al., 2007). Moreover, pastoral communities are also faced with dynamics in trade that distress their purchasing power represented by their livestock. Livestock prices will tend to reduce drastically due to the deteriorated condition of animals. When such conditions of more intense and frequent droughts continuously prevail, it aggravates pastoralists with one of the outcomes possibly being persistent poverty situations (Chantarat, Mude, Barrett, & Carter, 2013).

2.5. Global Recognition of Climate-Induced Migration

Sustainable Development Goals goal 10.7 includes the concept of migration. It states that: "Facilitate orderly, safe, regular and responsible migration and mobility of people including through the implementation of planned and well-managed migration policies"(OWGGASDG, 2015, p. 18). The United Nations Framework Climate Change Convention recently concluded global climate meeting Conference of Parties 23 (COP 23) negotiations in Bonn, and acknowledged the need to place human mobility; migration, displacement and relocation as a high international agenda point (UNHCR, 2017). The findings from the summit noted that devastating climatic events like hurricanes, droughts and floods are forcing people out of their places of living and highlighted the need to consider climate-linked migrations as a human rights issue, thus the need to protect persons displaced in urban areas by extreme and slow onset events was emphasized (UNHCR, 2017). Moreover, the need for integrated planning for human settlements as a measure to build resilience and avert displacement was suggested (UNHCR, 2017). In addition, the need for a more flexible comprehension of migration as a measure of both successful or failed adaptation was also highlighted (UNHCR, 2017).

The Hyogo Framework for Action 2005-2015, is built on the theme "Build Back Better" with a strong focus on disaster risk governance, disaster risk management. Sendai Framework, a successor instrument of the Hyogo Framework for Action focuses on the primary aim of building the resilience of nations and communities to disasters (UNISDR, 2005). On migration matters, the framework elevates the role of migration in Disaster Risk Reduction, particularly in building resilience in home and host regions. Governments agencies were encouraged to promote safe displacements in response to disasters. It acknowledged that if mobile populations are well managed, they can contribute to the resilience of communities and societies, with their knowledge, skills and capacities being harnessed into the design and implementation of disaster risk reduction plans (UNISDR, 2005).

With regards to migration, the New Urban Agenda in UN-Habitat III (2017) significantly notes that the majority of migrants and displaced populations move towards urban areas, thus significantly contributing to rapid urbanisation. It raises awareness on the need to shift to more inclusive planning and specifically, pushes for improved rights and protection for migrants and refugees for their access to facilities, services and opportunities as a drive towards sustainable urban development. The agenda also stresses the need for integrating migration concerns into development planning, as a means to address the vulnerabilities faced by such populations.

2.6. Earth Observation (EO) Techniques

2.6.1. Drought Assessment Indices: Remotely Sensed drought indices

Remotely sensed data and methods could quantitatively and continuously delineate the spatial and temporal variability of several drought features. These techniques can be utilized for assessment of drought vulnerability, damage and warning. In principle, there are two types of remote sensing systems for drought and operational monitoring, namely meteorological and environmental (or resource) satellites (Dalezios, 2017). The two types of meteorological satellites are geostationary such as (METEOSAT) and geosynchronous such as Advanced Very High-Resolution Radiometer (AVHRR) onboard the US National Oceanic and Atmospheric Administration (NOAA) (NOAA/AVHRR). On this basis, the geosynchronous, polar-orbiting meteorological satellites, e.g. NOAA/AVHRR and MODIS, fulfil the above requirements. Additionally, there are long series of databases already existing.

Remote sensing satellites used for extensive drought monitoring and impact assessment are geostationary (GEO) and low Earth orbit (LEO) (AghaKouchak et al., 2015). GEOs orbit at an altitude of 35,786 km and have orbits that are synchronized with the Earth's rotation (McVicar & Körner, 2013). These features allow them to provide information for a fixed field of view over a section of the Earth's surface. LEOs orbits at altitudes of 200-1200km and are typically placed in sun-synchronous orbits to obtain more than one observation per day over a given location. At present, the GEOs carry multispectral radiometers that collect information in the visible and infrared (VIS/IR) portion of the electromagnetic spectrum. On the other hand, LEOs carries a diverse range of sensors, including multispectral and hyperspectral sensors, laser altimeter and microwave (MW) sensors among others (AghaKouchak et al., 2015).

While optical-based vegetation indicators provide useful information on vegetation response to climate variability, they are however sensitive to cloud cover, atmospheric effects, water vapour and aerosols (AghaKouchak et al., 2015). Longer archives of data are preferred as they are useful in studying drought from a climate-related view and quantify drought impacts from an ecosystem perspective (AghaKouchak et al., 2015). Long archive data are used to quantitatively assess drought severity by using a drought-related variable like precipitation to calculate the extent of an anomaly or deviations from the longer-term environmental baseline (AghaKouchak et al., 2015). In comparison to conventional weather data, these remote sensing systems provide relatively inexpensive tools for regional applications such as monitoring vegetation conditions, agricultural drought and crop yield assessment. These systems also provide real-time observations, consistent data records and improved spatial resolutions.

To monitor and assess vegetation and crop yield, remote sensing systems that provide a low spatial resolution, high temporal resolution data and longer archives of data are typically used and most appropriate. This is because in these instances daily coverage is required to follow vegetation development throughout the season. Daily coverage is preferred to prevent loss of data and observations due to cloud sensitivity. These are among the motivations that played a fundamental role in the selection of GIMMS-AVHRR and the eMODIS satellites for this research.

Satellite Remote Sensing offers available tools and techniques to analyse the vegetation dynamics for agricultural drought as well as to assess the periods of vegetation stress in crops and vegetation status and quality based on climate variability, a primary indicator of agricultural drought. For example, the Moderate Resolution Imaging Spectroradiometer (MODIS) can capture drought indices such as Normalized Difference Vegetation Index (NDVI) which is a significant indicator of forage availability- a key element of livestock mortality in pastoral production systems (Chantarat, Mude, Barrett, & Carter, 2013;Vrieling et al. 2016). Also, for purposes of analysis and discussion, this study focused on drought as the deviations between the current and previous seasons of NDVI to assess forage scarcity proxies in Marsabit County, northern Kenya.

2.6.2. Operationalizing NDVI (satellite-derived indices) for Livestock Insurance Schemes

Over three million people, majorly pastoralists, and whose households greatly depend on livestock-based assets, reside in the arid and semi-arid lands (ASAL) of Northern Kenya. The livestock-based livelihoods account for more than two-thirds of average income (Chantarat et al., 2013). When severe drought hits, these communities face serious livestock losses that place their livelihoods at very grave economic risk, pushing these communities to tipping points of abject poverty and destitution (Barnett, Barrett, & Skees, 2008). Northern Kenya recorded four significant droughts having occurred between 1998 to 2008 (Adow, 2008). Such events are among the many which magnified the urgent need for livestock mortality risk management initiatives such as livestock insurance schemes, to pay either before or after drought-related losses occurred.

Large parts of East Africa have two rainfall seasons per year. There is "long rain" (March-May) and "short rains" (October -December) (Vrieling et al., 2016). Marsabit town and by extent Marsabit County falls within part of northern Kenya. The understanding of these seasons was essential for this research because for pastoralists, a failure of the long rains may result in large livestock losses at the end of the following dry season (Chantarat et al., 2013). In principle, pastoralist communities practice nomadic migration based on spatiotemporal variation of forage and water availability. This notion highly informed the manner in which the study aggregated the migration data acquired from the field for Marsabit Town.

Traditional claim-based insurance required proof of expensive losses incurred, which made this difficult for pastoralists, particularly those with a small herd size. This created an incentive for index-based livestock insurance schemes. With these schemes, indemnity pay-outs are made based on biophysical index that highly correlates with the actual losses (Barnett & Mahaul, 2007; Brown, Osgood, & Carriquiry, 2011). A major element of these schemes is to have a low "basis risk". The basis risk refers to risk households face where they do not get paid when they suffer loss or the opposite; they get paid when they do not suffer loss (Vrieling et al., 2016). The data used in the index construction are weather parameters like rainfall, which are estimated through either ground-based observation like rain gauges or satellite observations (Tapiador et al., 2012). Vegetation indices like Normalized Difference Vegetation Index (NDVI) are also used (Tucker, 1979). However, the reliability of data source for design options may vary depending on spatial and temporal integration (de Leeuw et al., 2014).

In an experimental study focused on designing and index-based livestock insurance (IBLI) scheme in Marsabit region of Northern Kenya, Chantarat et al. (2013) used satellite-derived NDVI time series to construct a seasonal forage scarcity index. To present the IBLI is still in use, however, in an attempt to reduce the basis risk, the method to translate the original NDVI series into an index have changed (Vrieling et al., 2014). In this experiment, payments to insured pastoralists were only made at the end of the season in which the index was calculated. In this case, the temporal average was computed as the coupled long rains-long dry (LRLD: March-September) season and coupled short rains-short dry (SRSD: October-February) season (Chantarat et al., 2013). This temporal aggregation implies that livestock suffer forage scarcity and pay-outs to pastoralists are only made after losses have been in incurred, especially, in case of a failed rainy season (Vrieling et al., 2016). These pay-outs only allow pastoralists to replace dead herd rather than to allowing pastoralists to protect their animals. Shortening the temporal frame and better defining the period of forage development across a season would improve the approach, by estimating season start-and-end- dates directly from temporal NDVI profiles to analyse vegetation greening and decay using phenological analysis (Meroni, Verstraete, Rembold, Urbano, & Kayitakire, 2014; Vrieling, de Beurs, & Brown, 2011).

The current International Livestock Research Institute (ILRI) IBLI design gathered MODIS (Moderate Resolution Imaging Spectroradiometer) satellite-derived NDVI time series data of 250m spatial resolution and 10-daily composites. These composites are spatially averaged per administrative unit, temporally averaged per season and subsequently compared between years to get an estimate of the relative seasonal forage conditions per unit (Vrieling et al., 2016). This MODIS NDVI time series was among the datasets used in this research and the IBLI methodology borrowed throughout the study.

2.7. Conceptual Framework

Several frameworks have been posited in an attempt to explain the role of environmental changes in migration dynamics. Critically, Jónsson (2010) notes that conceptually, there are two main categories that best conceptualise the relationship between environmental change and migration, these include a multi-level context specific driver approach and a more linear one-directional "push-pull" approach. The push-pull notion assumes that environmental change, especially degradation as the primary driver that triggers migration and other demographic responses.

The response of migration is often to related to negative outcomes such as climate change affecting economic activities, population growth and pressure force people out of their homes (Piguet, 2011). On the other hand, newer migration theories are emerging which postulate a broader notion of migration and environmental factors. These studies acknowledge the complexity of causes of migration which are primarily influenced by not only environmental factors but also other intervening socio-political and socio-cultural factors determine migration (IOM, 2007; Jónsson, 2010; Piguet, 2011).

This research focuses on the environment-migration nexus based on the more complex multi-causal nature of migration, and the multitude of transformations that occur as a result of the interaction between social, economic and political capitals (Black et al., 2011). This conceptual framework is borrowed from Black et al. (2011) and is illustrated in *Figure 2-3* below:

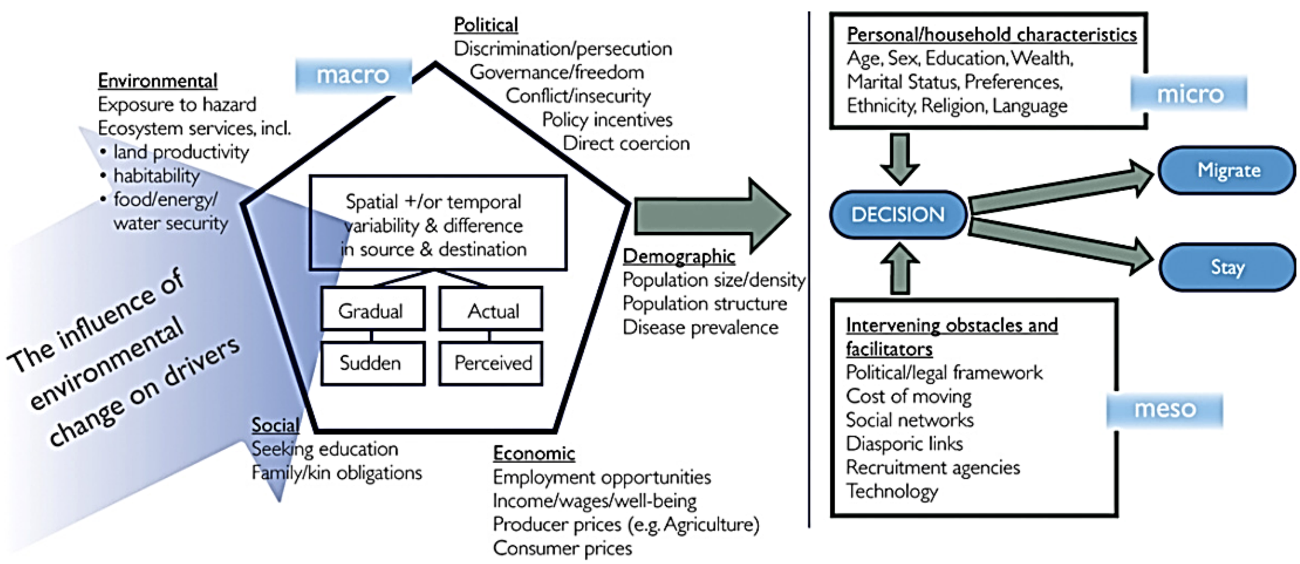


Figure 2-3: Conceptual framework for the drivers of migration. Source: Black et al. (2011, p. 5)

The motivation for borrowing this conceptual framework for this research is that the framework explains the relationship between the influence of environmental change on migration in a broader context while considering the interaction of the pentagon drivers that influence movement.

These dimensions include economic, political, demographic, social and environmental triggers which together, affect the decision to migrate or stay as well as the magnitude and direction of migration. These are arguments which this research is postulating for drought-induced urban migration of pastoralists in northern Kenya.

3. RESEARCH METHODOLOGY

This section introduces the study area, data and methods used in this research. Both primary and secondary data were used and are explained in more detail hereafter. Subsequently, the section illustrates how data was processed and employed to answer the above-mentioned research questions.

3.1. Study Area

The study was carried out in Marsabit Town, located in Marsabit County in the north of Kenya *(Figure 3-1)*. The town was chosen because it is located in one of the driest counties in Kenya, which has experienced drought for many years, including the most recent and severe event recorded in the first quarter of 2017. Marsabit Town is also surrounded by vast arid rural hinterlands that are populated by pastoralist communities.

Marsabit County is the second largest county in Kenya and is among the nine most arid counties (Republic of Kenya, County Government of Marsabit, 2017). The county spans a total area of 70,961.2Km^2. It borders Lake Turkana to the West, Samburu County to the South, Wajir and Isiolo Counties to the East. It shares an international border with Ethiopia to the North and lies between latitude 02° 45° North and 04° 27° North and longitude 37° 57° East and 39° 21° East. As illustrated in *Figure 3-5,* Marsabit and Moyale are the major urban centres in Marsabit County.

The county has two rainfall seasons per year. There is "long rain" (March-May) and "short rains" (October - December) (Vrieling et al., 2016). The area receives an annual average rainfall of 200mm-low and 1000mm-high. Average annual temperature ranges between 10.1 degrees Celsius and 30.2 degrees Celsius (Republic of Kenya, County Government of Marsabit, 2017).

The study county is divided into four sub-counties namely, Saku, Laisamis, North Horr and Moyale (Republic of Kenya, County Government of Marsabit, 2017). For the purpose of this study, the county was divided in 14 sub-units which are Index-Based Livestock Insurance (IBLI) units (*Figure 3-2*) namely: North Horr, Dukana, Turbi, Maikona, Kargi, Mt. Kulal, Loyangalani, Laisamis, Gadamoji, Obbu, Uran, Golbo, Central Moyale and Central Marsabit in which Marsabit town, lies. These units were based on existing administrative divisions. IBLI spatial units which were delineated as the insurance units in the International Livestock Research Institute's (ILRI) Index-Based Livestock Insurance (IBLI) project in Kenya.

The county had a population of 291,166 as at 2009, growing at an annual rate of approximately 2.5 percent. This translates into a projected population of 372,931 in 2017 (KNBS, 2014). The region is majorly inhabited by Cushitic speaking communities of the Borana, Burji, Gabbra and Rendille tribes.

Marsabit Town is the headquarters of Marsabit County, located on the extinct volcano Mt. Marsabit. The town is a trading and commercial centre facilitating supply and movement of goods and services between Moyale (goods from Ethiopia) and Isiolo (goods from Nairobi). The town had a total population of about 14,907 people in 1999 as projected (1999, Census). The city's population is projected to be 19,179 people in 2017 (KNBS, 2014). The average household size is five persons per household. Major structuring elements to guide the development of the town are Marsabit National Park and a forested mountain peak (Mount Marsabit), as well as the A2 Moyale- Ethiopia international road.

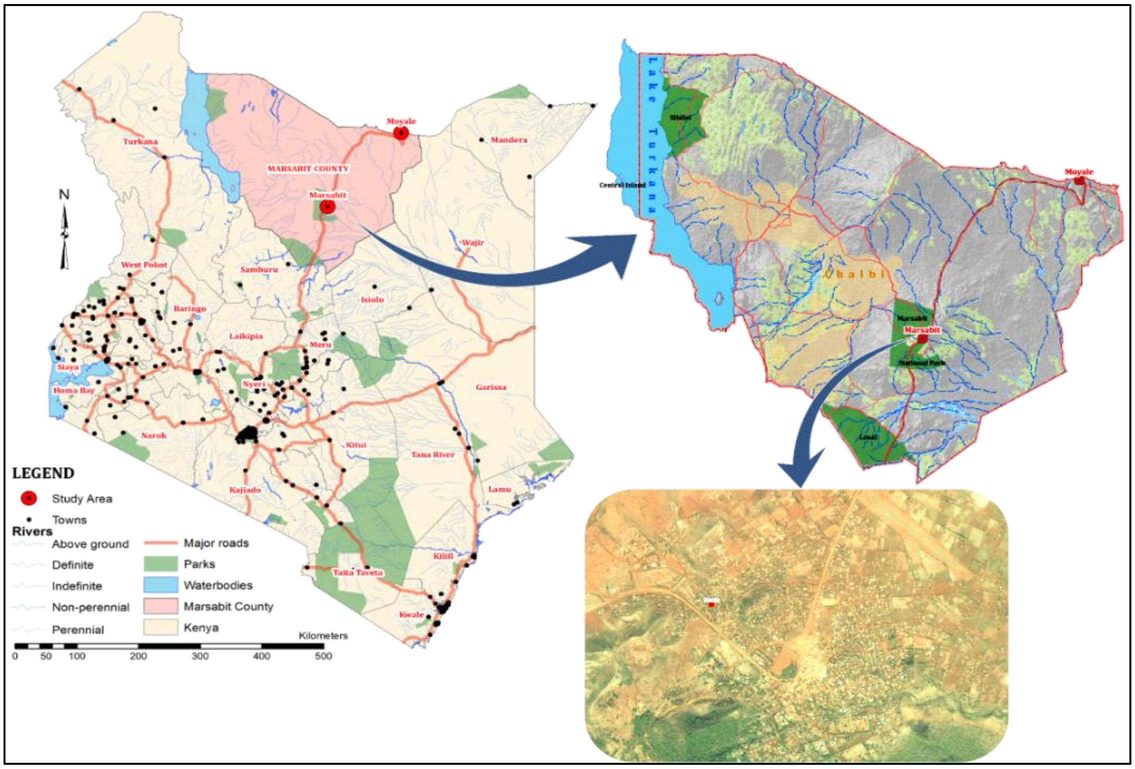


Figure 3-1: Location of Marsabit county in Kenya, and Marsabit Town within Marsabit County; google earth image of Marsabit Town. Source: Author

3.2. Data

This research used both primary and secondary data. Primary data sources were based on direct field observations through interactions with pastoralists currently residing in Marsabit Town, Key Informant Interviews (KII) and Focus Group Discussions (FGD). Secondary data sources included those based on remote sensing including the Normalized Difference Vegetation Index (NDVI), and literature collected by a desk study.

3.2.1. Field Work Data

The study employed a longitudinal approach to assess migration patterns of pastoralist population in the advent of drought. Spatial-temporal analysis of seasonal forage scarcity proxies, derived from NDVI time series was done to understand the dominant timings and dynamics of rural-to-urban migration of pastoralists. Pastoralists drop-out or former pastoralists that have migrated in the past to Marsabit Town, Northern Kenya, were selected as a case study. Primary data collection was done via a household survey which took place from September 2017 to October 2017. Data on migration dynamics, perceptions on quality of life and life histories on changing drought patterns were collected. Expert interviews with government officials and Non-Governmental Organizations (NGO's) working in drought or migration-related initiatives in Marsabit were also collected. Further details are provided in *Section 3.5*.

3.2.2. Remote sensing data

To obtain an independent temporal indicator of the relative severity of drought conditions within a specific season, Normalized Difference Vegetation Index (NDVI) time series were used in this study. The NDVI is a remotely sensed, freely-available proxy for green leaf biomass and leaf area index, related to primary productivity (Tucker & Sellers, 1986). In this study, as presented by Formica, Burnside and Dolman (2017), NDVI served as a proxy of vegetation productivity to help understand and explain migration patterns, routes and stop-over sites as well as pastoralist settlement decisions due to inter-annual variation within the long rain and short seasons. The NDVI time series data used in this research was obtained from the Eros Moderate Resolution Imaging Spectroradiometer (eMODIS) product produced from Moderate Resolution Imaging Spectroradiometer (MODIS) data which is operational and currently used by IBLI project and the Global Inventory Monitoring and Mapping Systems (GIMMS)- Advanced Very High-Resolution Radiometer (AVHRR) satellite.

For the eMODIS product, 10-day maximum value NDVI composites at 250 m resolution which were spatially averaged were spatially averaged per administrative unit, temporally averaged per season, and subsequently compared between years (2001 to 2016) to estimate the relative seasonal forage conditions per IBLI unit. These spatial units were used to derive a seasonal forage scarcity index *(Figure 3-3)*. The NDVI eMODIS data produced by United States Geological Survey (USGS) used was pre-processed using a temporal smoothing operator to reduce any atmospheric effects that degrade the NDVI signal (Vrieling et al., 2016). The filtered eMODIS data used was from March 2001 to September 2016 covering 16 Long Rain Long Dry (LRLD) (March-September) and 15 Short Rain Short Dry (SRSD) (October-February) seasons.

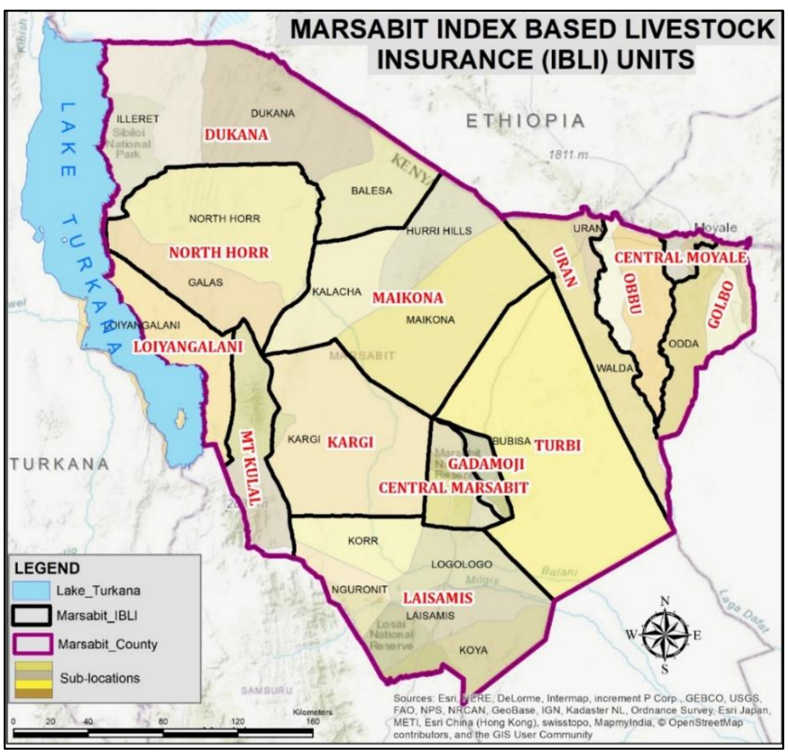


Figure 3-2: Marsabit Index-Based Livestock Insurance (IBLI) Spatial Units based on aggregated sub locations. Source: Author

To create a drought index, the forage scarcity index was computed to indicate how forage conditions for a specific season compare to the multi-annual average conditions in detailed processing steps illustrated in *Figure 3-3*. First, for each 10-day composite *(Figure 3-3a),* a spatial average per IBLI unit was done *(Figure 3-3b).* Based on the unit-specific start and end season *(Figure 3-3c)*, a temporal average of the spatial aggregates was done, resulting in a seasonal average NDVI per unit *(Figure 3-3d).* To assess how seasonal average NDVI per unit relates to multi-annual normal conditions, a z-score using the seasonal average NDVI and its standard deviation based on all years (Vrieling et al., 2016) was computed *(Figure 3-3e).* This is denoted as z-score for cumulative NDVI (zcNDVI) in the study. This indicates how many standard deviations the cumulative NDVI (cNDVI) for a particular season is above or below the multi-year average.

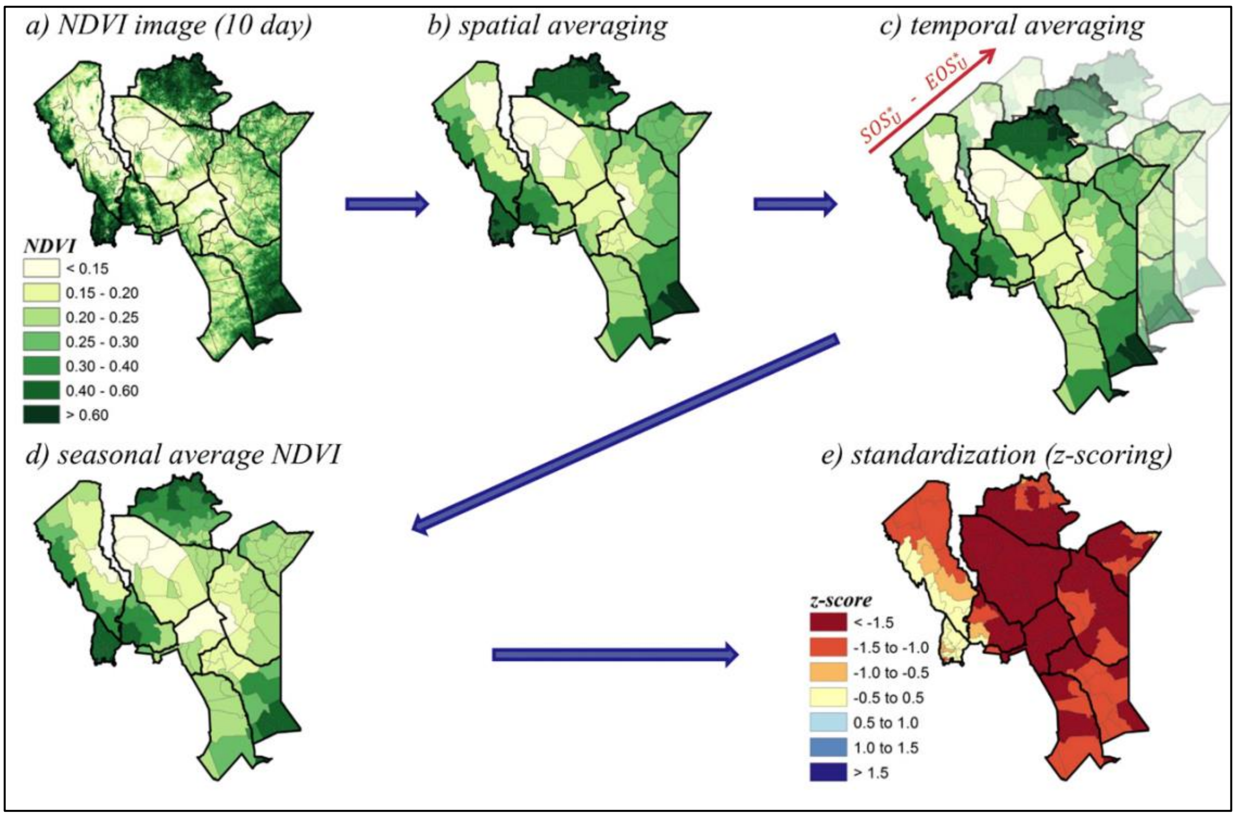


Figure 3-3: Processing steps for obtaining the forage scarcity index. Source: Vrieling et al. (2016, p. 48)

For the GIMMS-AVHRR, 15-day NDVI composites derived and summarised the eMODIS results per spatial unit, but now translating them into 15-day periods. This data was used from 1981 to 2015. The choice for analysing this time frame was informed from the migration data collected from the field. These translate to 34 LRLD (March-September) and 33 SRSD (October-February) seasons. However, for consistency in the analysis of seasons, the zcNDVI temporal data from both the satellite-derived NDVI time series datasets were considered for the overlap years of 2001L to 2015L. This translated to 14 LRLD and 13 LRLD.

A subsequent analysis of the two satellites for the overlap period was undertaken. Regression analysis with a scatterplot of the overlap years of 2001 to 2015 for the zcNDVI of eMODIS against the zcNDVI of GIMMS yielded an R^2 of 0.9466. *Figure 3-4* shows that the R^2 between the zcNDVI of GIMMS and eMODIS is very high as 95% of the variability is accounted for. The zcNDVI for both satellites was plotted per IBLI unit

(Appendix 1-GIMMS graph; Appendix 2- eMODIS graph). The resulting output proved that the zcNDVI for both satellites within the same epoch are relatively quite similar.

It is important to note that while IBLI uses eMODIS, the inter-annual seasonal variability of zcNDVI is practically the same for GIMMS. This implies that both datasets can be used interchangeably.

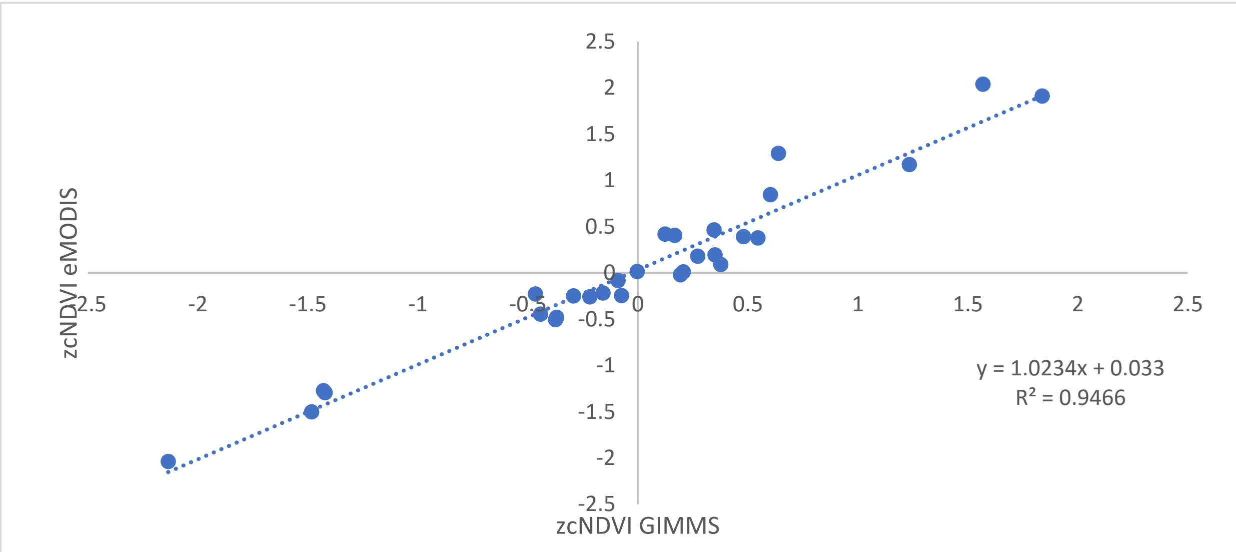


Figure 3-4: Regression analysis for zcNDVI of eMODIS against zcNDVI of GIMMS. Data: eMODIS and GIMMS satellites. Source: Author

Therefore, despite the IBLI project mostly using the eMODIS-based index as per Vrieling et al., (2016), the high similarity evidenced by *Figure 3-4* serves as a justification on which dataset to use. Specifically, the subsequent analysis was undertaken in this research mainly continued to focus on the single extended dataset of GIMMS (1981S-2015S) as it still significantly relates closely to the shorter epoch of eMODIS (2001L-2016S). A detailed summary of the used remote sensing data is shown in *Table 3-1*.

Table 3-1: Detailed description of data used for analysis

Data Type	Data Source	Data Specifications	Standardization Method	Rationale
Spatial-temporal Seasonal NDVI data	-Global Inventory Monitoring and Mapping Systems (GIMMS) Advanced Very High-Resolution Radiometer (AVHRR)	-Spans 1981L-20015L -Per 15 days' time-step -8x8km per pixel	-Z-scored seasonal average of aggregated NDVI data for GIMMS of Kenyan divisions and Ethiopian clustered villages (kebeles)	-Used for comparative cumulative and percentage analysis with migration data from the field, per season per year from 1981L to 2015L -Used for comparative analysis with overlap years of eMODIS from 2001L to 2015L

	-eMODIS (EROS Moderate Resolution Imaging Spectroradiometer)	-Spans 2001L-2016S -Per 10 days' time-step -250x250m per pixel	-Z-scored seasonal average of aggregated NDVI data for eMODIS filtered by FEWS-NET of Kenyan divisions and Ethiopian clustered villages (kebeles)	-Used for comparative cumulative and percentage analysis with migration data from the field, per season per year from 2001L to 2016L -Used for comparative analysis with overlap years of GIMMS from 2001L to 2015L
Rainfall	-Kenya Meteorological Department	-Monthly data measured in millimetres (mm) -Marsabit Meteorological station	-Computed per season and cumulated over months	-Used as an explanatory variable for migration, when combining with NDVI per season
IBLI spatial unit	-ILRI's Index based livestock Insurance scheme (IBLI) units Project	-Shapefile of IBLI administrative boundaries for Marsabit	-Used to compute the spatial aggregates for the forage scarcity index	-Extract IBLI geometry for area of Interest (Marsabit County)

Next to the NDVI data also rainfall data from the Kenyan Meteorological Department, and spatial boundaries, i.e., shapefiles from the Index based livestock Insurance scheme (IBLI) Project were used *(Table 3-1)*. Rainfall data and NDVI data were used as the two explanatory variables of pastoralist migrations. Rainfall data per season from 1981 to 2015 was comparatively analysed with the forage scarcity proxies (zcNDVI) data within a similar period.

The core of this research lies in objective two, which focused on a comparative analysis of migration data over time (empirically determined from responses in the field) with satellite-derived data to measure the performance of forage scarcity proxies' (zcNDVI).

3.3. Overall Research Methods

To achieve the above-mentioned objectives and answer corresponding research questions, a combination of qualitative and quantitative research methods was employed. These are set out hereafter in *Table 3-2* as the overall research strategy.

Table 3-2: Overall research strategy employed

Objective	Questions	Method	Data Collection	Data Analysis
Objective 1: Rural-to-urban Migration dynamics	- Temporal peaks of migration -Causes of migration -Origin locations from which pastoralists migrated	- Direct observation - Photography	-Household (HH) Survey (semi-structured questionnaire)	-SPSS Analysis -Content/thematic analysis

(timings, causes &sources)		-Walking-interviews	-Focus Group Discussion (FGD) -Key Informant Interviews (KII)	
Objective 2: Satellite-derived drought analysis to explain rural-to-urban migration peaks	-Seasonal forage scarcity proxies time series (NDVI) to explain dominant timings of migration	-Mixed	- eMODIS and GIMMS (Remote sensing) -Comparison with HH survey and FDG output	- Quantitative analysis -Content and descriptive analysis
Objective 3: Effects of rural-to-urban migration on pastoralist quality of life	- Current urban livelihoods: Qualitative perception on level of satisfaction/dissatisfaction with quality of life after migration -Maintenance of connection with origin places	- Direct observation -Photography -Walking-interviews	- Household Survey (semi-structured questionnaire)	-Qualitative Analysis

Figure 3-5 illustrates the overall methodological research framework. The framework gives a detailed summary of steps taken to achieve the research objectives and answer the research questions.

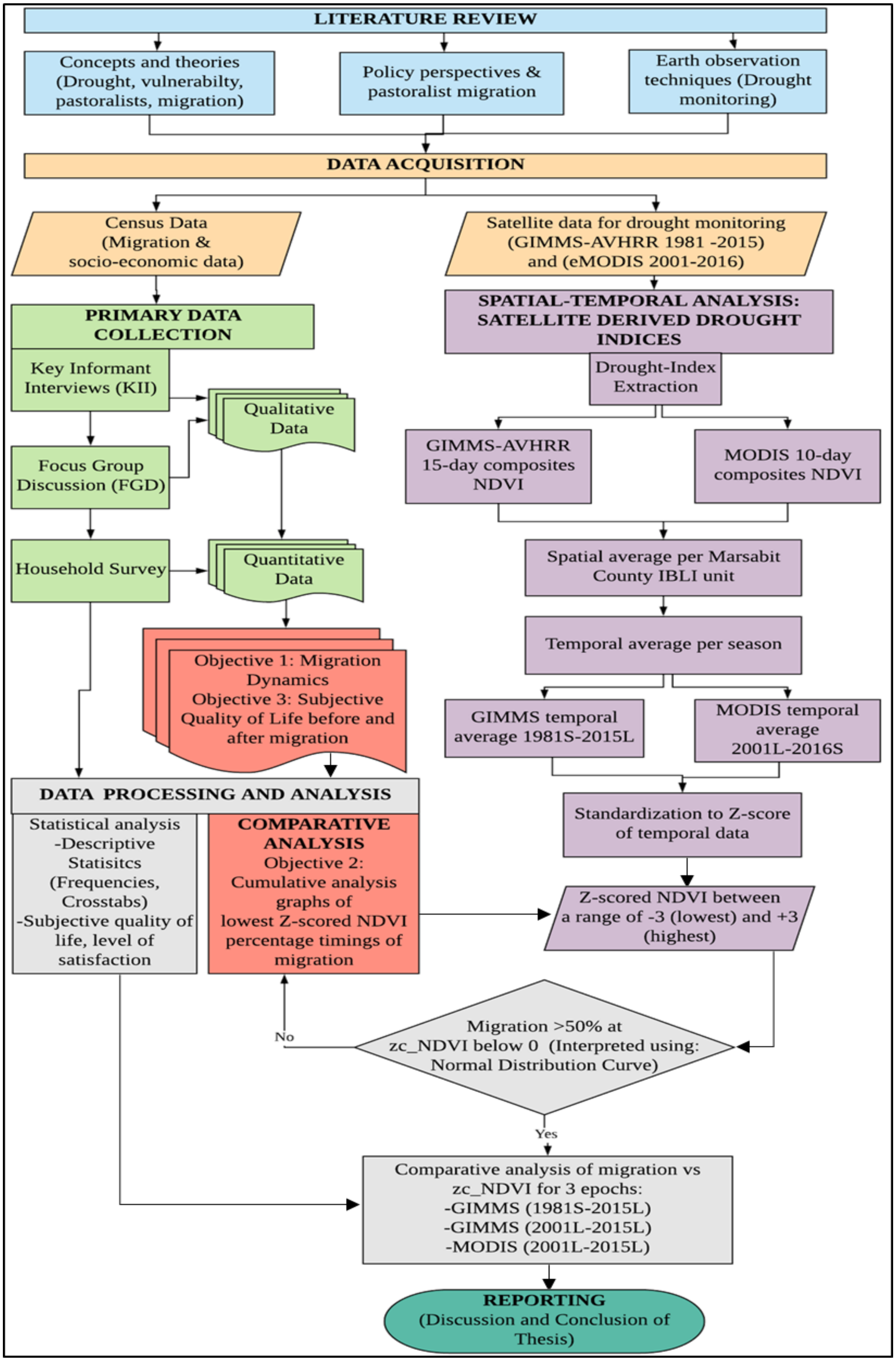


Figure 3-5: Overall Research Framework. Source: Author

3.4. Training and Pilot testing

Fieldwork was conducted between September 2017 and October 2017. Enumerators were identified with the help of the Marsabit District Statistics Office. The criteria for selection were that the enumerators were to be literate, have finished at least high school and possessed smart-phones. A translator was used to ease the communication between the researcher and the chiefs. The translator, local area chiefs per administrative unit, and enumerators underwent two day-long sessions of training conducted by the researcher on 22nd and 23rd September 2017. They were: 1) inducted on the overall objective of the study and essence of each study objective; 2) trained on how to use the OpenDataKit (ODK) of KoboCollect mobile application, the primary tool used for the household survey *(Appendix 3- Training of research assistants and chiefs)*. After training of the fieldwork team, the questionnaires were pilot-tested using the KoboCollect app with a small number of respondents (15 pastoralists) before conducting the actual interviews. The pilots revealed some problems not anticipated during the development of the questionnaire, e.g. issues related to question-wording, instructions and interpretations. Also, the know-how in use of the enumerators with the KoboCollect toolbox was assessed, and where clarifications were needed, they were provided. This resulted in several changes to the initial questionnaire and subsequently a much-improved final questionnaire *(Appendix 4-Proof of changes in questionnaire)*. *Figure 3-6* shows pictures of training and pilot testing phase of the research

a) Training of enumerators to set GPS for data collection using KoboCollect app

b) Translator, researcher, pastoralist migrant and chief after pilot of household survey

Figure 3-6: Field work phase: training of enumerators and testing of research tools. Source: Author

3.5. Sampling: Household Questionnaire survey

Purposive sampling was used to determine all pastoralist-drop outs who were residing in Marsabit Town. They were selected due to their homogenous characteristics of not being pastoralist anymore and having migrated to the urban area. The selection by homogeneity was made with the aim of limiting variability and reducing sampling error associated with heterogeneity of study populations (Kothari, Kumar, & Uusitalo, 2014). Migration data was collected from 295 randomly selected pastoralist-drop out households considering all of the five administrative sublocations of Marsabit Town *(Appendix 5-Map of sampling locations)*. Due to pastoralists drop-outs either settling in groups/clusters or spontaneously infiltrating into the urban areas and its peripheral region (Adow, 2008), the living arrangement was also selected as another sampling criteria (*Appendix 6-Sampling criteria*). Another requirement considered for sampling selection was informed by Adow (2008) who noted that the current trend of pastoralist migration comes in two forms; 1) some people entirely drop out of the pastoralist lifestyle and system, moving to urban centers to seek casual work or to depend on gifts from relatives; and 2) others move to the vicinity or periphery of urban centres as internally displaced people to find emergency food aid. To generate a rigorous empirical statistic, a representative sampling frame is required. However, forming a sampling frame was hampered by poor documentation on the number of pastoralist migrants affected by drought at both National and County government level. This necessitated use of primary sources of data, hence uses of chiefs to identify migrant pastoralist households for household survey.

The activity was a door-to-door exercise led by the various chiefs within their administrative areas of jurisdiction. In this system, local areas chiefs are typically considered as the first point of "registry" when people migrate to know reason for migration, permanence of migration, introduction into area and its residents. They are informed of the presence on entry of an individual into their area of jurisdiction.

Interviews were conducted with chiefs present in the household at the time of sampling. This had three purposes: 1) easing the entry into the communities that were otherwise reluctant to respond to the research team; and 2) identification of pastoralist-drop out households due to lack of existing comprehensive and credible census data on drought-related migration from either Marsabit County Government statistics or local NGOs'. The questionnaire was written in English. However, the translator played a double role of supervisor of the household survey team and thereby played a vital role in ensuring that the clarity of the objectives was maintained. The household survey questionnaire had a mix of both open-ended and closed-ended questions, covering 12 pages and lasting for about 30-minutes (*Appendix 7-Household questionnaire*). In general, the content of the household questionnaire included three major sections:

i. **Migration dynamics-** Interrogated the date of migration, routes and stop-overs, reasons for migration, community perception on changing drought patterns and effects of drought overtime
ii. **Socio-economic impacts of migration in town-** livelihood sources before and after migration, income, aid organisation, opinions on quality of life before and after migration, perceptions on rural places of origin and pastoralism in general
iii. **Household demographics-** gender, age, household size, household head, education level, asset-base.

As mentioned above, the questionnaire was formulated and administered in the KoboCollect mobile app *(Appendix 8-Researcher KoboCollect details)*. The KoboCollect toolbox is an Android-based OpenDataKit (ODK) used for primary data collection in humanitarian aid related emergencies and other challenging field environments, particularly in remote areas. It is a free open-source tool for mobile data collection which allows the use of mobile devices such as mobile phones and tablets. Among the main strengths of the app is the "skip logic" to questions, i.e. skipping subsequent questions (or not) based on the response given to previous questions—a feature which saves a lot of time during the administration of the tool. Also, the app has no limits on the number of forms, questions or submissions (including photos and videos) that can be saved on a person's device. The app was efficient to use as it allowed easy amendment of questionnaires, when needed "on the fly", and immediately deployed for use in the field. The interview scheme and collected data can be accessed either online or offline (UN-OCHA, 2017). Another incentive to use KoboCollect for this research was the possibility to use it in connection with the Global Positioning System (GPS) providing co-ordinates and real-time submissions of the number of questionnaires based on locations of enumerators at time of interviews. This geolocator setting enabled easy tracking and monitoring of the quality of data being collected per individual enumerator. Considering the hilly terrain of parts of the town and that drought can be viewed as a humanitarian issue in Marsabit County KoboCollect offered an ideal tool for primary data collection.

3.6. Focus Group Discussions (FGDs)

For this research two, FGDs of ten men (one discussion) and eight women (one discussion) were conducted. About eight to ten participants were targeted as advised by Kothari et al. (2014). The FGDs were separated by males and females. The FGDs allowed access to first-hand information on wide-ranging issues from elderly pastoralist men and their women (males and females above 65 years old), which served to answer objective one and three. Questions related to their life trajectories, attitudes and perceptions regarding the impacts of drought on their socio-economic and physical environments as well as migration trends. Causes, timing and impacts of drought-related migration over time were of particular interest to complement data of the household survey. The FGDs were thematically organised per gender. Gender-specific topics include, amongst others, livelihood sources before and after migration; gender roles during migration; education and health; ownership of property; drought impacts and coping mechanisms.

In parallel participatory GIS (PGIS)—also known as community or indigenous mapping (McCall, 2006)—was used for sketch mapping of migration routes and drought hotspots during the FDGs. An A0 tracing paper was mounted onto a satellite map of a similar size of Marsabit County and its surrounding regional context. These maps were provided to the community to map various information based on set questions. Coloured markers and stickers were provided for annotation of thematic issues identified. PGIS offers the application of a more socially integrated and qualitative GIS that actively engages people in the process of identifying and analysing spatial data (Dunn, 2007). This activity offered a triangulation of and complementary information to the analysis of drought-remote sensing data *(Appendix 9-FGD guide questions).*

3.7. Key Informant Interviews (KIIs)

Also known as expert sampling, five KIIs were conducted providing knowledge on expertise and experience in matters related to drought, migration and urban development. These interviews were held with a representative of the National Drought Management Authority Director-Marsabit County, the Director of Forest Services, a Physical County Planner, and four representatives of NGO's affiliated with drought activity. Non-profit organisations specifically, Red Cross, Japan International Co-operation Agency (JICA), Pastoralist Community Initiative and Development Assistance (PACIDA), Pastoralist Integrated Support Programme (PISP), Care Kenya, WFP (World Food Programme) and Concern Worldwide were engaged in gathering information about insights into-drought related migrations of pastoralists.

These initiatives and organisations were also asked to provide information about their engagement during a drought disaster and after the migration of pastoralists into the urban area. The qualitative data generated from these discussions were useful in validating the information acquired from the household survey and FGDs. *Table 3-3* summarises the qualitative data and stakeholder profiles used.

Table 3-3: Rationale for Stakeholder choice and data acquired

Stakeholder	**Reason for selection**
-Local weathermen	-Traditional indigenous knowledge of drought prediction methods and trends over time

-National Drought Management Authority (Marsabit County)	- Drought initiatives -Related migration activities
-County Meteorological department	-Data on drought trends over time -Rainfall data
-County Forest Officer	-Physical effects of migration on forest landscape
-County Development Officer	- Numbers of rural to urban pastoralist migrants know by county
-County Physical Planner	-Confirmation of town boundary -Urbanization trends over time with drought in perspective -Service provision, housing quality to pastoralist communities
Local Non-Profit Organizations - Red Cross, JICA, PACIDA, PISP, Care Kenya, WFP and Concern Worldwide	-Statistical information about pastoralist migrants -Activities and programmes working with pastoralist migrants

3.8. Data Analysis

This research followed an inductive approach in which the results are directly derived from specific data and used to obtain a broader understanding of particular phenomena (Lichtman, 2014). Both quantitative and qualitative data were used. Quantitative data analysis was done on Statistical Package for Social Sciences(SPSS) IBM statistics version 24 and Excel data processing platforms. SPSS analysis was used for multivariate statistics such as coding of responses into distinct categories, analyses of frequencies and cross-tabulations. In addition, the influence of satellite-derived indices on migration patterns were assessed; Excel platform was used for comparative analysis of cumulatively migration data with corresponding satellite-derived NDVI fluxes of time series data, in an attempt to explain the dominant timings of pastoralist drop-outs migration into urban areas. Qualitative analysis was done for KII and FGDs using the ATLAS.ti software version 8.0 undertaking a detailed content analysis of thematic areas.

3.9. Objective 1: Migration Dynamics

3.9.1. Aggregations of migration timings

To achieve objective one, the first set of analyses examined the dynamics of rural to urban migration of pastoralists currently residing in Marsabit Town. The investigation was driven by direct interactions with the local community to empirically determine their migration dynamics regarding temporal peaks, causes and origin/source areas of migration. For example, respondents were asked about when they migrated, specifically, when they left their previous rural location (if possible, day, month and year of migration). This was organised following the understanding of the usual seasons within Kenya and Marsabit County, i.e. Long Rain Long Dry (LRLD) from March to September and Short Rain Short Dry (SRSD) seasons from October to February. However, to account for possible delays in decision making and action, the aggregation of migration data was shifted by one month into Long Rain (L)- April to October; Short Rain (S) -November to March. The rationale for the shift is that very early in the season; the pastoralist cannot have much information yet about the performance of that season to base his decision to migrate on. Thus, for example, the decision to migrate in October is likely due to poor long rains conditions still. Rainfall data was computed per season from 1981 to

2015 and used for comparative analysis with the forage scarcity proxies (zcNDVI) data based on the understanding that precipitation affects the quality and quantity of forage per season. Both the eMODIS and GIMMS-AVHRR datasets were utilised for temporal trajectory analysis in cumulative percentage analysis, with the migration aggregates corresponding per season per year of migration. The purpose of this analysis was to correlate NDVI fluxes with migratory patterns during the bimodal seasons per year.

3.9.2. Causes of migration

The second research question of objective one interrogated the causes of migration of pastoralist communities into urban areas. In this research, a multiple response questions were posed to respondents from the household survey to give their top three reasons (push factors) of migration. The responses given were quantified into frequencies and aggregated per each option given in the question. This information was also triangulated with discussions from the expert interviews with both the NGO's and government officials.

3.9.3. Origin-Destination areas of pastoralist migrants

To understand the fluxes and migration patterns of pastoralist communities, a quantitative analysis was undertaken. Three items in the household questionnaire investigated the origin-destination places, routes followed and stop-overs. Frequencies generated from these questions were used to create a proportional flow line map of the direction of movements, origin, stopovers and destinations. The responses on migration flows were also supported by the expert interviews from the National Drought Management Authority and several NGOs.

3.10. Objective 2: Quantify satellite-derived drought-assessments for temporal peaks of migration

3.10.1. Satellite-derived drought indices

To compare the temporal distribution of migration with satellite-derived NDVI time series data, the cumulative percentage of migrations was plotted against the current season of zcNDVI at different thresholds. Cumulative percentage analysis was used to determine whether more migrations were reported for seasons during which zcNDVI indicated below-normal forage availability. Primarily, the research sought to solve the following fundamental question: Are there significantly more migrations if the current season had a low z-scored cumulative NDVI? To answer this question, the following subsequent questions were asked. For example: If we consider only seasons with zcNDVI below -2, what percentage of all migrations do they represent? If we consider only seasons with zcNDVI below -1, what percentage of all migrations do they represent? These questions formed the core of the analysis in this research.

In this method, first, all migration data was aggregated per season per year. Second, the zcNDVI was sorted from highest to lowest. Third, the migration frequency data was converted to percentages. Fourth, the percentages were converted to cumulative percentages of the sorted zcNDVI. Subsequently, a graph of cumulated migration against zcNDVI for the current season was plotted *(Figure 4-9)*. This technique is subsequently referred to as cumulative percentage analysis for migration against the current season of zcNDVI. The motivation for this approach was to determine what percentage of total migrations are represented at different thresholds of average zcNDVI for the current season.

The outcome of this comparative analysis was to illustrate a potential relation between temporal peaks of migration in cumulative percentage for the current season against z-scored cumulative NDVI thresholds derived from GIMMS AVHRR (1981S-2000L) and overlap periods of GIMMS AVHRR (2001L-2015S) and eMODIS (2001L-2015S) *(Figure 4-9).*

The normal distribution curve which contains z-scores and cumulative percentages were used to interpret the cumulative percentage graphs and make inferences about the data. In this figure, z-score was used to explain the zcNDVI threshold for the different cumulative percentages of migration. Here, below 0 zcNDVI was considered to be normal conditions at a mean of 0. Therefore, any standard deviations above or below 0 were considered an anomaly, more specifically, any negative deviation was considered as drought, going by the definition of drought in chapter 2, *Section 2.1.1.* Therefore, in this data, cases of zcNDVI at below 0, were assumed to be normally distributed, below 0 value of zcNDVI means that there are average conditions, below -1 means that it is one standard deviation below the average conditions. In this research, between below 0 and below -1 zcNDVI was considered as drought conditions. Any other zcNDVI threshold below -1 was considered as severe drought. *Figure 3-7* contains the normal distribution curved.

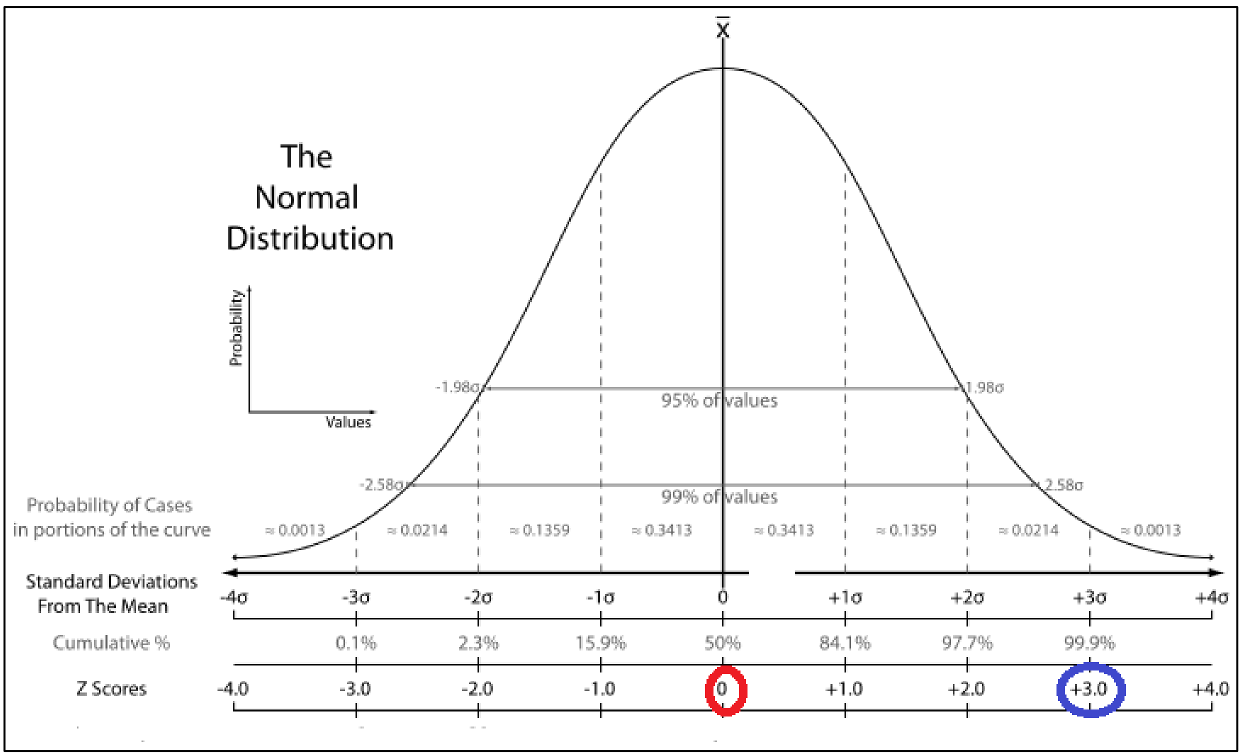


Figure 3-7: The Normal Distribution Curve with Z-Scores and Cumulative Percentages. Source: Statistics How To (2018)

3.10.2. Demographic of Migrants

3.10.2.1. Age analysis

To get a deeper understanding of the decision makers at the time of migration, further analysis through cumulative analysis of the age of migrants at time of migration was done against zcNDVI for the current season. Age of migrants was computed based on the current age at the time of interview. First, all age frequencies were extracted from field data. Second, this was further aggregated into different age groups from below 15 years to above 65 years to understand the age group distribution of respondents at the time of migration. Assuming that there may have been memory challenges of timing and causes of migration for the younger group of migrants below 15 years and above 65 years, these two age groups were filtered out. Age groups were further aggregated into three categories of 15-30, 31-50 and 51-65. Third, using these three age categories, the longer GIMMS 1981-2015 zcNDVI dataset, was used to compute the cumulative percentage analysis for the current season. The normal distribution curve *(Figure 3-7)* which contains z-scores and cumulative percentages were used to interpret the cumulative percentage analysis graph and make inferences about the data.

3.10.2.2. Gender analysis

To get a more in-depth understanding on the gender perspective of migration based on the discussions with women's focus group, additional analysis through cumulative percentage analysis for migration against the current season of zcNDVI of the male and female responses was done using GIMMS 1981-2015. First, an aggregation of all frequencies generated per male and female respondent was done. Second, the cumulative percentage analysis for the average current season plot. The normal distribution curve which contains z-scores and cumulative percentages were used to interpret the cumulative percentage graph and make inferences about the data.

3.11. Objective 3: Subjective Quality of Life (QoL)

Quality of Life (QoL) is multidimensional, relates to various domains (housing, income, health. built and natural environment, health) and the level of satisfaction that individuals have with those areas. Subjective QoL relates to the perceived or (self-) expressed (dis)satisfaction with specific domains or life in general. It refers to issues of expressed demands, needs, and wants (Berhe, Martinez, & Verplanke, 2014). To achieve objective three on subjective quality of life, in particular, the questionnaire asked questions on the migrants perceived their quality of life before and after migration. Using the Likert scale where (1=Very Dissatisfied and 5= Very Satisfied), pastoralists qualitatively perceived their quality of life before and after migration from rural places of origin, to the urban destination of Marsabit Town. The respondents were also asked about their current asset- base, income sources, and livelihood activities before and after migration, their future in pastoralism and plans of moving back to destination areas. The responses were quantified into frequencies and analysed comparatively.

3.11.1. Content Analysis of qualitative data

Content analysis was done to develop a narrative from the discussions that described main thematic areas emerging about migration dynamics related to causes of migration, destination locations, timings of migration and changing drought episodes and patterns over time. All recorded expert interviews and FGD meetings were transcribed and qualitatively analysed using the ATLAS.ti software version 8.0 software. The software was used to code the transcribed text generated for detailed analysis. Statements from data were coded into categories based on keywords. These were subsequently reported where relevant per objective.

3.12. Ethical Considerations

This research endeavoured to be ethically conscious. The following ethical issues were addressed, given per general stage of the research:

i. Pre-Field work

A fieldwork letter from the researcher's school was prepared and used throughout every activity of the research process for informed consent *(Appendix 10- Fieldwork Letter)*. After the case study area was selected, the researcher identified critical stakeholders on the ground. Due to the convenience of the study area being the researcher's home country, where possible, contact details of key informants were sought in advance. Where available, calls and emails were made before the fieldwork begun and appointments set in advance. This communication process enabled the researcher to profile necessary stakeholders for ease of networking, timely and transparent stakeholder consultation towards building mutual trust.

Also, in the design phase, consideration was given to the critical role of the spatial distribution of households as well as socio-economic and socio-cultural demographics of pastoralists residing in Marsabit Town. Moreover, clarity on the purpose of the research was given while recognising power relations, making the study more efficient and effective

Characteristics regarding age structure, socio-economic status, education level and ethnic backgrounds were considered based on advice from key informants, literature and print sources, as well as the different ethnic groupings of Burji, Borana, Rendille and Gabbra.

ii. During Fieldwork

Clarity on purpose and objective of assignment and data collection was a priority. The translator is the entry point to the communication between the research and the community was met separately and trained on the objective of the assignment. He was then instructed again with the rest of the enumerators to ensure a common understanding of the research objectives and data collection process. Also, based on the critical role of chief and elders in pastoralist communities, all chiefs who represented an area of jurisdiction within the study area were met in advance. Contacts were shared, and fieldwork itinerary for the entire fieldwork was set.

Selection of research assistants considered gender and tribe representativeness. Despite the high level of illiteracy among the community members of Marsabit, particularly among women and girls, two ladies (both completed secondary school) and two men (both completed first degree in university) were selected as enumerators. Tribe representativeness was also considered as enumerators' tribes included: two Boranas, one Rendille and one Gabbra, that represented significant tribes within Marsabit County. Among other prerequisite criteria, the enumerators were required to speak both English and local dialect, as interviews were conducted in the local dialect. All were treated equally and empowered through training on how to use the KoboCollect App tool.

Being an area regularly hit by drought, the trend from previous studies done by other researcher and organisations seemed to provide financial or food supplies to support to these communities during desperate drought situations. This reflected back on the research with some community members expecting some support from enumerators and researcher. To manage these expectations, consistent elaboration on purpose of the research was done. However, facilitation money was paid to FGD participants for their transportation from peripheral areas of the town into Marsabit central business district.

During the KIIs and FGDs, informed consent was sought before recording and taking pictures and videos. Further, disaggregated male and female discussions were held in appreciation of the cultural gender roles and consensus was built on what information could be mapped. Sketch mapping enabled the pastoralist communities affected by drought to document their migration trajectories regarding drought hotspots, grazing grounds and migratory corridors over the years, using a wide range of materials and stationeries. As suggested by Rambaldi, Kyem, McCall, and Weiner (2006), the participatory mapping practice focused on community empowerment, integrated applications of geospatial technologies, and was demand-driven and user-friendly. After the FGDs, participants were also informed about how the maps and their rich spatial knowledge would be utilised (McCall, 2009).

iii. Post-Field work and post research

Data acquired from the field was kept anonymous, where requested. However, all other information acquired from the field was referenced based on the sources with consent from individuals or organisations who provided it. Also, as requested by community and county government officials, an abridged copy of this thesis will be shared with the officials from the County Government of Marsabit at the end of this research.

3.13. Limitations of the Study

Statistical census data- Lack of credible population estimate on pastoralist migrants affected by drought in Marsabit. The 2009 national census conducted in Kenya would have presented the best approximation of migrant population in Kenya and Marsabit region. However, due to a lack of such data both at national and county level, proxies of migration numbers from Non-Governmental Organizations (working on drought projects in the area) and local area chiefs offered the next best option. It is the mandate of a chief to be familiar with all members of the community he/she serves. It is also common practice for pastoralist communities to report to a chief on arrival into a given area of jurisdiction. Considering these reasons, using the knowledge of chiefs for sampling is regarded a suitable option. However, the study acknowledges that this may not have been the most credible basis for implementing a sampling strategy under other circumstances.

High expectations- Generally, there were support/aid expectations from both the community (aid and Key Informants (research usage outputs). To cope with these expectations, the researchers consistently iterated the purpose of the study and the utilisation of the research output.

Logistical constraints- Initially, there were three enumerators. However, after the first day of fieldwork, the vastness of the study area and the long travelling distances in sparsely populated hilly terrain combined with the harsh climate (drought) led to hiring additional two enumerators. These were subsequently rigorously trained, causing a slight increase in expenditure.

Smartphone challenges-Kobo challenges due to lack of charged phone. This problem was curbed through the use of portable power-banks. Due to its anticipation, these limitations did not have any considerable effect on the quality of data obtained.

On the overall, these limitations did not have any considerable effect on the quality of data obtained as well as the findings of this assessment.

4. RESULTS

This chapter presents the research analysis, results and major fieldwork observations. The section is organised in line with the study objectives.

4.1. Objective 1: Pastoralist Migration Dynamics: Temporal Peaks, Causes and Source Areas

4.1.1. Temporal Distribution

The temporal peaks of migration were assessed from three perspectives: 1) the dominant timings of migration by season (Long Rain season -April to October) and (Short Rain season- November to March); 2) the dominant timing of migration per decade and 3) the dominant timings of migration per month irrespective of year.

Figure 4-1 presents the results for 1) dominant timings of migration by season, comparing migration between the long rain season and short rain season per year.

Figure 4-1 also shows that there were more migrations noted in the long rain season as compared to the short rain season. 1995L, 1997L, 1998L, 1999L, 2000L, 2009L, 2011L and 2017L experienced high migrations of more than ten pastoralists. Other years of high migration that stood out with five to ten migrations per season are 1991L, 1996L, 2001L, 2002L, 2006L and 2010L. Interestingly, 1999S also yielded a high migration. Eleven people moved into Marsabit town in that season — by far the highest number of migrations documented in any of the short rainy seasons.

As noted the migration in the long rain season is higher than in the respective short rain season. This is the case in 62% (23 years) of the 37 years. However, this is not the case for the more recent years. For example, since 2012 migrations in the short rain season tend to be higher than in the long rain season.

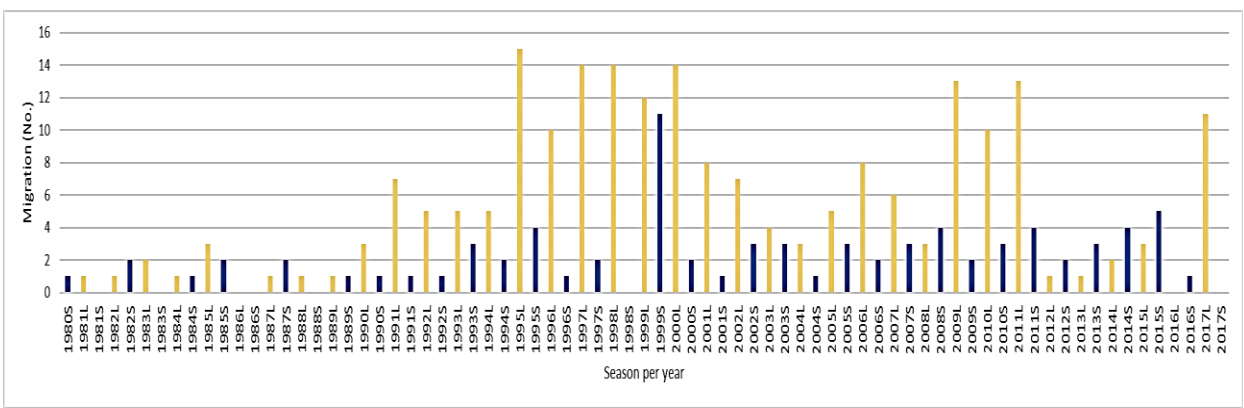


Figure 4-1: Number of documented migrations aggregated per bimodal seasonality (1980-2017) Key: Light brown shows the number of migrations in the Long rain season (April-October); dark blue shows the migrations in the Short rain season (November-March). Source: Author.

Figure 4-2 reports the results for 2) the dominant timing of migration per decade. The figure shows that the majority of respondents migrated within the last two decades, specifically between the years of 1991 to 2000 and 2001 to 2010. *Figure 4-2* also shows that of the sampled data in this research, there is a declining trend in migrations over the last three decades, with 41.4% of the entire sample migrating between 1991 and 2000 and only 14.1% during the latest decade.

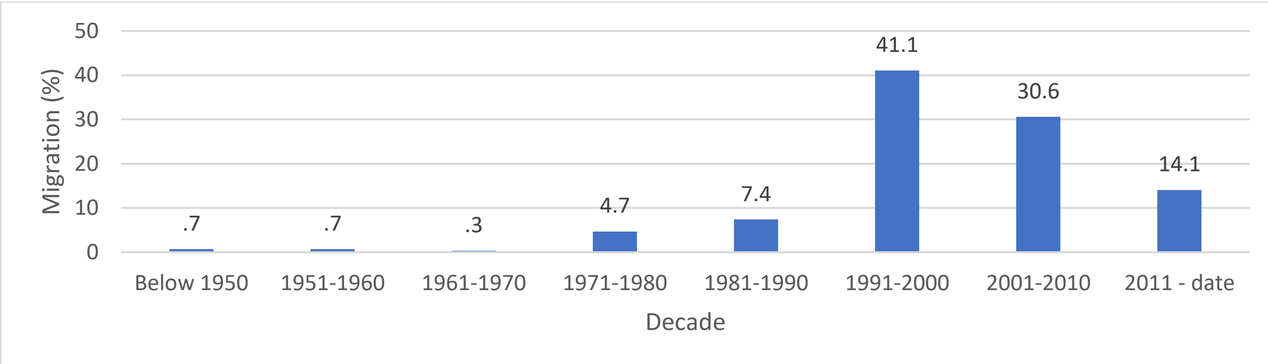


Figure 4-2: Temporal peaks of migration by decade. Figures show the percent of migrations in the respective decade as compared with the entire sample. Source: Author.

Finally, *Figure 4-3* shows the findings for 3) dominant timings of migration per month. Irrespective of the year, respondents reported having mainly migrated into Marsabit in September. 47.3% of all migrations reported occurred in that month. This shows that rural-urban migration is mainly happening towards the end of the long rain season; an indicator that the long rain season may have performed poorly.

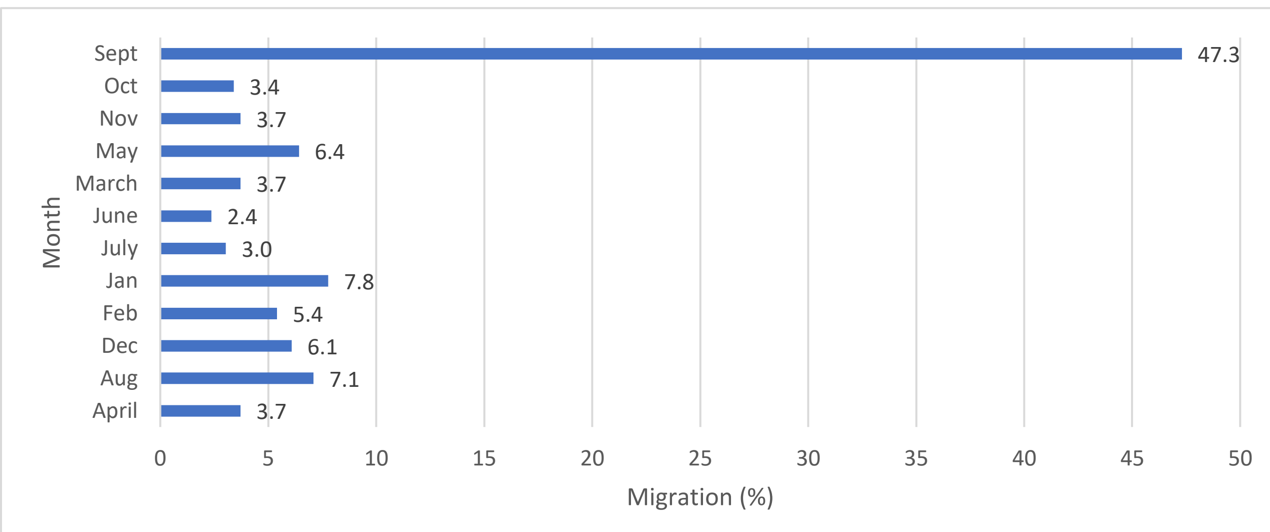


Figure 4-3: Migration per month of all data. Percentages relate to recorded migrations per month relative to all recorded migrations. Source: Author.

4.1.2. Causes of migration

Causes of migration were covered in the questionnaire, discussed in the focus group discussions and addressed as part of the interviews with NGO and officials in the county. Results of all three groups of stakeholders are subsequently reported. According to the questionnaire, the majority of the respondents strongly perceived their vulnerability to environmental risks, such as drought, that is considered the main driver of out-migration. Of the 295 randomly selected respondents, 53% (female) and 47% (male), an aggregation of the results yielded reasons of migration. The top three reasons for migration were drought, lack of rain and lack of water for livestock, respectively. This indeed shows the strong relationship between migration and drought hazards. *Figure 4-4* presents these and other causes of migration per response.

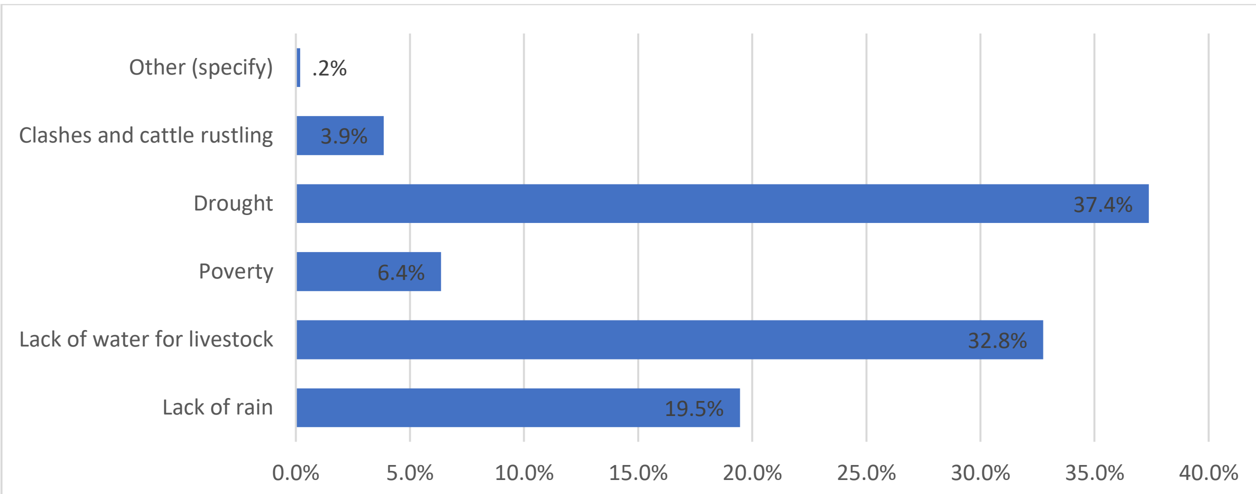


Figure 4-4: Reasons for migration. Source: Author

Some of the qualitative answers from the Focus Group Discussions were also related to the question on causes of migration, for example: *"When our animals suffer, we suffer."* (28-year-old Borana herder). Other interviewees when asked about reasons for migration, said: *"We have no water to drink. We drink dirty water; there is no rain for three years now." (*45-year-old Borana woman); *"In all my life, never experienced drought like this one before. It is very harsh." (*100-year-old Rendille pastoralist); *"120 out of 150 of my cattle died, no food, no water, they become too weak. We have to lift them for them to walk. It is this drought killing them." (*68-year-old Borana herder).

Figure 4-5 presents the impact of drought on livestock.

a) Slaughtered cow which succumbed to drought

b) Livestock carcass of cattle overwhelmed by drought

Figure 4-5: Devastating effects of drought on livestock. Source: Author

Interviews with NGOs and other officials also yielded insights into the causal relationship between drought and migration. These stakeholders provided a more diverse picture. For example, an interview with the resilience officer of Concern Worldwide NGO of Marsabit office mentioned the following as a cause of migration: "*Force to modernise, force to be educated, force to access health services, access to school feeding programmes are among the key attractions".* The town administrator of Marsabit County commented: *"Access to economic opportunities, services and amenities like water tracking is attracting migration along the road network. But permanence or temporariness of migration is highly dependent on success in town".* Also, other indirect impacts such as cattle rustling, ethnic and resource-based conflict were reported to cause migration. A Red Cross officer reported: *"Conflict among communities is a major reason for migration into Marsabit Town. The Turbi massacre was a memorable inter-clan-based conflict between the major Borana and Gabra communities".* Further questioning revealed that the Turbi area is predominately resided by Gabra community. In July of 2005, armed Borana members attacked the Gabrra community living in this area and killed over people most of who were children.

During the FGDs and KIIs conflict was identified as another primary cause of migration. Because of that, the communities identified types of conflicts and their geolocations around the county through a participatory mapping exercise *(Appendix 11- FGD Map). Figure 4-6* below is a map culmination of this participatory activity. Results yielded resource-based inter-clan conflicts between the Turkana, Dasnach and local communities along Lake Turkana. Another resource-based conflict in areas such as Uran, Turbi, Maikona and around Mt. Kulal (Samburu county border) was based on accessing water points and grazing grounds for the animals. Moreover, human-wildlife conflicts regarding high elephant invasion were also reported around Central Marsabit IBLI unit and in the Gadamoji areas was reported around Mt Marsabit.

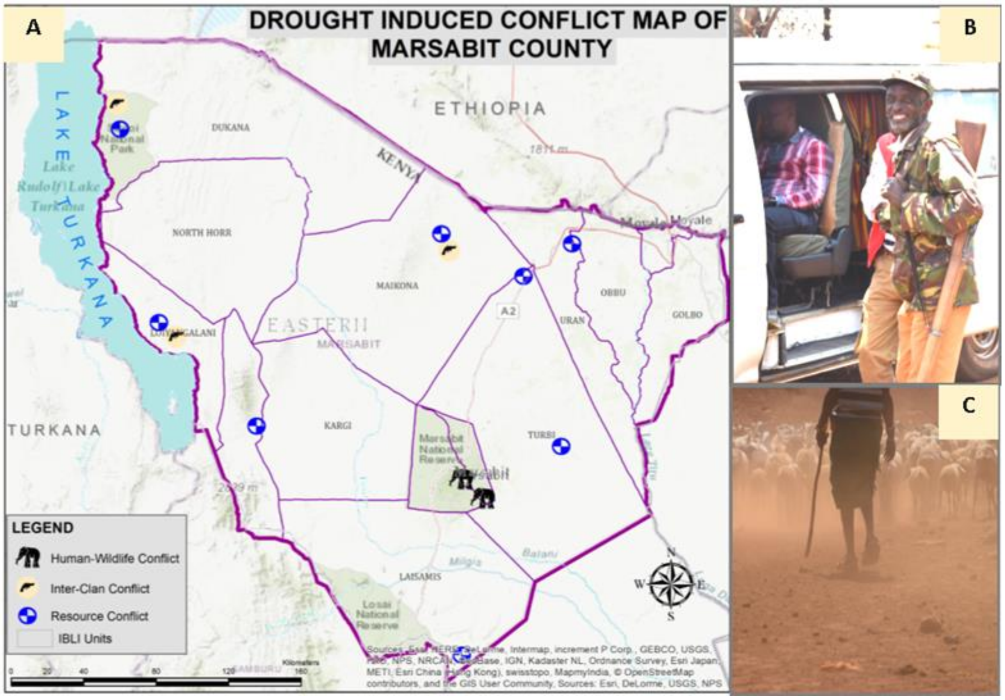


Figure 4-6: Reasons for migration due to drought-induced conflict: **A**-Locations and kind of conflict in Marsabit County, as determined during focus group discussions. **B-**Police reservist talking about conflict; **C-**Cattle shifting due to risk of rustling as a form of resource conflict. Data: Local spatial knowledge. Source: Author

4.1.3. Source Areas of Migration (Origin Locations)

According to the questionnaire data, most of the respondents moved to other places near-by before moving to Marsabit Town directly. Of the respondents' interviewed, 69% relocated to the surrounding local market centres within the drought-hit areas before eventually moving to Marsabit town while others (31%) moved directly into the town *(Appendix 12-Table of stop-over responses)*. Moreover, a comparison between the original locations as given by respondents with the GIS and Google Earth locations of each area mentioned provided additional insights. This illustrates that 97% of the migrants came from rural drylands of the rural Marsabit county into Marsabit town while only 1% came from surrounding counties equally hit by droughts such as Turkana, Samburu and Isiolo *(Appendix 13-Table of responses of origin location)*. Another 2% migrated from neighbouring countries like Ethiopia. *Figure 4-7* illustrates a proportional flow line map of origin areas, migration routes, and stop-overs towards the final destination of Marsabit Town as reported by the interviewed migrants since the year 1941. It is apparent from *Figure 4-7* that there were migrations within and outside the county. A closer inspection of the inset in *Figure 4-7* further revealed many flows within the destination of Marsabit Town itself.

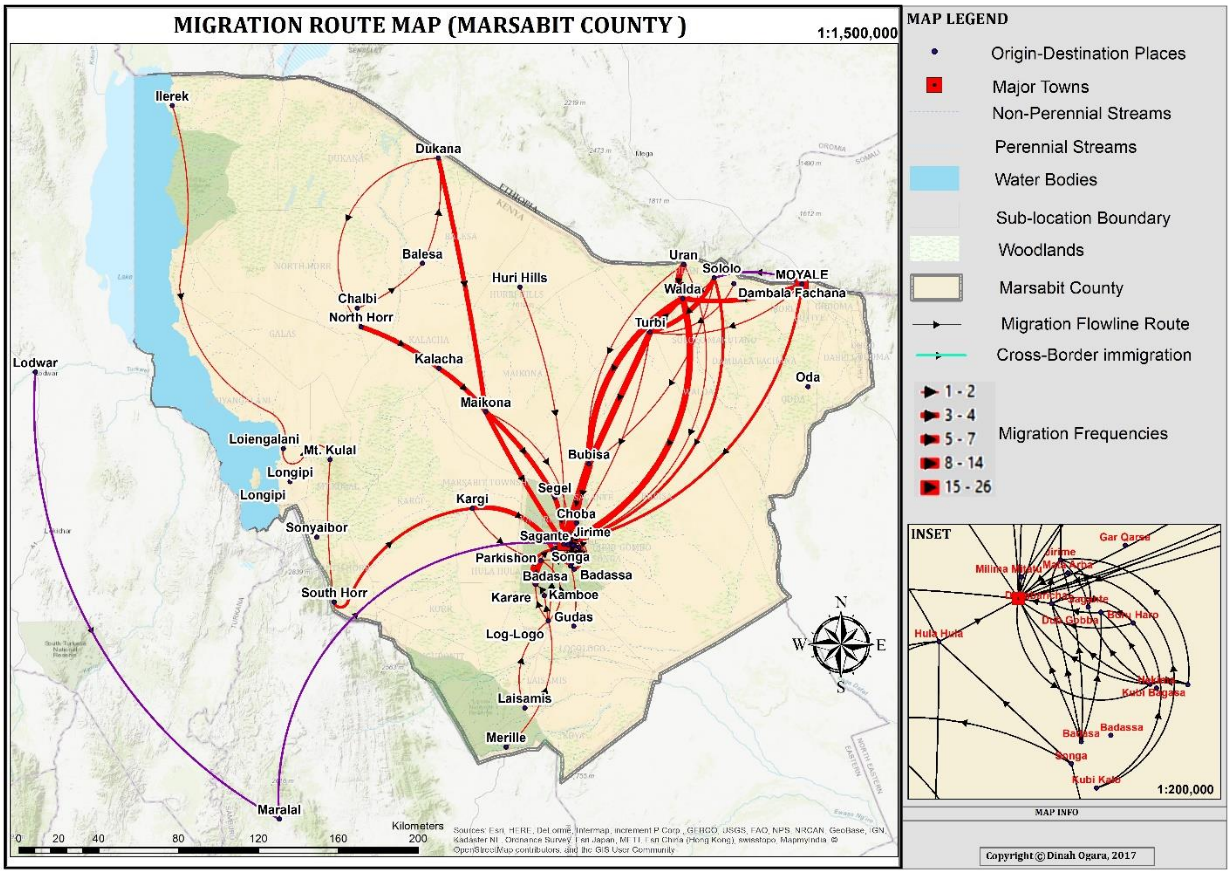


Figure 4-7: Origin-Stop Over and destination locations of pastoralists during urban migration. The large map shows the routes of migration from outside as well as within Marsabit County. The inset (small map) gives a representation of the movements with the urban area of Marsabit. Source: Author

4.2. Objective 2: Quantify dominant timings of migration using satellite-derived drought assessments

4.2.1. Migration cum Rainfall and NDVI bimodality (1981-2015)

Figure 4-8 shows a plot of rainfall and zcNDVI against migration from 1981 to 2015, clustered by season. It reveals, first, that the times of low rainfall and low zcNDVI overlap. Second, what was striking about *Figure 4-8* was the similarity in pattern between the low peaks of both NDVI and rainfall with high peaks of migration for some seasons. For example, 2000L and 2009L stand out for having a particularly low NDVI performance and high migration. Additionally, 2011L recorded low rainfall and shows among the highest migration.

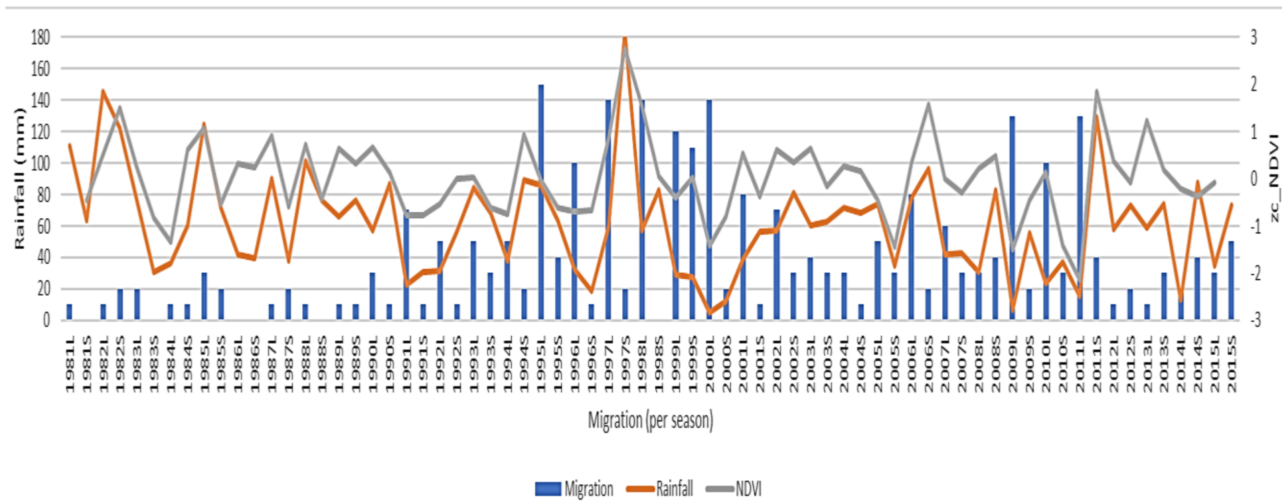


Figure 4-8: Migration cum Rainfall and zcNDVI per season (1981-2015). Source: Author

Third, a look at time periods reveals that, e.g., between 2000L and 2006S seasonal rainfall, and corresponding zcNDVI values increase. Within the same period, migration goes down because there was enough pasture for livestock and water for pasture regeneration. Contrary to this, a look at the period between 1997L and 2000L provides evidence that rainfall drastically reduces within these three years. Subsequently, zcNDVI values for these corresponding years gradually decreased, and at the climax of lowest performing rainfall and zcNDVI, migration of respondent interviewed was at its highest.

The migration can be attributed to pastoralists adapting in response to severe drought, depleted and deteriorated conditions. A similar scenario is evident within the period of 2008L and 2011L. To quantitatively define the observed relationship, migration frequencies were regressed on zcNDVI. An R^2 value of 0.43 was obtained for zcNDVI long and short rain seasons as explanatory variables, and R^2 of 0.50 for zcNDVI and Rainfall as explanatory variables to migration. See *appendix 14* for diagnostic regression statistics. According to this, the relationship between migration and zcNDVI or rainfall is not linear, but the explanatory variables account for a significant percentage of migration.

4.2.2. Comparative analysis of satellite-derived drought indices and migration data

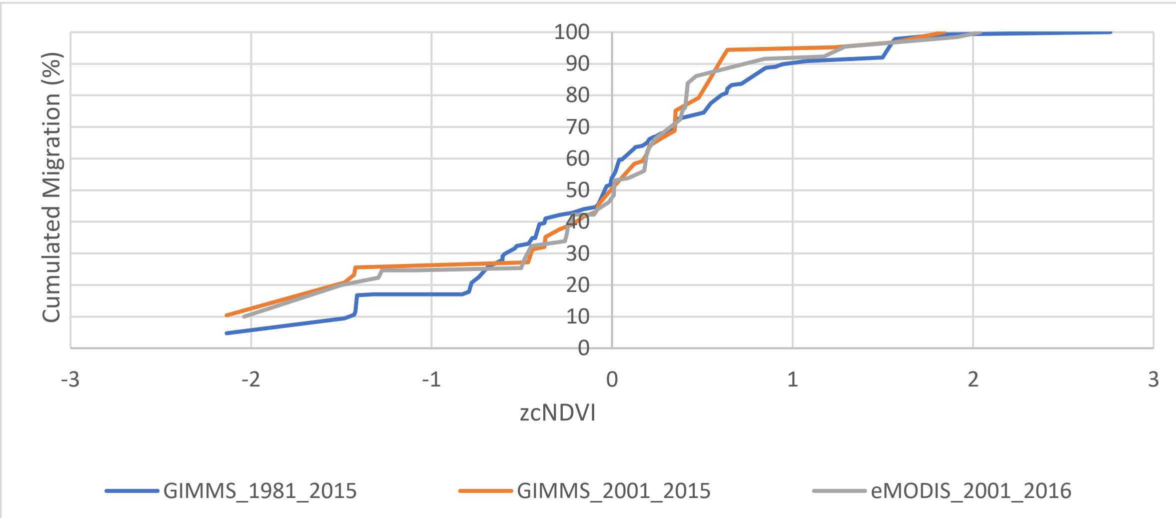


Figure 4-9: Cumulated migrations plotted against the zcNDVI per season. Zero (0) zcNDVI values indicate normal NDVI conditions, as averaged over the respective period. zcNDVI values below zero (0) indicate dry conditions; the lower the value the drier. For example, zcNDVI at below -1 shows a condition of 1 standard deviation below the mean. Data: Field Survey and remote sensing data. Source: Author

Figure 4-9 presents a comparison of the cumulative migration with the average of zcNDVI of the current season for the three different time lapses and two satellite sources of data. When zcNDVI for the GIMMS 1981-2015, GIMMS 2001-2015 and eMODIS 2001-2016 was plotted against the percentage of all migrations, relatively low differences were detected between the datasets. For the entire period which is GIMMS epoch of 1981 to 2015, 58% of all migrations occurred for zcNDVI values below zero (0). At the zcNDVI threshold of below -1 the GIMMS 1981-2015, 18% of all migrations are recorded. Comparatively, for GIMMS 2001-2015 and eMODIS 2001-2016 epochs, 50% and 52% of all migrations respectively, occurred for zcNDVI values below zero (0). At the zcNDVI threshold of below -1 for GIMMS 2001-2015, 28% of migrations are recorded. For eMODIS, at zcNDVI threshold of below-1, 25% of all migrations are recorded.

The result in *Figure 4-9* was interpreted using *Figure 3-7*; in a standard normal distribution of zcNDVI, zero (0) denotes average conditions, whereas -1 means that the condition is one standard deviation below the average condition. Therefore, it would be expected that at zcNDVI threshold of below zero (0), 50% of migrations occur. Similarly, 15.9% of cumulative percentage migration would be expected at zcNDVI of below -1 as shown in *Figure 3-7*. However, in *Figure 4-9*, the value of the cumulative percentage of migrations is 8%, 10% and 10% for GIMMS_1981_2015 eMODIS_2001_2016 and GIMMS_2001_2015 respectively at a standard deviation of -2. This is above the expected 2.3% at this threshold in a standard normal distribution case. Similarly, the cumulative percentage of migrations of 18%, 28% and 25% are registered at zcNDVI of below -1 which is still higher than 15.9%. As for the cumulative percentage of migrations at a zcNDVI value of below zero (0), 58%, 50% and 52% are recorded for GIMMS_1981_2015, GIMMS_2001_2015 and eMODIS_2001_2016 respectively. Thus, according to these results, drought is an explanatory variable of rural to urban migration of pastoralists under extreme drought conditions. At average conditions of zcNDVI below 0, drought remains an explanatory variable for the whole dataset, GIMMS_1981_2015, but is not for the recent drought events between 2001 – 2016.

4.2.3. Demographic Analysis of migrants

Demographic analysis is among the indicators of households' vulnerabilities, rationale and abilities to decide to migrate. In this study age and gender of migrants was analysed to understand vulnerabilities of pastoralist migrants at the time of migration. Based on the justification of graph in *Figure 3-4* on regression of satellites, the subsequent analysis used the longer period data set of GIMMS from 1981-2015.

4.2.3.1. Age frequencies

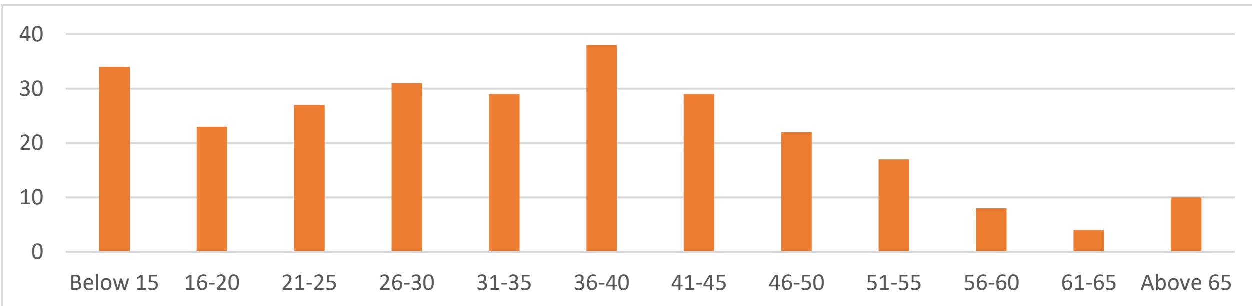


Figure 4-10: Age of migrants at time of migration. Data: Field Survey. Source: Author

Figure 4-10 illustrates that the majority of respondents were between the age of 36-40 and below 15 years of age at the time of migration irrespective of drought conditions. Due to the questionnaire requesting for in-depth details of migration data per month during the year of migration, the possibilities of information bias, particularly on the side of the pastoralist migrants, many of who migrated when they were still below the age of 15, may be high.

4.2.3.2. Age group analysis and satellite-derived indices

To assess migration based on zcNDVI by age groups, the cumulative analysis for both the average zcNDVI current season was conducted. Justified by *Figure 3-4* above, the subsequent analysis also used the longer data set of GIMMS from 1981-2015. It was assumed that migrants either below ages of 15 or above ages of 65 might have some recall challenges such as remembering both timings and motivation to migration. Thus, based on results from *Figure 4-10* above, both age groups of below 15 and above 65 were excluded for subsequent analysis. *Figure 4-11* shows the analysis of the different age groups at the time of migration.

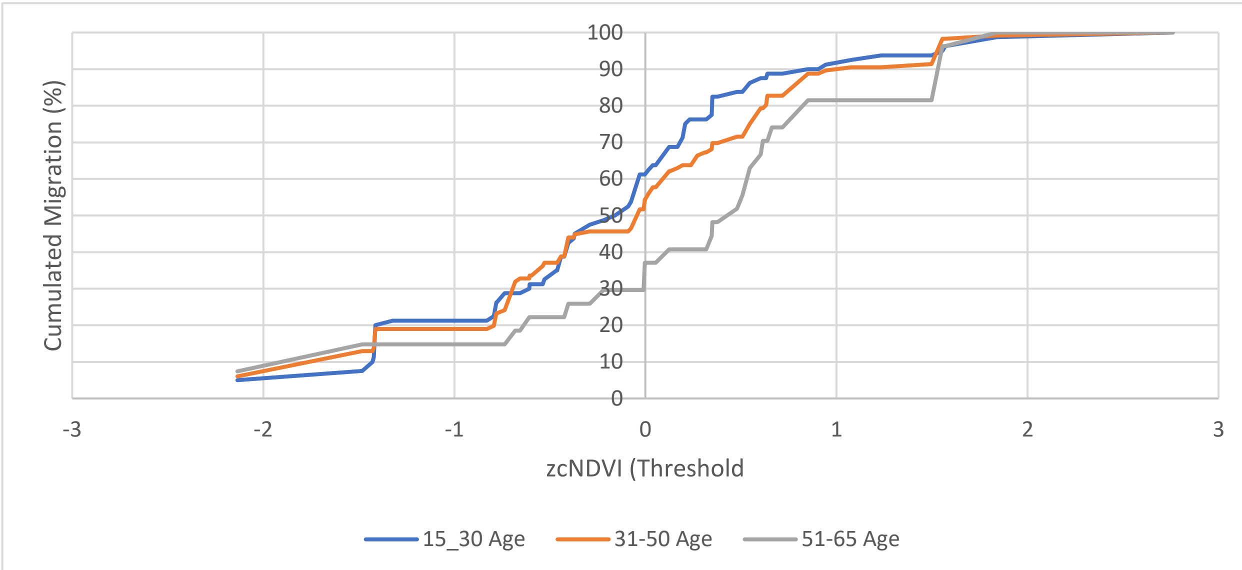


Figure 4-11: Average of the zcNDVI for current season per different age groups. 0 zcNDVI values indicate average NDVI conditions. zcNDVI values below 0 indicate dry conditions; the lower the value the drier. Data: Field survey and remote sensing data. Source: Author

Although differences are small, they seem to suggest that at earlier ages the response to drought is a little stronger. At zcNDVI of -2, migrants aged between 15 to 30, 31 to 50, and 51 to 65 record cumulative percentage migrations of 8%, 10% and 10% respectively. At zcNDVI of -1, corresponding cumulative percentage migrations of 22%, 19% and 16% are recorded. According to these results, as is the case for total migrations (Figure 4-7), extreme drought condition is an explanatory variable for rural to urban migration of pastoralists. It is observed that at drier conditions below -1, the older age groups (31-50 and 51-65) migrate more than the younger age group (15-30). However, at zcNDVI of -1, the younger age group migrates more than older age groups.

4.3. Objective 3: Qualify Effects of Migration on Livelihood

4.3.1. Livelihood Sources and Income

Before migration, 89% of the respondents were pastoralists, 7% practised farming and 3% business/ commerce. The remaining 1% engaged in other income generating activities like charcoal burning. Comparatively, most (54%) migrants currently residing in Marsabit town now engage in manual labour (such as Watchmen, construction workers for men and maids and hotel workers for female) as their primary livelihood activity. Most of them earn between KES 5,000 to KES 10,000 (approximately 41 EUR to 82 EUR) per month. Other income generating activities are farming (31%), business (10%) and others (5%). Others represent interviewees who are either beggars, depend on relief aid or are unemployed.

Figure 4-12 presents the current income of pastoralist drop-outs in Marsabit urban areas. *Figure 4-13* presents the livelihood activities of pastoralist drop-outs in Marsabit Town.

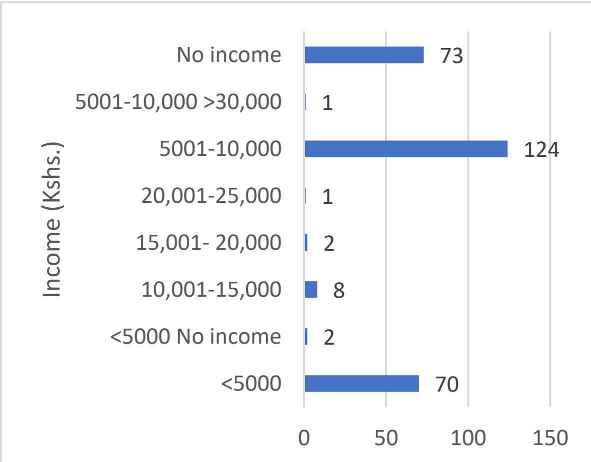


Figure 4-12: Current Income of migrants in urban area. Data: Field Survey. Source: Author

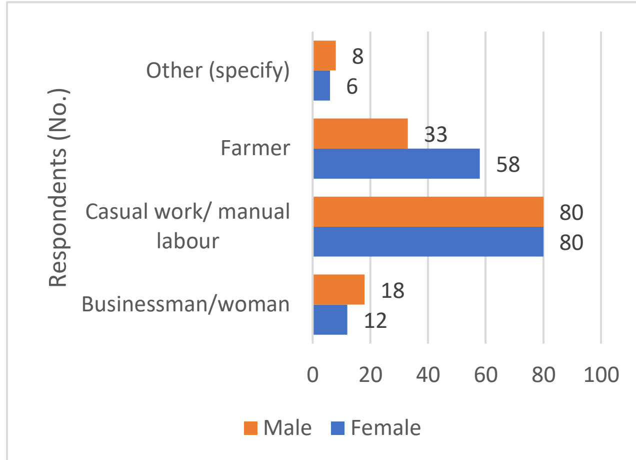
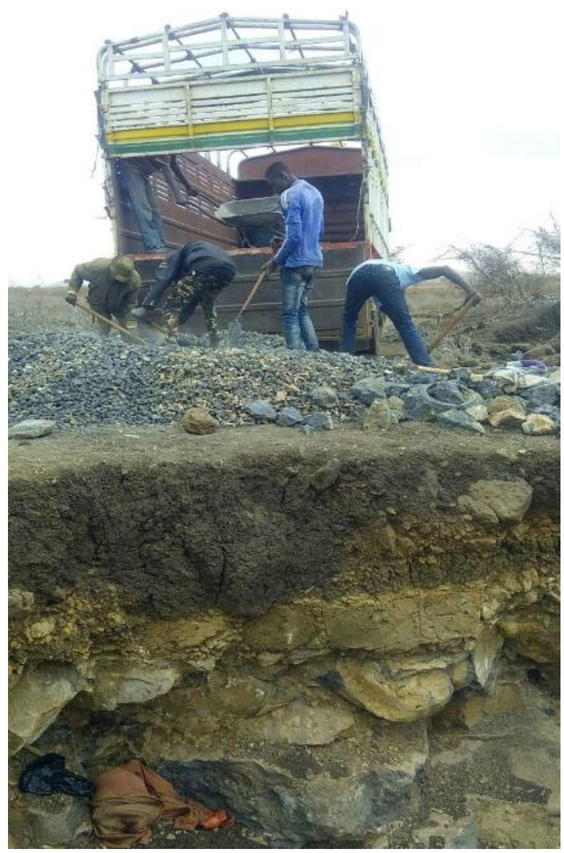


Figure 4-13: Current Livelihood of migrants by Gender. Data: Field Survey. Source: Author.

a) Female pastoralist illegally selling firewood.

b) Bundle of firewood retailing at Kshs. 550 sold illegally



c) Youth mining ballast at Quarry

Figure 4-14: Livelihood Diversification of pastoralist drop-outs showing illegal (a) and b) and (c) legal practices. Source: Author.

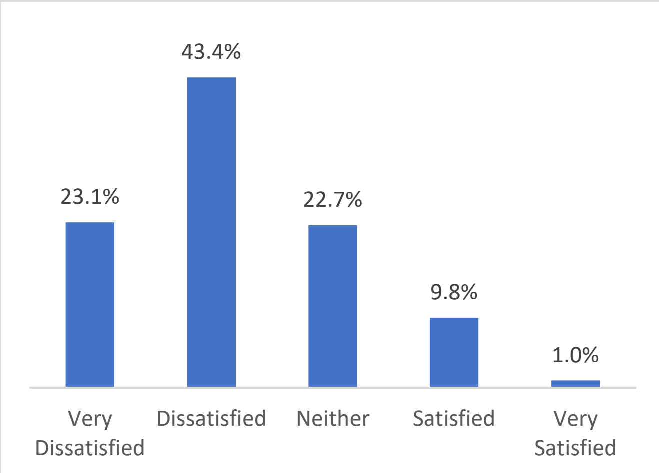


Figure 4-15: Level of satisfaction of quality of life before migration. Data: Field Survey. Source: Author

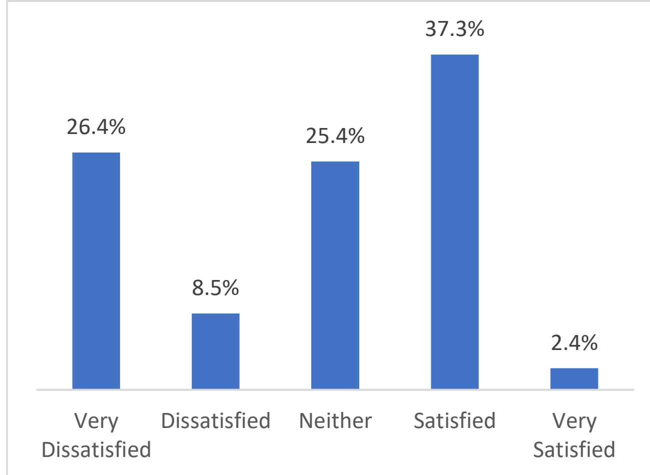


Figure 4-16: Level of satisfaction of quality of life after migration. Data: Field Survey. Source: Author

Using the Likert scale where (1=Very Dissatisfied and 5= Very Satisfied), pastoralists drop-outs qualitatively perceived their quality of life before and after migration from rural places of origin, to the urban destination of Marsabit Town. As illustrated in Figure 4-15, the majority of the respondents were dissatisfied and very dissatisfied with their quality of life before migration. Similarly, as shown in Figure 4-16, there were mixed reactions on their quality of life after migration with 37.3%, 26.4% and 26.4% were satisfied, very dissatisfied or neither respectively. Further probing into the reasons behind these perceptions exposed interesting results. The respondents were asked two separate questions on 1) whether they had interests to remain in the urban area and 2) asked about prospects of practising pastoralism again if given an option to choose between other thriving livelihoods. Most pastoralists drop-outs (96.2%) were more comfortable in the urban centres and were not willing to return to their rural homes/areas, while 3.04% were willing to move back. However close to 63.9% were ready to move back to pastoralism given an opportunity, 35.5% were not willing to move back to pastoralism, and 0.34% were not sure.

4.3.2. Perceptions of effects of migration on Livelihood conditions

Of the respondents who wanted to move back to pastoralism, most (69.3%) felt that the main reason for their return to this livelihood was that pastoralism was more economically beneficial and 21.3% also felt that pastoralism improves their living standards, mostly due to presence of by-products like milk and meat which they could use within the house or sell for income. *Figure 4-17* presents the reasons for wanting to move back to pastoralism.

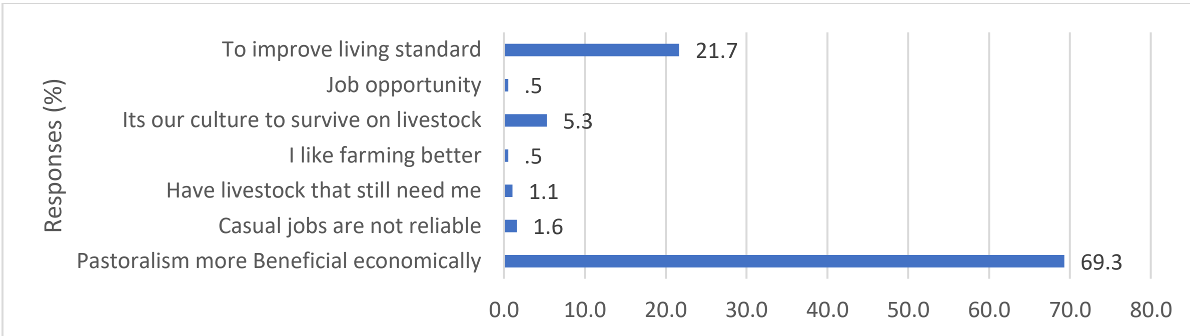


Figure 4-17: Reasons for wanting to go back to pastoralism. Data: Field Survey. Source: Author

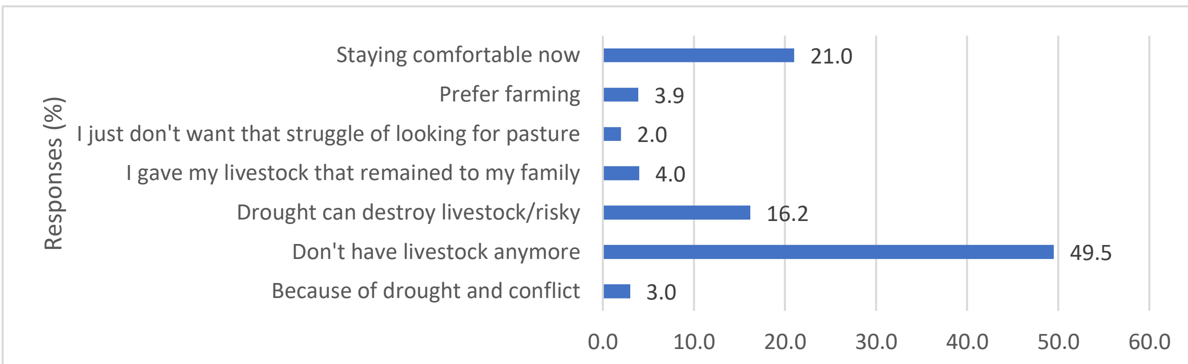


Figure 4-18: Reasons for not wanting to go back to pastoralism. Data: Field Survey. Source: Author

Figure 4-18 shows the reasons for respondents not wanting to go back to pastoralism. Among those, 49.5% of the respondents mentioned the lack of livestock as being the major reason for not wanting to move back into pastoralism.

4.3.3. Retained connection to places of origin

96% of respondent interviewed are still connected to their family while 4% are not connected to their places of origin. Most (78%) migrated with their households to the destination area of Marsabit 22% of respondents migrated individually. In cases where respondent did not relocate with household or clan, still, 89% of the respondents know where they stay, and 11% do not. Most of the migrants remain connected to their family they left behind in their places of origin. Others send remittances home while a few practice remote pastoralism. As explained by one of the respondents and the chief, remote pastoralism is when a pastoralist at the time of dropping out of pastoralism gives his remaining herd to a relative, clan member or neighbour. This arrangement is made on an agreement that the pastoralist drop-out would move to town to look for work and send money back to the person he entrusted his herd with. It is a coping strategy to spread risk. *Figure 4-19* summarises how pastoralists keep the connection to their families.

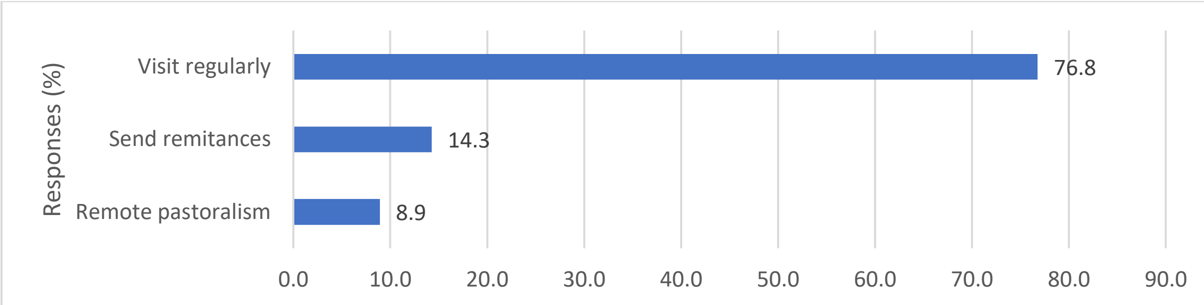


Figure 4-19: How connection to origin areas is retained. Data: Field Survey. Source: Author

4.4. Additional Information

4.4.1. Support from Institutions

On matters dealing with support from institutions (government agencies, international organisations, NGOs) during drought and after migration, government institutions, non-governmental organisations and Faith-Based Organization offer support to communities during a drought disaster and after migration into the urban area. However, some community members felt more support could be provided to cope with the adverse impacts of drought, and particularly for a more successful migration to the urban areas.

Organizations like the National Drought Management Authority (NDMA), Red Cross, Japan International Co-operation Agency (JICA), Pastoralist Community Initiative and Development Assistance (PACIDA), Pastoralist Integrated Support Programme (PISP), Care Kenya, WFP (World Food Programme), the "Deutsche Gesellschaft für Internationale Zusammenarbeit" (GIZ), and the Catholic Church among others were mentioned.

Aid is offered in the form of food donations, cash transfers, livestock insurance pay-outs, land provisions to settle on, grass donations for remaining livestock, as well as water and even goat provisions. As presented in *Figure 4-20*, the majority of respondents felt that there was no assistance they received during migration.

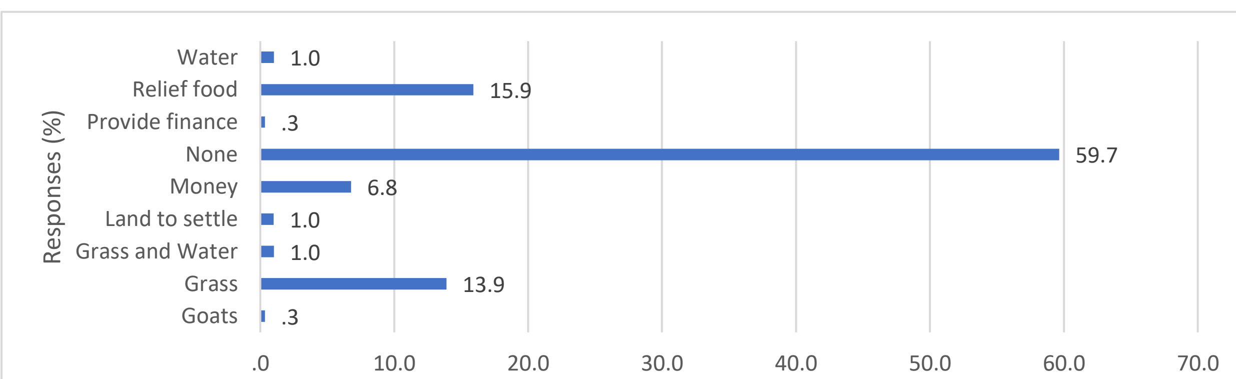


Figure 4-20: Type of assistance given by organisations. Data: Field Survey. Source: Author

4.4.2. Gender dimension of drought-linked migration

From the women's focus group discussions, it emerged that men sometimes migrate first to scout for a new environment, and then earn money to send it back as remittances (e.g. via MPESA). *Figure 4-21* shows the gender plotted against average of the current season of zcNDVI, about 63% of migration were male at zcNDVI of values below 0, and 50% were female migrations. This indicates that men respond to drought more than women under slight drought conditions. However, looking at a zcNDVI values below 0, under extreme drought conditions this turns to the opposite. At zcNDVI of below -1, we have a value of 22% accumulated female migrations and only 12 % of male migrants. In addition, at zcNDVI of below -2, female migrants record 8% against 5% of the male. This implies that women migrate in response to more severe conditions of drought than men since in both zcNDVI of below -1 and below -2, 15.9% and 2.3% in a normal distribution case is exceeded.

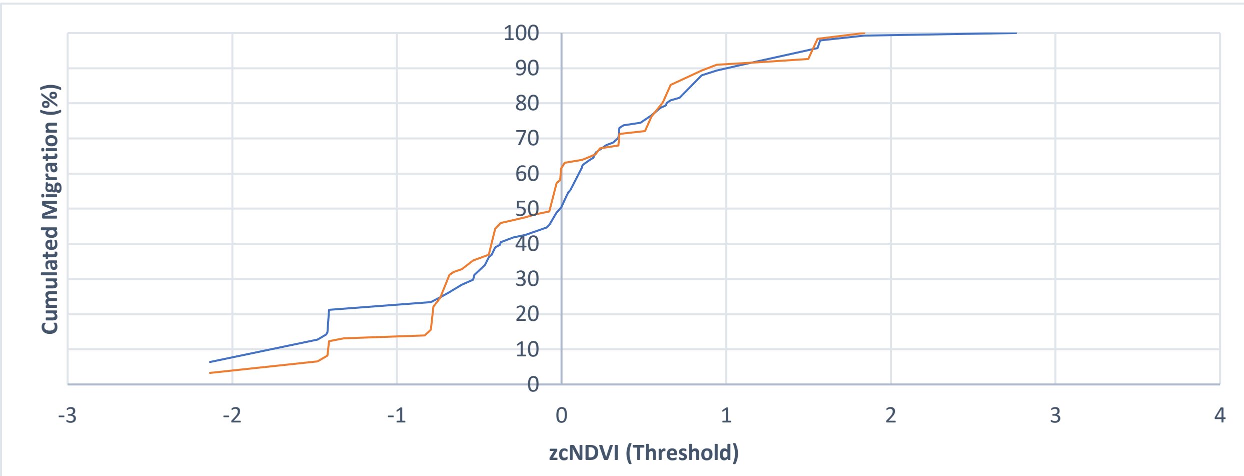


Figure 4-21: Gender plotted against average of current season of zcNDVI. 0 zcNDVI values indicate normal NDVI conditions, as averaged over the respective period. zcNDVI values below 0 indicate dry conditions; the lower the value the drier. Data: Remote sensing and field work data. Source: Author

If men do not get work, then women sell firewood, burn charcoal, engage in illegal mining activities or work as maids in the Town. The women are left tending to the household and the children. However, women also migrate. One interviewee reported that: *"We keep moving to follow the rain or closer to water points"*. Another respondent mentioned: *"When there is conflict, we lose our husbands, our sons and our cattle. We have to look for work"*.

Also, during drought women in the rural areas are forced to walk for up to 10 to 20 kilometres in search of water. These challenges make them migrate to urban areas in search of services, only to find dirty water which causes diarrhoea, cholera and even death for the elderly ones. Women also reported high malnutrition among children. The long distance they have to cover to access healthcare for either their children, the elderly or themselves, especially during maternity, worsen the already dire conditions. Commenting on health challenges women face during migration challenges, one of the interviewees said: *"During migration, we give birth along the way, with the help of other female friends. Sometimes the children are born sick, or they die."* One participant commented: *"The drought is so harsh that the animals have no food anywhere, they cannot survive, without animals, we have no milk for our children, no food for ourselves, without food, there will always be a problem."*

To curb some of the challenges, some NGO's and governments have designed programs to help alleviate some of the burdens on women. The government started mobile clinics to ease maternal health care and treat children.

Boreholes have been dug in some drier areas to reduce distances walked by women to access water. Food aid helps reduce poverty and malnutrition.

5. DISCUSSIONS

The primary objective of this study was to assess how drought contributes to rural-urban migration and livelihood dynamics of pastoralists in Northern Kenya. This chapter discusses central findings and insights of the research drawn from the analysis and results in chapter three and four and is compared with existing knowledge and research from other similar studies where necessary.

5.1. Temporal distribution of migration of pastoralists

The results of the study revealed that the migration in the long rain season is higher than in the respective short rain season. This is the case in 62% (23 years) of the 37years of migration data aggregated per bimodal seasonality (1980-2017) of Marsabit County as covered in this study *(Figure 4-1)*. The year of 1995L, 1997L, 1998L, 1999L, 2000L, 2009L, 2011L and 2017L experienced high migrations of more than ten pastoralists. Other years of high migration that stood out with five to ten migrations per season are 1991L, 1996L, 2001L, 2002L, 2006L and 2010L. Interestingly, 1999S yielded high migrations of elven people, which may be explained by extended poorly performing long rain season in 1999L and followed by failed short rains within the same year, implying that gradual and prolonged adverse changes in the environment may have a much greater adverse impact on the livelihood systems of these communities and inducing their decision to migrate or stay. The results from the temporal peaks of migration concur with Huho and Mugalavai (2010) who account for drought documented in the past. They revealed that between 1990 and 2010, the government of Kenya declared five drought-related national disasters in 1992/93, 1995/96, 1999/2001, 2004/2006 and 2008/2009. Further, the movements in 2006 and 2009 are supported by Howden (2009) who further asserted that over three million pastoralists in northern Kenya were impacted by severe droughts of 2006 and 2008/2009, noting that these drought events have been increasing in frequency and severity over time.

Further, the results of the study illustrated that migration patterns and decisions of pastoralists communities are pegged mainly on the success or failed performance of rainfall seasons over a long period. Declining rainfall amounts and high variability over time explains not only a single drought event but the longer term cumulative aspects of changing environmental conditions which influence the vegetation growth succession, livestock and livelihood dynamics of pastoralists' communities. This notion is in agreement with Henry, Schoumaker et al. (2004) in their study on migration in Burkina Faso noted that long-term studies on environmental variables provide a more useful understanding on long-term migration decisions of households in the Sahelian region based on long periods of environmental degradation induced by environmental change.

While there are several possible units of measurements of time (weeks, months or years) that can be used to measure migration timings, the bimodal season of Long Rain (March-May) and Short Rain (October to December) proved useful to illustrate the migration pattern of pastoralists communities in this study. For drought-related migration studies, aggregations by season though tedious depending on the amount of data in use, best offers the means to comprehend tipping points of pastoralist drop-outs and their related drought-linked urban migrations. This, however, can be different in others studies and strongly depends on the purpose or intended objective of any one given research.

5.2. Causes of migration

There is a multitude of transformations linked to the multi-causal nature of migration induced by environmental change, that is to say, environmental change induced migration is not easily discernible from other reasons. Investigating the causes of migration of pastoralist communities and their push factors to migrate has provided several key insights that are in tandem with current migration studies and literature. It is evident from this research that the pastoralist drop-out communities investigated in this study, strongly perceived their vulnerability to environmental risks, that is, persistent drought and associated adverse impacts are the major triggers to migrate into Marsabit town *(Figure 4-4)*. However, discussions with experts on the ground revealed much greater complexities associated with the reasons for migration. In this instance, the key informants explained that in addition to drought is a significant contributor of pastoralist out-migration from their rural drylands, other external forces additionally influence the decision to migrate to urban centres. Among them are the force to modernise, force to access infrastructure services like internet, power, mobile network and transport, force to be educated and access healthcare services, and others.

The multi-causal nature of causes of migration is demonstrated in Fratkin et al. (2004); pastoralists in sparsely populated parts of Northern Kenya (where the Rendille live) are said to settle not only in response to the environmental stress of drought and famine but also as a result of geopolitical challenges such as ethnic clashes, cattle rustling and livestock raiding. Several such examples of conflicts are noted in Marsabit, for example 1) Historically, there have been inter-ethnic tensions between the dominant communities of Borana and Gabra in Marsabit. The Turbi massacre is a memorable example that was mentioned during the key informant discussions. At least 53 people, of whom 21 primary school pupils, were killed by Borana pastoralists. The fight was partly because of livestock theft and pasture lands as well as longstanding disputes between the two communities (Stidsen, 2006, p. 446). 2) Traditionally, conflict has been based on resource conflicts such as fight for land water points and grazing grounds *(Appendix 15- Image of conflict over water points)*, however, in 2011 and 2013, the pastoralist groups of Borana and Gabra in Moyale sub-county were in violent ethnic clashes because of political exclusions instigated by local politicians (Obuya, 2014). 3) Cross-border conflicts over scarce pasture and water between the Isiolo border and Marsabit counties is especially escalated during the peak of drought. During election periods, tension and conflicts are particularly high as politician insight their respective communities. A notable example is the 1997 border disputes over community land. During the election campaigns, local politicians seeking office made promises of restoring land wrongly lost to border communities along the Isiolo-Marsabit border. This fuelled tension among the communities making this particular year, a violent election year (Abdille, 2017). These geopolitical situations are likely to play a role in increasing conflict and thus increase migration into urban areas.

The complexity of causality of migration is re-iterated in this study. The data revealed that in some odd instances there were a high number of migrations even with positive zcNDVI values (e. g: 1998L had 14 migration counts at a positive zcNDVI value 1.5 and 14 migration counts at the positive zcNDVI value of 0.8509 *(Appendix 16- Migration and zcNDVI table)*. Some of these migrations may be explained by rising ethnic tensions among communities, as 1997 was an election year, which normally has higher instances of conflict that resulted in the Kokai Massacre, another critical conflict that occurred in the county in this year, regardless of zcNDVI. In this case, conflict is probable to have induced the migration. These outcomes can be explained by the fact that when migration occurs during drought, other context-specific non-environmental factors interact with drought; it is a more complex inter-relationship between environmental factors and mobility dynamics rather than a simplistic mono causal-relationship (de Bruijn & van Dijk, 2003; Jónsson, 2010). Pastoralists migrants in Marsabit County may have been responding to a range of pressures and not just to climate change in isolation. However, it is important to note that it can also take time for a pastoralist to respond with a decision to quit pastoralism; a few droughts could be the trigger, but the real migration may only come if in subsequent (good) seasons the pastoralist still does not manage to build up his herd. These findings concur with the study of Jónsson (2010) in the Sahelian region, which states that not only are migrants in drylands pushed-out of marginal degraded environments, but also their migration is intertwined and inseparable with political, economic and cultural factors too.

5.3. Inter and Intraregional Migrations

This study shows that drought yields an array of migratory patterns. Pastoralists in Marsabit town came from Marsabit County, neighbouring counties or neighbouring international countries, which means that both short and long-distance migrations were documented *(Figure 4-7)*. Regarding quantification, however, nearly all came from the surrounding rural drylands of Marsabit County; very few migrants came from the neighbouring arid counties of Turkana, Samburu and Isiolo, or from neighbouring Ethiopia. International movements of pastoralist as a product of drought and environmental change are acknowledged by Bassett and Turner (2007), who studied the Fulbe pastoralists of the Sudano-Guniean region. Also, these pastoralists crossed the borders to neighbouring countries during drought.

Traditionally, pastoralists have managed uncertainty and risk associated with arid lands including drought through long-distance movements and livestock mobility (Scoones, 1995). To cope and adapt to the unreliable rainfall and pasture distribution to which their natural environment predisposes them, pastoralists must practice mobility (Barton et al., 2001). However, as illustrated by this research, there is a shifting trend in the flows of these communities in northern Kenya, who are tending to fall out of their livelihood systems and more permanent move to urban areas.

The study also identified migration routes, stop-overs and destination areas. Over two-thirds of the respondents migrated first to the surrounding local market centres around Marsabit town, i.e. drought-hit areas like Turbi, Bubisa and Maikona, before eventually moving to Marsabit town. About one-third moved into Marsabit town directly.

Marsabit Town, being the administrative core and headquarters of the larger Marsabit County, is the final destination area. The town attracts pastoralists from far rural drylands of the county into either the surrounding peripheral areas or into the town. As explained by key informants in both the NGO's and government offices, the migrants who successfully make it into the town seek economic opportunities in the hope of sending remittances back home, while others only make it to the urban-peripheral areas where they settle in clustered villages waiting for aid. This coincides with the study of Adow (2008) which notes that the emerging trend of pastoralist migration in northern Kenya comes in two forms; 1) move to urban areas in search of casual work leading to complete drop-out of pastoralist lifestyle; or 2) move to periphery of urban centres as internally displaced people, with emergency aid becoming their main livelihood.

5.4. Satellite-derived drought assessments to explain the dominant timings of migration

The relationship between satellite-derived drought indices and rural to urban migration of pastoralists remains to be a topical and non-trivial issue. According to the results of this study, a significant relationship between temporal forage scarcity indices (i.e. NDVI) derived from satellite imagery and pastoral out-migration patterns is established. As illustrated in *Figure 4-9,* satellite-derived drought indices depict an association between dominant timings of migration and forage scarcity proxies at specific thresholds. In this research, zcNDVI scores below -1 were interpreted as extreme drought conditions; the range of 0 to -1 was considered mild drought. Similarly, Vrieling et al. (2016) adopt a z score threshold of -0.842 as a trigger to initiate indemnity payouts, and Jain et al. (2015) operationalise severe drought as z score values less than -1.

In this study, drought as an explanatory variable of migration is demonstrated by the fact that more cumulative rural to urban migrations are recorded in extreme drought conditions than in mild and average zcNDVI. At zcNDVI of -2 and -1, the cumulative percentage migration is higher than a standard normal distribution case. When both migration and NDVI data are normally distributed, then drought fails to be an explanatory variable. However, in this study, migration is positively skewed *(Figure 5-1),* thereby reiterating the low-NDVI-more-migrations phenomenon illustrated in the results chapter. On the other hand, both satellites revealed that cumulated migrations were above the expected 50% for slight drought conditions (i.e. zcNDVI). In both cases, it could be inferred that migration to urban areas was partially triggered by drought events. This, therefore, answers the alternative hypothesis postulated in this research that there is a relationship between temporal seasonal forage scarcity indices derived from satellite time series and pastoral out-migration patterns.

However, a remaining question is the implications of a skewed distribution of sampled migration data. *Figure 5-1* shows that this is the case as the data is positively skewed. Statistical tests would be necessary to evaluate the relationship between the migration data and vegetation indices bearing in mind that the distribution of the datasets differs. However, as a first indication, the results of this study are very informative. A comparison of the normally distributed zcNDVI and positively skewed migration data *(Figure 5-1)* suggest that the frequency of more migrations are on the left of the distribution, which corresponds to the zcNDVI values below zero (i.e. drought conditions). This makes an even stronger case for migrations being as a result of drought conditions.

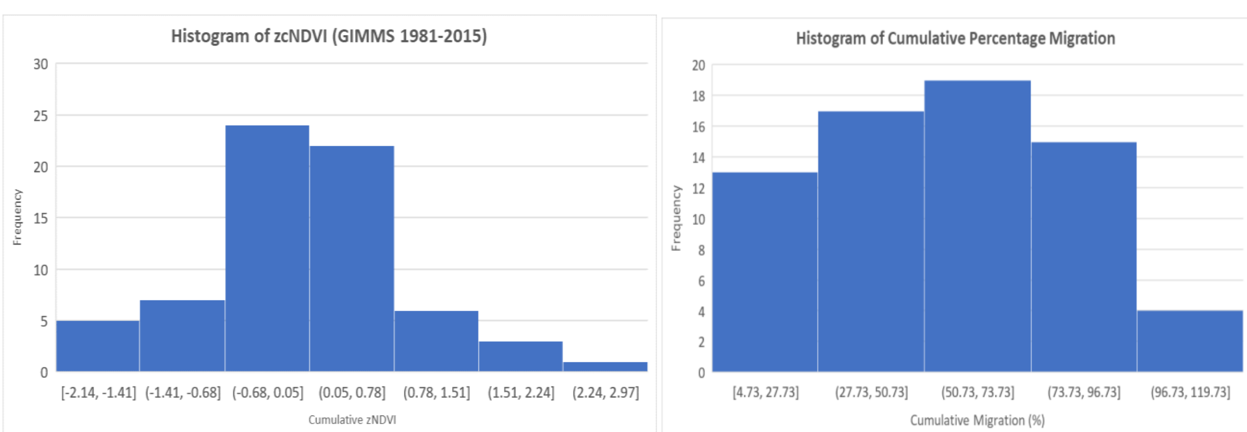


Figure 5-1: Histogram of zcNDVI (left) and cumulative migration (right) showing normal distribution and a slight positive skew respectively. Source: Author

In a bid to explain a potential linkage between drought and rural to urban migrations of pastoralist-drop out communities in northern Kenya, the study selected Marsabit Town as a case study site. The study applied an inductive study approach in which the results of the study, assuming a normal distribution of the data, confirm a possible contribution of drought conditions to out-migration of pastoralist communities into urban areas. In this case, the observations may be generalised to a large population. However, in light of the surprisingly unexpected performance of the normal distribution of the curve, skewed graph implies that:1) Data may not necessarily be generalised 2) Migration studies are context and purpose-specific depending on the objective of the study

5.5. Quality of life before and after migration

Pastoralist livelihood and income profiles gradually shift from natural-resource based livelihoods to more sedentary manual labour income-generating activities, with poverty being an outcome in both cases. In the analysis of people's perceptions and subjective experiences on drought-related migration and their quality of life, the study revealed that most respondents were pastoralists before migration but shifted into manual labour activities on entry into Marsabit Town. Most pastoralists explained that their motivation to move was mostly because of drought and its related impacts on their livelihood. These results are in tandem with Henderson, Storeygard, and Deichmann (2017) who highlight that pastoralist community residing in rural areas are also forced to migrate to cities due to failing livelihood systems; they abandon pastoralism and seek more non-pastoral trade activities in the towns.

The study found that most migrants become manual workers on entry into the town. There were also others who did not get any income-generating activities on entry into the city and largely depended on relief aid, begging or were unemployed, falling into what Barrett et al. (2006) define as either temporary or permanent poverty traps. Consequently, in the urban areas, displaced pastoralists suffer from marginalisation that eventually traps them in the vicious cycle of poverty (Schrepfer & Caterina, 2014).

However, despite the adverse outcome of an increase in production of a low-class urban poor, the results of the study yielded a mix reaction on the subjective quality of life of pastoralist migrants. This study found that most migrants were dissatisfied with their quality of life before migration and, indeed, most were relatively satisfied with their quality of life after migration. Further probing revealed that most respondents were more comfortable in urban centres and were not willing to go back to their rural homes but most were ready to move back to pastoralism if given an opportunity. Rural arid lands inhabited by pastoralists are highly susceptible to stresses associated with drought (McCabe, 1987).

Another significant finding of this research is that connections established through migration should be considered. People migrate, but at the same time do not give up on their places of origin. Migrants retain connections to their places of origins in two ways: 1) those whose families are in the rural areas are regularly going to visit, and 2) those who are able or practice remote pastoralism send remittances (they leave their surviving livestock with relatives in the rural areas and send payments to take care of the livestock). It is important to note that poverty emerges from both, as a trigger of migration and a result of migration. When in the destination areas, migrants are forced to seek alternative sources of income to survive. This shifting nature of livelihoods would mean two things: acquisition of a new skill set for pastoralist but also a potential challenge in itself if migrants do not successfully get employment.

5.6. Gender Dimension

Men and women are disproportionally affected by drought-related migrations. In this research, results from the women's focus group of the study showed that women were left behind to look after the household, children and the elderly in the hope that men would either find alternative employment and send remittances or find a better settling location for the family and grazing ground for the livestock. *Figure 4-11* on the age of migrates revealed that though small, younger age groups especially men tend to migrate first. As presented in the case of Ghana by Carr (2005), younger men would out-migrate relatively quickly leaving women behind to look after the household. Older men would remain behind for as long as possible in an attempt to maintain their positions of local household authorities. This is similar to Afifi (2009) study in Niger which showed that women were usually left behind by their emigrated husbands. Climate change disproportionally affects women through worsening already existing inequalities in access to resources, decision making, institutional access, added household burden and exposure to violence (Morrow, 2008; UNDP, 2009). "Gender-influenced cultural expectations, policies and institutions intersect to shape migration's causes and consequences" (Hunter & David, 2009, p. 1). Since migration is a gendered process, climate change yields different migratory experiences for males and females.

5.7. General limitations and implications of the study

While findings of the study agree with findings from other similar works and researchers, some limitations of the study may restrict the extent to which the findings of this research are reliable and can be generalised. Methodological challenges such as lack of an existing statistically reliable and valid census migration database, which inevitably caused lack of formulation of a proper sampling frame. This may have limited the study to sampling through resource persons such as the chief. This may also have to an extent, exposed study to information biases such as collection of data limited to only those pastoralists availed by chiefs at their convenience. Several other challenges in the comparative analysis of migration and satellite-derived drought assessments, need to be considered:

1) **Sampling and questionnaire challenges-** Sample size regarding migration frequencies definitely affected the outcomes of satellite-derived NDVI-migration comparison. The GIMMS NDVI satellite data with the longest temporal profile only begun in 1981 yet migrations data sampled begun from 1941. 19 migration counts were lost between 1941 and 1981 when the comparative analysis of the research begun, 17 of whom, migrated above the year of 1955 *(Appendix 17- Migration dates per response)*. Also, due to the randomness of the sampling procedure, some of the seasons per year in the dataset either had no migration counts or very limited migration numbers to compare the zcNDVI data with. These blanks may have affected the general cumulative computations. Perhaps, future studies may consider collecting a larger sample which may reach more migrants and populate the migrations data per season per year for a more robust comparison.

2) **Recall Bias issues:** The results of the demographic analysis regarding the age of respondents seem to suggest that a significant number of respondents were below the age of 15 or above the age of 65 at time of migration. Therefore, it is highly probable that this may have influenced their inability to remember the particular month, year or motivation to migrate at time of migration. This may have influenced their accuracy in giving information on the month, season or specific year of migration.

In this research, what worked was the bimodal seasonality aggregations of migration data, which were used in comparison with the satellite-derived based zcNDVI time series forage scarcity proxies. Through this interdisciplinary approach, the study was able to combine methods that explain migration patterns of pastoralists based on the seasonal performance of vegetation growth. Also, the longitudinal approach of spatial-temporal analysis of zcNDVI against migration worked. This captured some the cumulative aspects of drought as a slow onset environmental hazard that if persistent, overtime influences decisions of pastoralist to permanently migrate into urban areas. Also, combination of qualitative and quantitative data collection methods served to fill information gaps especially in reasons for migration and perceptions of quality of life before and after migration.

In the broader context of the urban and regional planning discourse, this study offers insights into the need to plan for resilience both in the rural and urban areas of dryland ecosystems. Resilience planning may encompass both community resilience planning as well as land-use resilience planning in the rural areas.

For future research, the study recommends: 1) increased interdisciplinary approaches to help similar researches examine in-depth the multi-causal nature of migration and 2) further assess the aspect of quality of life in the destination areas of pastoralist migrants.

6. CONCLUSION AND RECOMMENDATION

This chapter synthesises and reflects on the objectives and related questions of the research based on the results and analysis of chapter 4. Responses are provided to the research questions asked. The section concludes with some recommendations for urban planning policy and science.

6.1. Conclusion

6.1.1. Reflection on the Objectives and research questions

The primary objective of the study was to assess if and whether drought contributes to rural-urban migration and livelihood dynamics of pastoralists in Marsabit Town, Northern Kenya. The research set out to empirically determine whether environmental changes, specifically drought, could be a major trigger of migrations of pastoralists into urban areas, and the resulting socio-economic impacts of migration on the pastoralists while in destination areas. To this end, data on timings, causes and source areas of migration were collected from the field by way of semi-structured interviews with migrants in urban areas. This was followed by a comparative analysis of the empirically collected migration data with satellite-derived drought indicators of forage scarcity proxies (NDVI and their processed zcNDVI) acquired from GIMMS-AVHRR (period 1981-2015) and eMODIS (period 2001-2015). Finally, the study also qualitatively investigated the effects of urban migration on the livelihoods and lifestyles of migrant pastoralists and total pastoralist drop-outs, based on the interview data.

Results of this study show that there is a relationship between temporal seasonal forage scarcity indices derived from satellite time series and pastoral rural to urban migration patterns. This study used plots of zcNDVI against cumulated migrations to test a potential relationship. Further, the overall results of this research, assuming a normal distribution of the dataset, inferred that drought might have a probable effect on rural to urban migration of pastoralist drop-outs into Marsabit town, using forage scarcity indices of NDVI time series satellite-derived data.

This implies that other context-specific non-environmental factors are interacting with drought conditions which also result in migration, rather than assuming a simplistic linear push-pull relationship between drought and migration. Also, the study revealed that the livelihood and income profiles of pastoralist drop-out gradually shift from natural-resource based livelihoods to more sedentary, income-generating activities —often casual labour, with poverty being a direct consequence in some cases. Furthermore, the study revealed that younger age groups migrate in response to slight drought conditions, however, as the drought conditions worsen, more of the older groups migrate. Lastly, from the gender perspective, it emerged that during slight drought conditions, men migrate as the first response to drought, later, when conditions worsen, women migrate more.

The study also developed a quantitative framework, which can be helpful in other, related studies investigating the relationship between drought and migration using satellite-derived drought indices.

Hereafter, the concrete answers to the research questions raised at the onset of the study are provided:

Objective 1: To determine the dynamics, i.e., timing, source areas and causes of rural-to-urban migration by former pastoralists who now reside in Marsabit Town.

1. **What are the temporal peaks in rural-to-urban migration?**

   Looking at the annual cycle, there were more (62%) migrations noted in the long rain season as compared To the short rain season. When looking at decades, there were more migrations of between the years of 1991-2000 (41.1%) than 2001 to 2010 (30.6%). Also, the month of September and January in all years of the data sample is most migrated. Conclusively, it can be deduced that pastoralist decisions to migrate from rural to urban areas often occur as a result of extended poorly performing long rain seasons.

2. **What are the main causes of migration?**
   Based on the fieldwork responses, 37.4% of sampled pastoralists mentioned the environmental risk of drought and its related impacts as the major trigger to migrate into urban areas. 32.6% attributed their reason for migration to lack of water for livestock and domestic use, while lack of rain, poverty, clashes and cattle rustling collectively account for 30%. However, more qualitative responses revealed other underlying socio-economic and geopolitical factors contribute to migration, revealing the complex multi-causal nature of environmental migration.

3. **Where are the original locations from which pastoralists migrated?**
   In this research, the migration flows of pastoralists during severe drought conditions are within borders of migrants' home county of Marsabit. However, migration spillovers from neighbouring counties and country were recorded. Specifically, 97% of the migrants came from rural drylands of the rural Marsabit county into Marsabit town while only 1% came from surrounding counties equally hit by droughts such as Turkana, Samburu and Isiolo. The remaining 2% migrated from neighbouring countries like Ethiopia. The areal extent of drought is seen to influence both intra-county and inter-county migrations including international in-flows of pastoralist who reside in surrounding dryland areas.

Objective 2: To quantify the extent to which satellite-derived drought assessments may explain the dominant timings of migration of pastoralists.

1. **Can seasonal forage scarcity proxies, derived from NDVI time series, explain the temporal peaks/dominant timings of rural-to-urban migration of pastoralists?**

   Based on the results of this research, a relationship between satellite-derived seasonal forage scarcity indices and pastoral out-migration exists. At zcNDVI of -1 the value of the cumulative percentage of migrations is 8%, 10% and 10% for GIMMS_1981_2015 eMODIS_2001_2016 and GIMMS_2001_2015 respectively at a standard deviation of -2. This is above the expected 2.3% at this threshold in a standard normal distribution case. Similarly, cumulative percentage of migrations of 18%, 28% and 25% are registered at zcNDVI of -1 which is still higher than 15.9%. As for the cumulative percentage of migrations at a zcNDVI value of below zero (0), 58%, 50% and 52% are recorded for GIMMS_1981_2015, GIMMS_2001_2015 and eMODIS_2001_2016 respectively. Drought as an explanatory variable of migration is demonstrated by the fact that more migrations are recorded in extreme drought conditions than in mild and average zcNDVI.

Objective 3: To qualify the effects of migration on the livelihood of migrants'.

1. What are the current livelihoods of migrant pastoralists in urban areas?

The results of the study demonstrated that most (54%) migrants become manual workers on entry into Marsabit Town. However, some respondents were not able to get any income-generating activities on entry into the city and mostly depended on relief aid and begging. The study also revealed that most respondents were pastoralists (89%) before migration but most (54%-mentioned previously) shifted into manual labour on entry into Marsabit Town. Other income generating activities are farming (31%), business (10%) and others (5%). Others represent interviewees who are either beggars, depend on relief aid, or are unemployed. Based on these results, it can be concluded that pastoralist drop-outs who reside in urban areas often undertake more menial jobs to diversify their livelihood activities, while on the one hand they are empowered with new skills, on the other hand others who were unsuccessful to get alternate income sources end-up unemployed, begging or dependent on aid for survival. These outcomes may lead to poverty and eventual destitution. This portrays the potential of migration as a measure of successful adaptation, as well as the existing vulnerabilities and risks (identity, culture loss and production of poor migrant class) of associated with unsuccessful adaptation in the urban area.

2. What is the perceived level of satisfaction/dissatisfaction of migrants' quality of life before and after migration to urban areas?

Majority of pastoralists perceived their quality of life as very dissatisfied (23.1%) and dissatisfied (43.4%) before migration. However, when probed on their perceptions on quality of life after migration into the town, there were mixed reactions on quality of life as most responded to being satisfied (37.3%) while a significant group was also very dissatisfied (26.4%). From this research, it was evident that, urban centres are more preferred in comparison to rural areas. Importantly, most pastoralists drop-outs (96.2%) were more comfortable in the urban centres and were not willing to return to their rural homes/areas, while 3.04% were willing to move back. However close to 63.9% were ready to move back to pastoralism given an opportunity, 35.5% were not willing to move back to pastoralism and 0.34% were not sure. This has planning implications for improving quality of life in rural areas.

3. To what extent do migrant pastoralists remain connected to their place of origin?

From this research, it is evident that pastoralists migrate but at the same time do not give up on their places of origin. As 96% of migrants retain connections to their places of origin. The either regularly visit for those whose families are in the rural areas, send remittances for those who are able or practice remote pastoralism where they leave their surviving livestock with relatives in the rural areas and send payments to take care of the livestock.

6.2. Recommendations

6.2.1. Contribution to policy

The findings of this study suggests the following policy recommendations around a number of issues on matters related to drought-linked migration of pastoralist into urban areas:

Potential of migration for adaptation and resilience: There is need for the Marsabit County Government and national government to consider possibilities that migration offers rather than looking at it as a challenge. This requires deliberate investment in resettlement planning initiatives that are inclusive of community opinions in the process. This should consider the influential role that the private sector can play through public-private partnerships.

Drought adaptation and resilience strategies: The study recommends context-specific planning efforts for livelihood diversification options in places of origin, that is, rural Marsabit. There is a need for the Marsabit County government to increase investment in the rural dryland areas on drought-adaptation strategies, specifically, alternative sources of livelihoods for pastoralist adversely affected by drought. The development of rural areas may include area-based initiatives such as establishing drip irrigation schemes in drought devastated areas such as North Horr, Uran and Loyangalani as well as people-based initiatives such as crop insurance schemes, skills diversification for women, improved fishing skills for men and youth. These actions may influence both the land-use resilience of rural areas as well as the pastoralists resilience and adaptive capacities, thus increasing the diversity of possible responses to drought, one of which may be an incentive to stay in rural areas. These adaptation strategies may give pastoralists a choice on whether to voluntarily leave for other destinations areas such as towns, or not.

Participatory planning: The research recommends increased collaborative community-driven environmental protection initiatives. Pastoralists traditionally depend on natural resources for survival and livelihoods. They employ their indigenous knowledge of livestock management and nature preservation. There is a need for the County Government of Marsabit to incorporate their traditional livelihood and environmental conservation strategies into policy implementation plans and activities.

Management of migration and demographic data: The study recommends the establishment of an online updatable migration database both at the national and county level. Through a collaborative initiative among critical stakeholders such as Kenya national government, Marsabit County government, the private sector, NGOs, FBOs and local community representatives, a detailed census of migrants, and continuous documenting of existing data should be established. The database may not only focus on detailed household demographic characteristics of those affected by adverse impacts of environmental change. The database should also include data on where migrants came from, reasons for migration as categorised in the study including environment-related questions. The creation of this database will enable more reliable population figures, easy sharing and efficient management of migration and demographic data to plan for more robust forecasts and future responses. The study will appropriately inform policy and planning for drought mitigation measures.

Protection of right of displaced migrants: The research recommends the recognition and protection of the rights of displaced pastoralist migrants in their destination area of Marsabit Town by the national and county government. These include the legal rights that pastoralist migrants are entitled too; for example, rights to place, rights to water, education healthcare. Physical planning needs to acknowledge the existence of these vulnerable groups, make specific provisions for service provision and equal access to opportunities in their destination areas.

6.2.2. Contribution to science

Despite its exploratory nature, this study offers some insight for the scientific community into methodological possibilities of considering the *weight* of environmental factors in migration dynamics that also concurs with

Piguet (2011). A significant lesson drawn from this research for practice in science is the need for future studies on environmental change-related migration to shift from a simplistic-linear push-pull approach to a more versatile methodology that integrates and considers the complex multi-causal nature of migration. Environmental change-related migration is often indirect and not easily discernible from other reasons due to the multitude of transformations that occur.

A major strength of this research was the use of quantitative multivariate methods to assess the effects of drought on rural pastoralist out-migration patterns into urban areas. The use of remote sensing-based satellite-derived drought indices and community-based survey data proved suitable and adoptable methodology for other similar empirical studies. In this type of research, there is need for more interdisciplinary collaborations between environmentalist and planners as a central methodological input. This interdisciplinarity is crucial to understand the linkage between environment and migration. The interdisciplinary cooperation will help better conceptualise and validate the interaction between environmental change and migration for better resilience planning.

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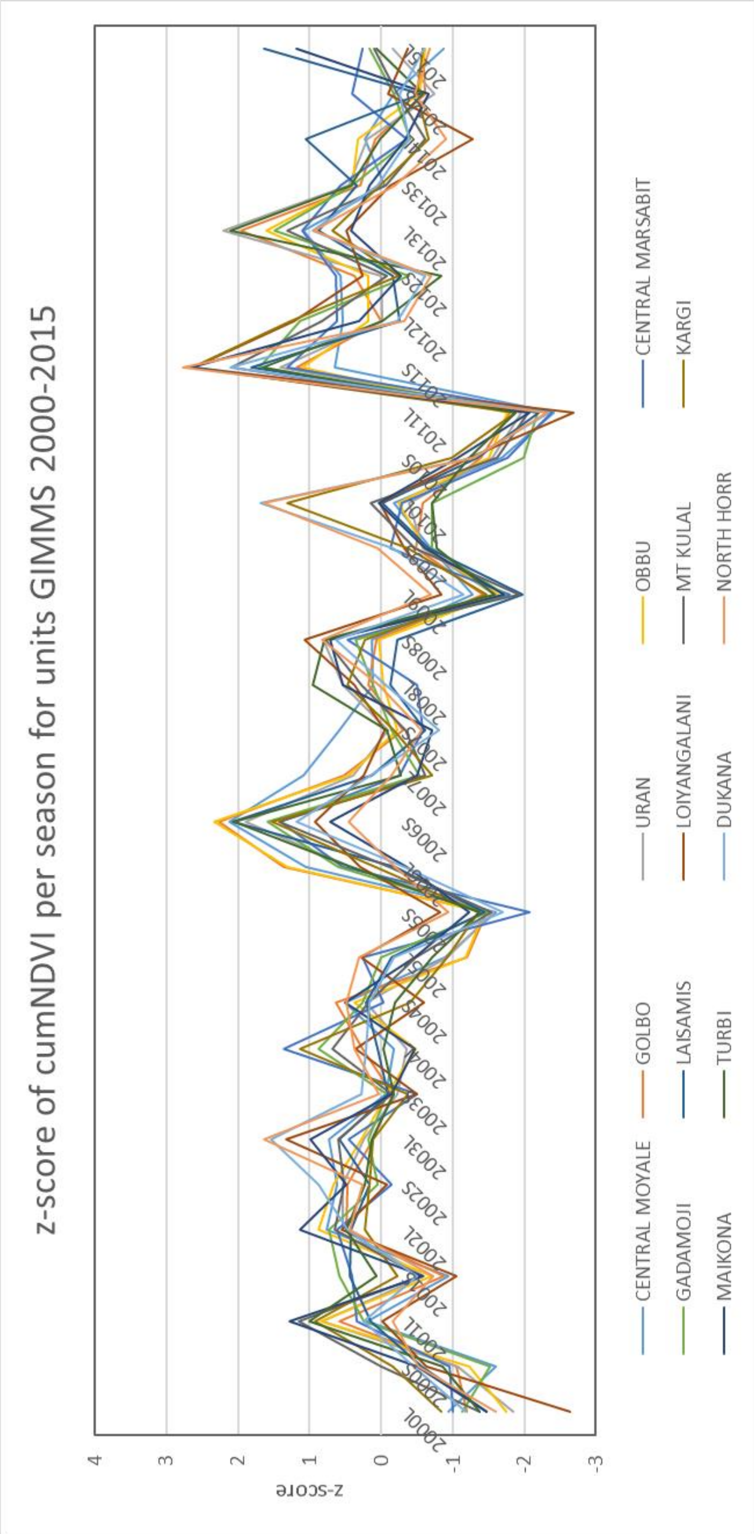
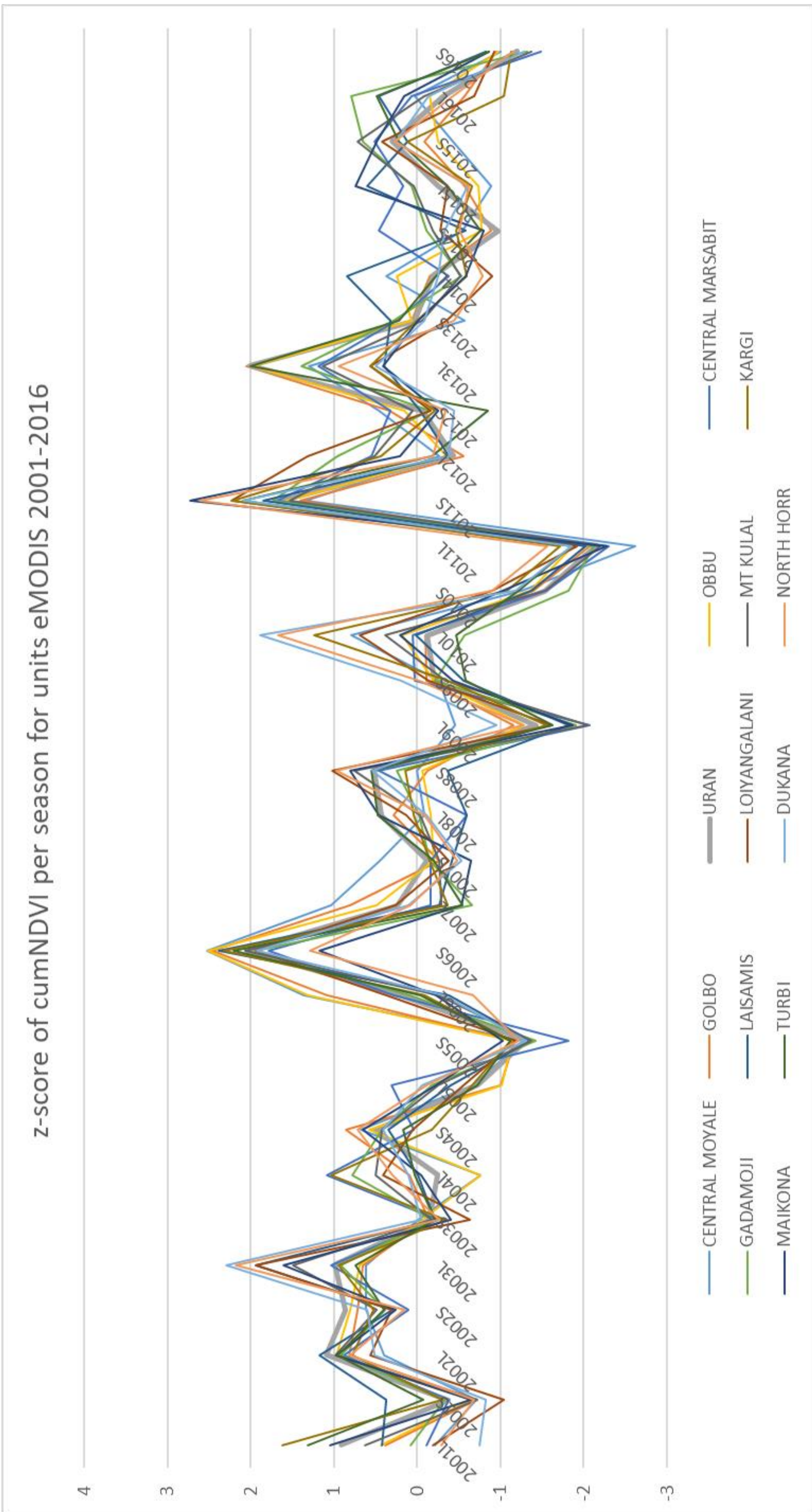
APPENDICES

1) GIMMS-AVHRR zcNDVI per IBLI Unit (2001-2015)



2) **eMODIS zcNDVI per IBLI Unit (2001-2016): Graph used to formulate the hypothesis. Source: Pre-processed NDVI time series eMODIS (2001-2016) for spatial units which are the current insurance units used in the IBLI project (Vrieling et al., 2016)**



3) Training of research assistants

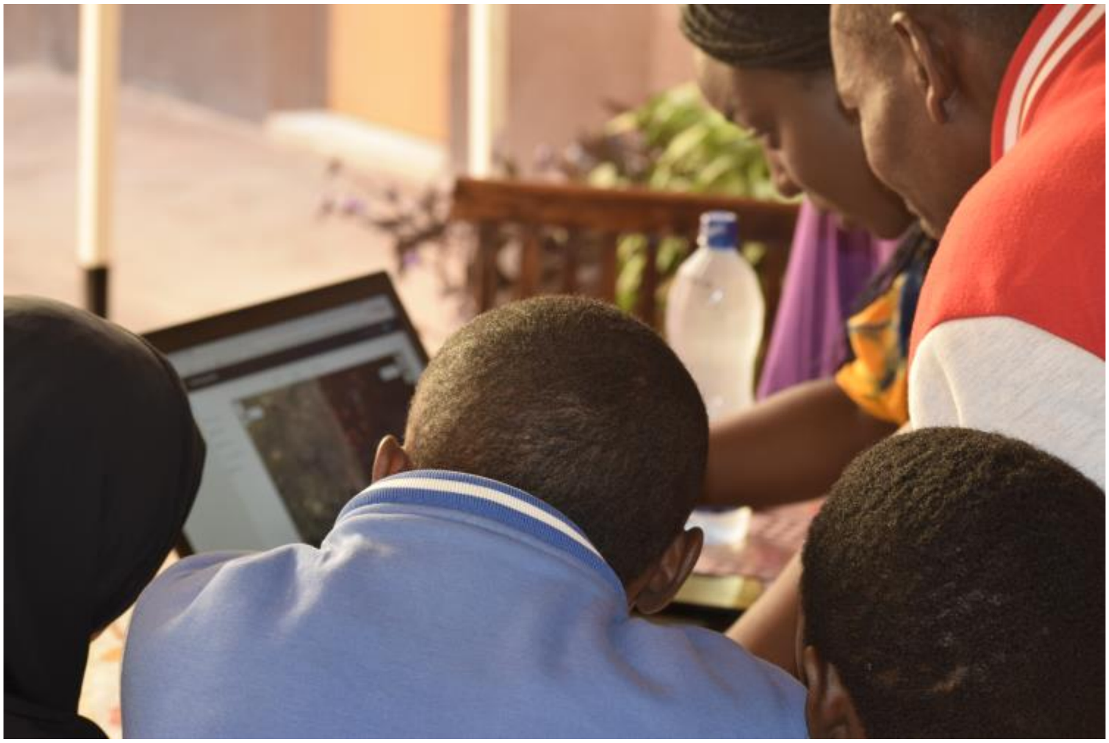
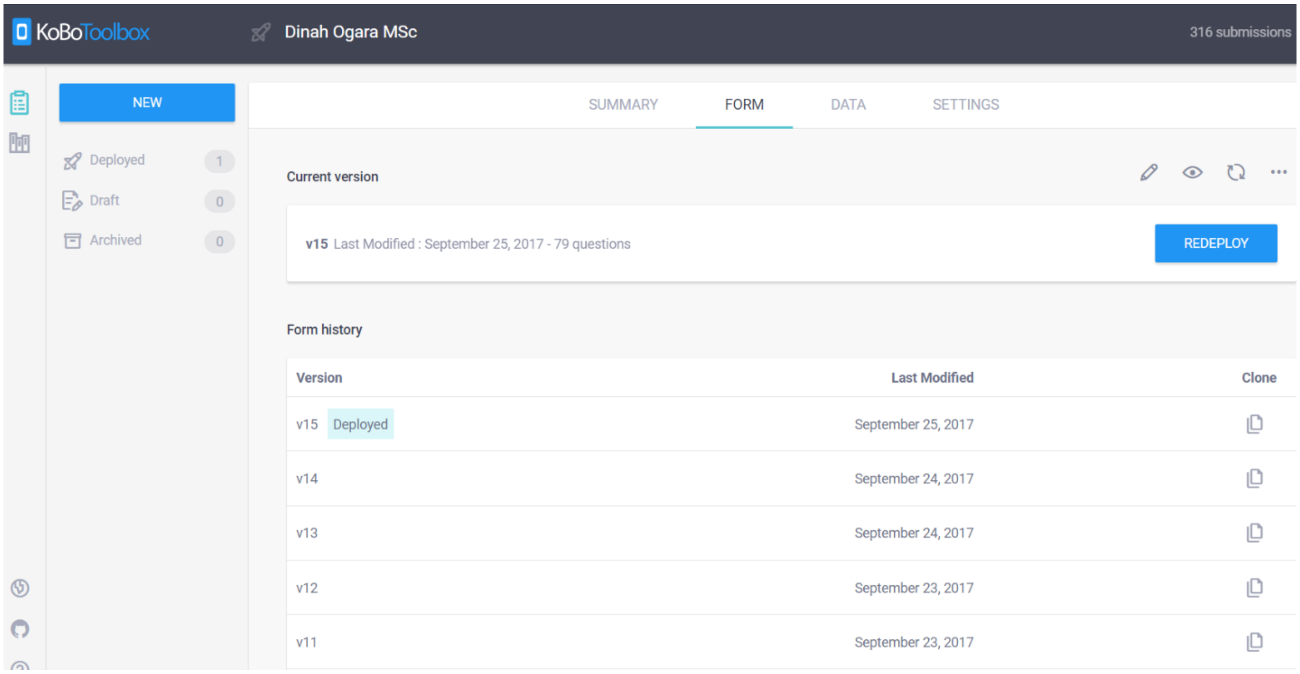
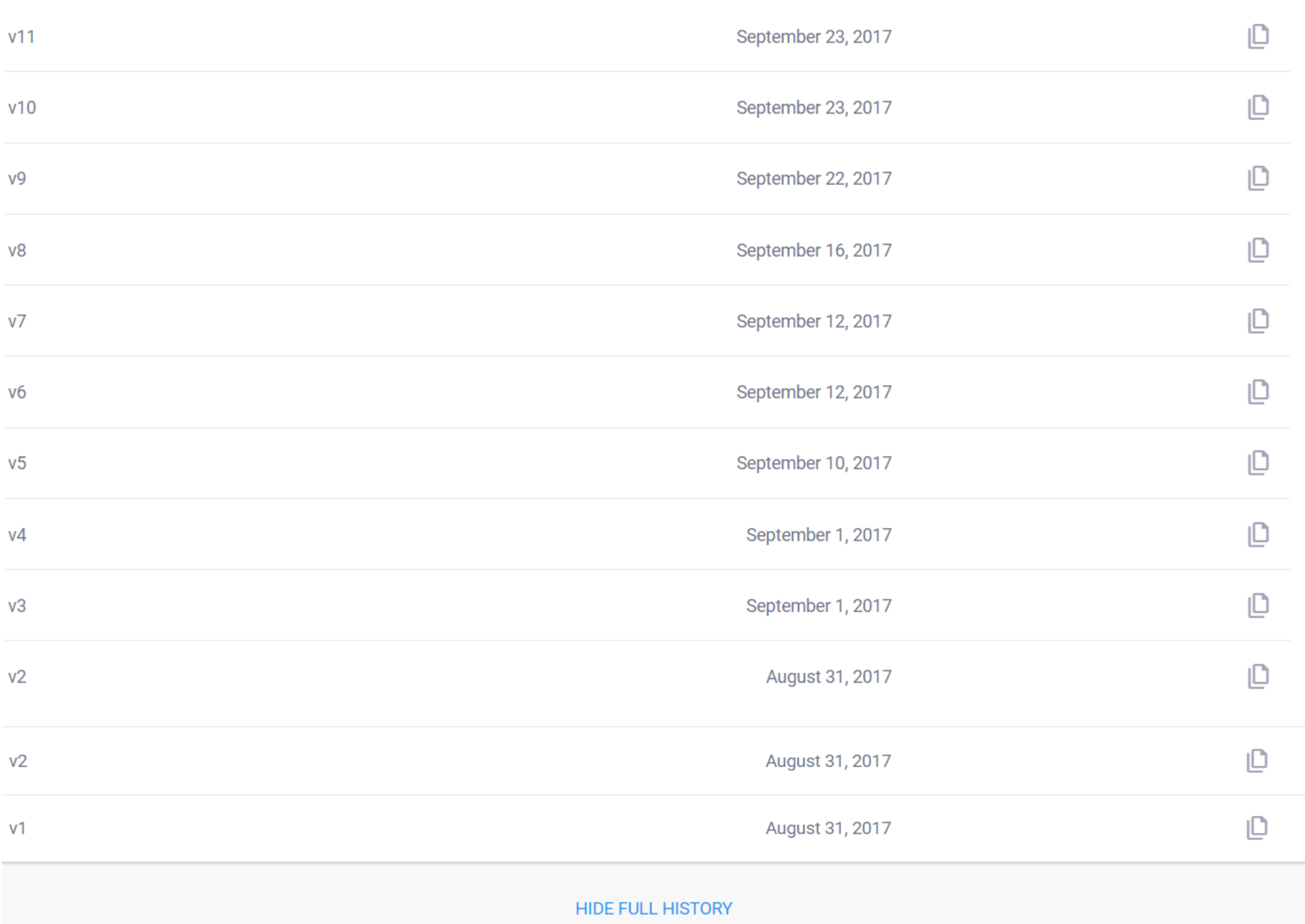


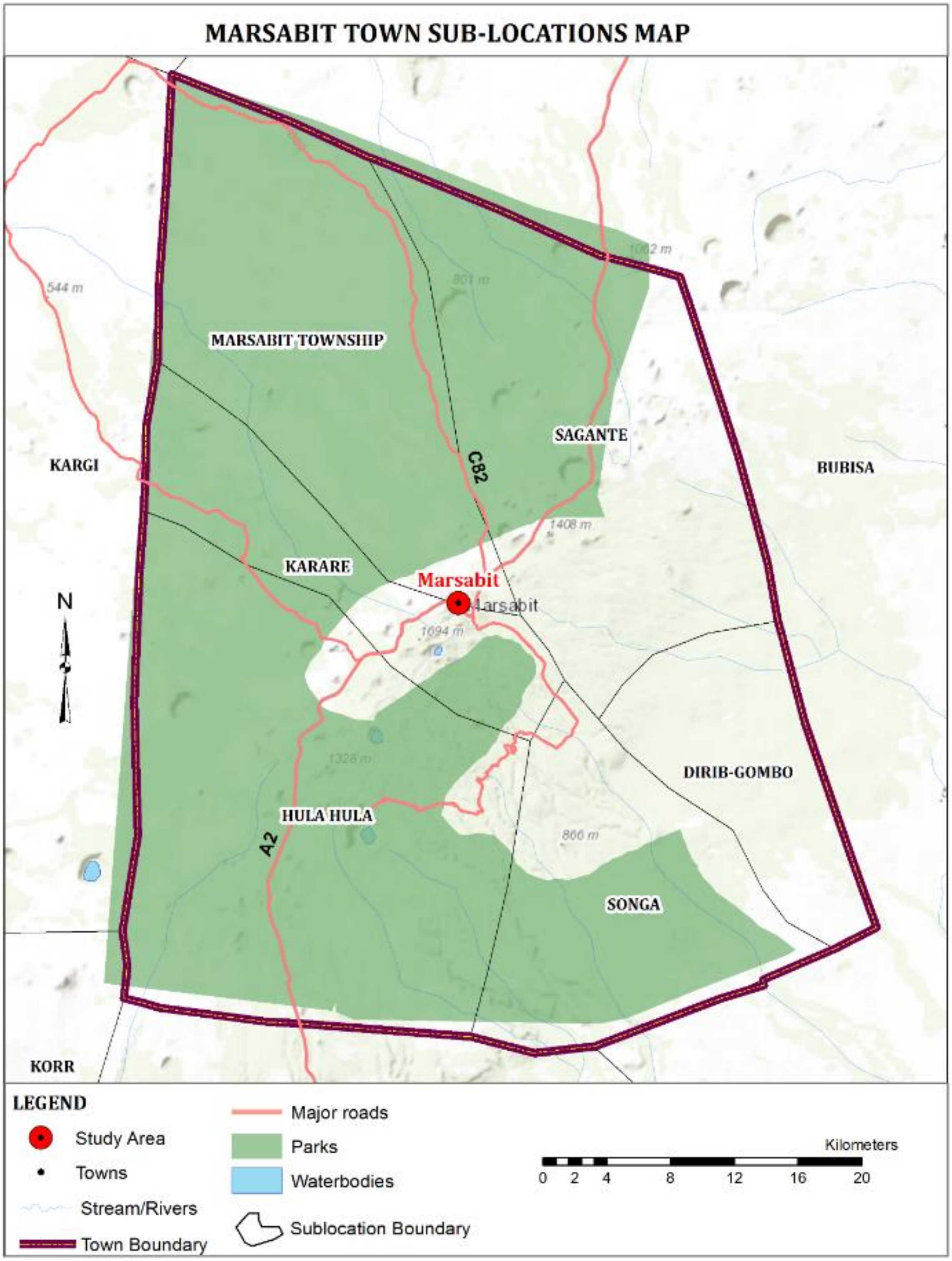
Figure 0-1: Training of translator and enumerators. Source: Author

4) Track of changes made of questionnaire



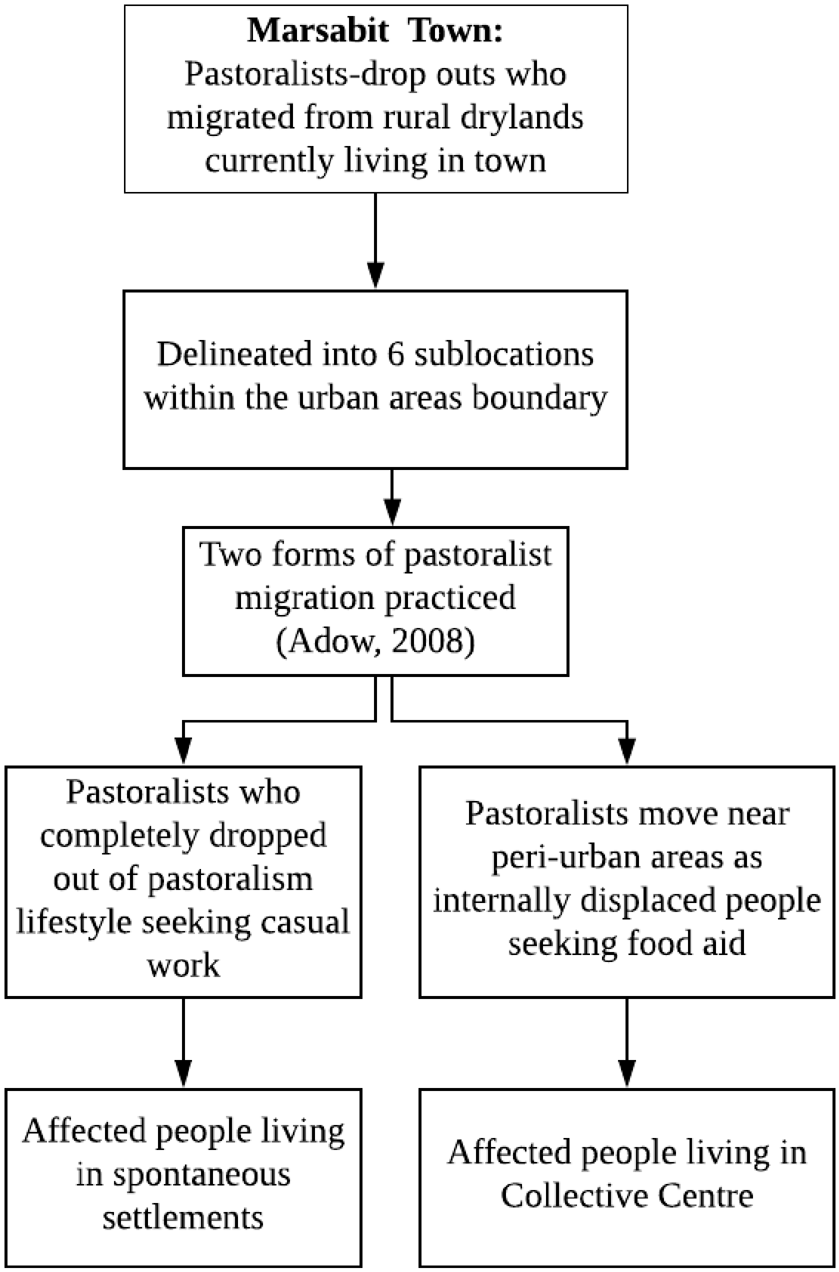


5) Map of Sample Sites



Map 1: Marsabit Town sub-locations used for sampling the household survey. Source: Author

6) **Criteria for purposive Sampling**



Source: Author

7) **Household Questionnaire**

(Attached at the end of the document)

8) KoboCollect App User Details: Mobile Data Collection

The online version of the questionnaire was designed by creating a user account in the web-interface of KoboCollect and installing the app in mobile phone and field tablet. After creating the account, following steps followed: **Step 1-** a form (household questionnaire) was designed using the skip logic setting, saved private and deployed for use offline. This allowed enumerators to skip to next relevant question depending on the response of previous question given; **Step 2-** data collection was done, the password to the account was given to enumerators, and deployed form was downloaded on their phones and tablets; **Step 3-** data cleaning and analysis was done. All forms collected were submitted and downloaded in excel. Code book was created and data then where necessary, exported to SPSS for analysis.

Figure 0-2: Researcher's KoboCollect user details and data sampling locations.

9) **FGD-Guide Questions by Gender**

FOCUS GROUP DISCUSSION FOR MEN AND WOMEN HELD IN MARSABIT AT RESIDENT LOCATION OF CHIEF OF DAKABARICHA LOCATION

A. DYNAMICS OF PASTORALIST URBAN MIGRATION

Identify the following general issues:

1. Observed environmental changes observed over time
2. Drought and changing trends
3. Causes of migration
4. Life before and after migration
5. Life after migration
6. Social networks and migration

B. GENDER CHALLENGES

A) CHANGING DROUGHT PATTERNS OVERTIME

1. Understanding the season and climate patterns over the years
2. Quality of environment in the past and now/ prediction methods
3. Traditional drought adaptation measures

B) SOCIO-ECONOMIC ISSUES PER GENDER FOR PASTORALIST DROP-OUTS

1. Gender roles before, during and after migration
2. Challenges of migration to urban areas faced by men
3. Conflict and effects on gender
4. Decision making powers at community and household level- Ownership of livestock and property
5. Drought impacts and gendered coping strategies
6. Gendered access to resources
7. Modernization trends
8. Gendered access to health and education services in Town
9. Gendered community initiatives tailored for

C. MAPPING PROBLEMS (All together)

Identify the following on the A0 map provided:

1. Locations of Origin (rural drylands) of migration
2. Locations of stop-over during migration
3. Worst Droughts in the last 30 years (season and local name of drought)
4. Drought Hotspot Areas
5. Resource Conflict Areas
6. Human wildlife conflict areas
7. Trans boundary Conflict Areas

D. DEVELOPMENT PRIORITIES

1. Community Vision for development
2. Community Values
3. Top 5 Development Priorities (general policy issues that participants would like addressed)

10) Field Work Letter

UNIVERSITY OF TWENTE.

To whom it may concern

FACULTY OF GEO-INFORMATION SCIENCE AND EARTH OBSERVATION

DATE
04 August 2017

OUR REFERENCE
UPM/17717/JV/mn

PAGE
1 of 1

SUBJECT
Request for support

Dear Sir or Madam,

We herewith certify that Ms. Dinah Achieng Ewuradjoa Ogara is registered at the University of Twente, Faculty of Geo-Information Science and Earth Observation (ITC), the Netherlands, as a student attending an 18-month Master of Science (MSc) course in Urban Planning and Management. ITC has more than 60 years of experience and develops and transfers knowledge in the field of Geographic Information Systems and Remote Sensing.

As part of the MSc course, Ms. Dinah Achieng Ewuradjoa Ogara will be performing an MSc Research project entitled 'Assessing the fluxes and impacts of drought induced migration of pastoralists into urban areas of Northern Kenya. A case of Marsabit Town, Marsabit County'. The MSc Research will include a period of 'fieldwork' consisting of secondary and primary data collection, which will tentatively take place in Marsabit Town, Marsabit County, Kenya from 01-10-2017 to 05-11-2017.

The MSc Research mainly concerns applying remote sensing and GIS technologies to assess and understand how drought is affecting rural to urban migration decisions of pastoralists in Northern Kenya It is hoped that this MSc research will contribute to an evidence-based empirical methodology that quantifies environmental migration decisions, specifically, whether and how drought affects the decision of pastoralists to move from rural to urban areas.

ITC highly appreciates your support in providing her with the necessary information during the stated fieldwork period.

We guarantee you that any information made available to Mrs Dinah Achieng Ewuradjoa Ogara, will only be utilized for the research objectives and not for any other purpose. Additionally, Mrs Dinah Achieng Ewuradjoa Ogara will make proper acknowledgement and reference to the source of the information in the final document.

Yours sincerely,

UNIVERSITY OF TWENTE. FACULTY ITC

drs. J.J. Verplanke
Course Director Urban Planning and Management
Faculty of Geo-Information Science and Earth Observation (ITC) - University of Twente

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11) Focus Group Discussion Mapping Excercise

Figure 0-3: Participatory mapping exercise of migration dynamics. Source: Author

Figure 0-4: Some of the participants, both men and women, from the Focus Group Discussions. Source: Author

12) Responses on Stop-over during migration

Table 0-1: Last stop over before Marsabit Town

Responses	Frequency	Percent
	4	1.4
Badasa	4	1.4
Balazi	2	.7
Balesa	1	.3
Bubisa	**23**	**7.8**
Buro	1	.3
Chalbi	1	.3
Dakabaricha	4	1.4
Did Galgallu	1	.3
Did not stop	**92**	**31.1**
Dirib	34	11.5
Dirorgha	1	.3
Dokatu	1	.3
Dubgoba	3	1.0
Ejars mutha	1	.3
Gadamoji	1	.3
Gar qarsa	1	.3
Gas	1	.3
Gombo	1	.3
Hula Hula	3	1.0
Imaltu	1	.3
Irres baji	1	.3
Jaldesa	1	.3
Jirme	2	.7
Kamboe	1	.3
Karare	3	1.0
Karatina	1	.3
Karghi	1	.3
Kargi	1	.3
Kubi	10	3.4
Kubi banya	2	.7
Kubi qalo	1	.3
Loglogo	3	1.0
Maikona	2	.7
Malkademtu	1	.3
Maralal	1	.3
Marsabit	7	2.4
Marsabit town	2	.7
Mekona	1	.3
Moyale	2	.7
Ola yaa	1	.3
Olla racha	1	.3
Oronder	1	.3
Parkishon	11	3.7
Qachacha	3	1.0
Qubbi	1	.3
Sagante	10	3.4
Segel	1	.3
Shurr	2	.7
Sololo	3	1.0
Songa	1	.3
Thub tuni	1	.3
Turbi	4	1.4
Ulaula	6	2.0
Uran	1	.3
Walda	25	8.4
Total	296	100.0

13) Table of responses of Origin-Destination locations

Table 0-2: Migration routes followed during migration

Q5. What were the routes followed during migration?					
	Frequency	Percent		Frequency	Percent
Missing	1	.3	Gadamoji-Dirib-Gombo-Sagante-Marsabi	1	.3
Badasa-Dirib-Sagante-Marsabi	8	2.7	Gadamoji-Kubi-Marsabit	1	.3
Badasa-Dub Goba-Marsabi	1	.3	Garfulesa-Kubbanya-Jirime	1	.3
Badasa-Marsabit	8	2.7	Gofchoba-Marsabit-Marsabit	1	.3
Badassa-Dirib-Marsabi	1	.3	Golbo-Bubisa-Marsabit	1	.3
Badassa-Dirib-Sagante-Gabbra Scheme-Marsabit	2	.7	Gudas-songa-hulahula-Marsabit	1	.3
Biliqi-kubi qalo-Boru Haro-Gilo-Marsabit	1	.3	Hekima, waqo jaldesa, nagayo, town	1	.3
Boru haro- Marsabit	2	.7	Helu--Marsabi	1	.3
Bubis- Gofu Choba-Town	4	1.4	Huri hills-Dirib-Marsabit	1	.3
Bubis-Diid galgallu-Marsabit	1	.3	Hurri hills-saku-Marsabit	2	.7
Bubisa-Marsabit	3	1.0	Irri-Qubi qalo-Qachcha-Sagante	4	1.4
Bubisa-Torbi-Walda-Marsabit	6	2.0	Jaldes-shur-kob adhi-Marsabit	1	.3
Bubisa-Turbi-Marsabit	1	.3	Jaldesa-Dakabaricha-Marsabit	1	.3
Chalbi-Dukana-Balesa-Maikona-Segel-Marsabit	1	.3	Jaldesa-Dokato-kubiqalo-Marsabit	1	.3
Dadach lakole- Dirib center-Marsabi	1	.3	Jaldesa-kubi-gadamoji-Marsabit	1	.3
Dadamoji-dirib-sagante-wako jaldesa-Marsabi	1	.3	Jaldesa-kubi-gadamoji-Sagante-Marsabit	1	.3
Dakabaricha--Marsabit	1	.3	Jaldesa-saku-Marsabit	1	.3
Dakabaricha-Boru haro-Marsabit	1	.3	Jaldessa-Marsabit	1	.3
Dakabaricha-Dub goba-Marsabit	1	.3	Jirime-Marsabit	1	.3
Dakabaricha-jirime-Marsabi	2	.7	Jirme-Sagante-Marsabit	1	.3
Dakabaricha-Marsabit	3	1.0	Jirmi-Marsabit-Marsabit	1	.3
Dakabaricha-Mata Arba-Marsabit	1	.3	Kachacha-Boru Haro-Marsabit	1	.3
Dakabaricha-mountain-Marsabit	2	.7	Kachacha-kubi bagasa-Marsabi	2	.7
Dakabaricha-Nagayo-Marsabit	1	.3	Kalacha-Mikona-Gombo-Marsabit	2	.7
Dambala fachana-turbi-bubisa--Marsabit	1	.3	Kamboi-Karare-Prkishon-Marsabit	1	.3
Diid Galgallu-Bubisa-Turbi-Marsabit	4	1.4	Karare-Hulahula-Marsabit	2	.7
Dirib Gombo-Dakabaricha-Marsabit	2	.7	Karare-Kijiji-Hulahula-Marsabit	3	1.0
Dirib-kobi-Marsabi	1	.3	Karare-Nagayo-Marsabit	1	.3
Dirib-kubi-alhidaya-Marsabi	1	.3	Karare-Parkishon-Marsabit	11	3.7
Dirib-kubi-jime-Marsabi	1	.3	Karare-Saku-Marsabit	1	.3
Dirib-kubi-milima mitatu-Marsabi	1	.3	Karatina-Hulaula-Marsabit	1	.3

Dirib-kubi,Badasa-dakabaricha-Marsabi	1	.3	Karatina-Mata Arba-Marsabit	1	.3
Dirib-Marsabit	1	.3	Kargi-Hulahula-Marsabit	3	1.0
Dirib-Mountain-Marsabit	3	1.0	Kargi-Kurti-derr-hulahula-Marsabit	1	.3
Dirib-sagante-gabbra scheme-Marsabit	7	2.4	Kubi bagassa-Dirib-Dakabaricha-Marsabit	1	.3
Dirib-sagante-jirime-marsabit	2	.7	Kubi bagaza-Dirib-Marsabit	1	.3
Dirib-sagante-marsabit	3	1.0	Kubi bagaza-IDP center-Marsabit	1	.3
Dubgoba village to wako jaldesa	1	.3	Kubi Gadamoji, Dakabaricha	1	.3
Dubgoba-Thuriye-Marsabit	3	1.0	Kubi qallo,harp huqa athi,gar qarsa, town	1	.3
Dubgoba-wako jaldesa	1	.3	Kubi Qalo-mata arba, Town	1	.3
Dubgobba-Manyatta Durie-Marsabit	2	.7	Kubi qalo,Dirib-Marsabit	1	.3
Ethiopia-moyale-Marsabit	1	.3	Kubi-Banya-Jirme-Marsabit	1	.3
Sagante- Dirib center	1	.3	Kubi,Dirib-dakabaricha-Marsabit	1	.3
Sagante- Kubi-jirime	1	.3	Kubikalo,kubibagasa, Dirib, Wako Jaldesa, Dakabaricha, Town	1	.3
Sagante-Boru haro	2	.7	Laisamis,Laghlokho,parkishon-Marsabit	1	.3
Sagante-Boruharro	1	.3	Lalesa to mata arba-Marsabit	1	.3
Sagante-Dakabaricha	7	2.4	Lodwa,Maralal,Marsabit-manyatta chorora	1	.3
Sagante-Dirib-Malka demtu	3	1.0	Logholokho-lesamis	1	.3
Sagante-Jirime-Marsabit	1	.3	Sololo-Bubisa-Marsabit	10	3.4
Sagante-nagayo	1	.3	Songa- hula hula	1	.3
Sagante-town	1	.3	Songa-hulahula-saku town	1	.3
Sagante, Dirib, Du Gobba, Manyatta Durie, Town route	1	.3	Songa-parkishon-hulahula	1	.3
Sagante,Bad as a,Dirib	1	.3	Thogogicha-shura-marsabit	1	.3
Sagante,Dubgoba	1	.3	Turbi-Bubisa-Marsabit	7	2.4
Sagante,Dubguba-jirime	1	.3	Turbi-Walda-Marsabit	3	1.0
Shurr-Qubi Bagasa, Dirib, Sagante, Gabbra scheme, town	2	.7	Uran-Bubisa-Marsabit	2	.7
Wabera-nagayo	1	.3	Uran-walda-marsabit	10	3.4
Walda-Bubisa-marsabit	4	1.4			

TOTAL	FREQUENCY	PERCENTAGE
	296	100.0

14) Regression Diagnostic Statistics

***Migration regressed against NDVI Long Season and NDVI Short season**

Regression Statistics								
Multiple R	0.66046							
R Square	0.436207							
Adjusted R Square	0.379828							
Standard Error	2.130239							
Observations	23							
ANOVA								
	Df	*SS*	*MS*	*F*	*Significance F*			
Regression	2	70.21991	35.10996	7.73702	0.003245			
Residual	20	90.75835	4.537917					
Total	22	160.9783						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	4.453887	0.445045	10.00773	3.12E-09	3.52554	5.382234	3.52554	5.382234
NDVI_L	-2.10762	0.540262	-3.9011	0.000886	-3.23458	-0.98065	-3.23458	-0.98065
NDVI_S	-0.53668	0.520676	-1.03074	0.314969	-1.62279	0.549431	-1.62279	0.549431

***Migration regressed against Long Season NDVI + Short Season NDVI + Rain Long Season +Rain Short Season**

Regression Statistics								
Multiple R	0.707428							
R Square	0.500454							
Adjusted R Square	0.389444							
Standard Error	2.11366							
Observations	23							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	4	80.56218121	20.14055	4.50817569	0.010663			
Residual	18	80.41607966	4.46756					
Total	22	160.9782609						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	7.18994	1.978349	3.63431	0.001896	3.03358	11.34630	3.03352	11.34630
NDVI_L	-1.9011	0.790176	-2.40591	0.027095	-3.56119	-0.240995	-3.56119	-0.240995
NDVI_S	0.48784	0.848771	0.57481	0.572533	-1.29532	2.271087	-1.29531	2.271087
LR	-0.00554	0.020757	-0.2668	0.792652	-0.04915	0.038072	-0.04914	0.038072
SR	-0.03455	0.023446	-1.47342	0.157911	-0.0838	0.014712	-0.08380	0.014712

15) Photograph of Resource Based conflict

Figure 0-5: Photograph on tension over water resource at Lalesa, Marsabit Count. Source: Boru Molmolla Galgallo, 2016

16) Table of migration and NDVI from 1981 to 2015

Table 0-3: Comparative analysis of Migration frequencies and field work data

Year	Migration Frequency	zcNDVI average of all IBLI units	Year	Migration Frequency	zcNDVI average of all IBLI units
1981S	0	-0.4622	2002S	3	0.3465
1982L	1	0.5072	2003L	4	0.6389
1982S	2	1.4981	2003S	3	-0.1585
1983L	2	0.2322	2004L	3	0.2724
1983S	0	-0.8302	2004S	1	0.1679
1984L	1	-1.3220	2005L	5	-0.4420
1984S	1	0.6150	2005S	3	-1.4288
1985L	3	1.0793	2006L	8	0.3511
1985S	2	-0.5290	2006S	2	1.5699
1986L	0	0.3181	2007L	6	-0.0026
1986S	0	0.2379	2007S	3	-0.2916
1987L	1	0.9042	2008L	3	0.2075
1987S	2	-0.5961	2008S	4	0.4802
1988L	1	0.7172	2009L	13	-1.4824
1988S	0	-0.4250	2009S	2	-0.4652
1989L	1	0.6328	2010L	10	0.1242
1989S	1	0.3127	2010S	3	-1.4214
1990L	3	0.6616	2011L	13	-2.1353
1990S	1	0.1286	2011S	4	1.8390
1991L	7	-0.7795	2012L	1	0.3769

1991S	1	-0.7708	2012S	2	-0.089
1992L	5	-0.5369	2013L	1	1.2342
1992S	1	-0.0086	2013S	3	0.1947
1993L	5	0.0179	2014L	2	-0.2181
1993S	3	-0.6058	2014S	4	-0.3690
1994L	5	-0.7370	2015L	3	-0.0740
1994S	2	0.9432			
1995L	15	-0.0300			
1995S	4	-0.6069			
1996L	10	-0.6809			
1996S	1	-0.6561			
1997L	14	0.8509			
1997S	2	2.7606			
1998L	14	1.5545			
1998S	0	0.0544			
1999L	12	-0.4026			
1999S	11	0.0395			
2000L	14	-1.4126			
2000S	2	-0.7932			
2001L	8	0.5463			
2001S	1	-0.3743			
2002L	7	0.6028			

17) Migration Dates

Month and Year or migration	Frequency	Percent		Frequency	Percent
16-DEC-1941	**1**	.3	07-SEP-1992	2	.7
04-SEP-1950	**1**	.3	27-SEP-1992	2	.7
27-SEP-1957	**1**	.3	27-MAR-1993	1	.3
24-SEP-1960	**1**	.3	04-MAY-1993	3	1.0
01-SEP-1965	**1**	.3	06-SEP-1993	2	.7
12-OCT-1971	**1**	.3	04-JAN-1994	1	.3
04-JAN-1972	**1**	.3	08-FEB-1994	1	.3
28-MAY-1974	**1**	.3	08-MAR-1994	1	.3
09-SEP-1974	**1**	.3	25-MAY-1994	1	.3
25-DEC-1974	**1**	.3	05-SEP-1994	2	.7
24-JAN-1975	**1**	.3	07-SEP-1994	1	.3
24-SEP-1975	**1**	.3	04-OCT-1994	1	.3
16-OCT-1975	**1**	.3	02-NOV-1994	1	.3
07-FEB-1978	**1**	.3	06-NOV-1994	1	.3
03-SEP-1978	**1**	.3	27-MAY-1995	1	.3
24-JAN-1979	**1**	.3	07-AUG-1995	2	.7
09-SEP-1979	**1**	.3	30-AUG-1995	1	.3
10-SEP-1979	**1**	.3	03-SEP-1995	2	.7
26-FEB-1980	**1**	.3	04-SEP-1995	6	2.0
26-JAN-1981	1	.3	11-SEP-1995	1	.3
07-SEP-1981	1	.3	13-SEP-1995	1	.3

08-JUN-1982	1	.3		24-SEP-1995	1	.3
25-JAN-1983	1	.3		25-DEC-1995	1	.3
27-JAN-1983	1	.3		06-FEB-1996	1	.3
12-SEP-1983	1	.3		25-FEB-1996	1	.3
27-SEP-1983	1	.3		08-SEP-1996	1	.3
27-MAY-1984	1	.3		09-SEP-1996	8	2.7
27-MAR-1985	1	.3		16-SEP-1996	1	.3
09-SEP-1985	1	.3		11-MAR-1997	1	.3
24-SEP-1985	1	.3		15-APR-1997	1	.3
27-SEP-1985	1	.3		13-MAY-1997	1	.3
24-NOV-1985	1	.3		12-AUG-1997	1	.3
25-FEB-1986	1	.3		01-SEP-1997	1	.3
26-JAN-1988	1	.3		02-SEP-1997	1	.3
25-OCT-1988	1	.3		03-SEP-1997	1	.3
09-MAY-1989	1	.3		08-SEP-1997	5	1.7
25-DEC-1989	1	.3		26-SEP-1997	1	.3
03-JUN-1990	1	.3		27-SEP-1997	2	.7
03-SEP-1990	3	1.0		24-JAN-1998	2	.7
03-JAN-1991	1	.3		27-APR-1998	1	.3
09-SEP-1991	5	1.7		03-AUG-1998	1	.3
16-SEP-1991	1	.3		29-AUG-1998	1	.3
17-SEP-1991	1	.3		01-SEP-1998	1	.3
25-JAN-1992	1	.3		06-SEP-1998	1	.3
07-APR-1992	1	.3		07-SEP-1998	6	2.0
27-SEP-1998	3	1.0		26-SEP-2004	1	.3
06-APR-1999	1	.3		28-DEC-2004	1	.3
04-AUG-1999	1	.3		26-APR-2005	1	.3
06-AUG-1999	1	.3		04-JUL-2005	1	.3
09-AUG-1999	1	.3		30-AUG-2005	1	.3
31-AUG-1999	1	.3		05-SEP-2005	1	.3
05-SEP-1999	1	.3		24-SEP-2005	1	.3
06-SEP-1999	4	1.4		24-DEC-2005	1	.3
27-SEP-1999	2	.7		02-JAN-2006	1	.3
02-NOV-1999	1	.3		26-FEB-2006	1	.3
27-NOV-1999	1	.3		04-APR-2006	1	.3
27-DEC-1999	1	.3		09-MAY-2006	1	.3
24-JAN-2000	1	.3		02-JUL-2006	1	.3
26-FEB-2000	1	.3		28-AUG-2006	1	.3
30-MAR-2000	1	.3		29-AUG-2006	1	.3
26-APR-2000	1	.3		04-SEP-2006	1	.3
28-AUG-2000	1	.3		26-SEP-2006	1	.3
29-AUG-2000	2	.7		25-OCT-2006	1	.3
30-AUG-2000	1	.3		25-NOV-2006	1	.3
04-SEP-2000	3	1.0		25-FEB-2007	1	.3
05-SEP-2000	4	1.4		26-APR-2007	1	.3
24-SEP-2000	1	.3		10-JUL-2007	1	.3
05-OCT-2000	1	.3		26-JUL-2007	1	.3
27-NOV-2000	1	.3		31-JUL-2007	1	.3
26-FEB-2001	1	.3		10-SEP-2007	1	.3

10-APR-2001	1	.3		29-OCT-2007	1	.3
03-SEP-2001	3	1.0		25-NOV-2007	1	.3
05-SEP-2001	1	.3		26-DEC-2007	1	.3
10-SEP-2001	2	.7		31-DEC-2007	1	.3
09-OCT-2001	1	.3		10-JUN-2008	1	.3
27-FEB-2002	1	.3		06-SEP-2008	1	.3
28-MAY-2002	1	.3		16-SEP-2008	1	.3
02-SEP-2002	1	.3		02-MAR-2009	1	.3
03-SEP-2002	1	.3		13-MAR-2009	1	.3
08-SEP-2002	1	.3		17-MAR-2009	2	.7
09-SEP-2002	2	.7		26-APR-2009	1	.3
08-OCT-2002	1	.3		05-MAY-2009	2	.7
01-DEC-2002	1	.3		12-MAY-2009	1	.3
03-DEC-2002	1	.3		19-MAY-2009	1	.3
04-DEC-2002	1	.3		17-JUN-2009	1	.3
10-MAY-2003	1	.3		11-AUG-2009	2	.7
26-JUL-2003	1	.3		07-SEP-2009	1	.3
07-SEP-2003	1	.3		08-SEP-2009	2	.7
08-SEP-2003	1	.3		15-SEP-2009	1	.3
21-FEB-2004	1	.3		26-SEP-2009	1	.3
25-FEB-2004	1	.3		24-JAN-2010	1	.3
02-MAR-2004	1	.3		26-JAN-2010	1	.3
06-JUL-2004	1	.3		13-APR-2010	1	.3
05-SEP-2004	1	.3		25-MAY-2010	1	.3
27-JUN-2010	1	.3		26-SEP-2012	1	.3
06-SEP-2010	1	.3		25-NOV-2012	1	.3
25-SEP-2010	1	.3		27-JAN-2013	1	.3
26-SEP-2010	3	1.0		26-JUN-2013	1	.3
27-SEP-2010	1	.3		25-JAN-2014	1	.3
26-OCT-2010	1	.3		27-JAN-2014	1	.3
21-DEC-2010	1	.3		27-FEB-2014	1	.3
25-JAN-2011	1	.3		27-JUL-2014	1	.3
26-JAN-2011	1	.3		26-SEP-2014	1	.3
12-APR-2011	1	.3		25-DEC-2014	1	.3
10-MAY-2011	1	.3		25-JAN-2015	1	.3
25-JUN-2011	1	.3		27-JAN-2015	1	.3
13-AUG-2011	1	.3		26-SEP-2015	1	.3
14-SEP-2011	1	.3		27-SEP-2015	1	.3
20-SEP-2011	1	.3		25-FEB-2016	1	.3
25-SEP-2011	1	.3		27-DEC-2016	2	.7
26-SEP-2011	3	1.0		27-MAR-2017	1	.3
27-SEP-2011	2	.7		27-JUL-2017	1	.3
04-OCT-2011	1	.3		28-AUG-2017	1	.3
08-NOV-2011	1	.3		24-SEP-2017	1	.3
11-JAN-2012	1	.3		26-SEP-2017	1	.3
25-JAN-2012	1	.3		27-SEP-2017	1	.3
27-FEB-2012	1	.3				
TOTAL	FREQUENCY			PERCENTAGE		
	296			100.0		

Dinah Ogara MSc

Household Questionnaire. Assessing the fluxes and impacts of drought- induced migration of pastoralist communities in to urban areas: A case of Marsabit Town, Marsabit County, University of Twente, The Netherlands

A1. Interviewer Name

- ◯ Dinah Ogara
- ◯ Sixtus odumbe
- ◯ Abdukarir Mohammed
- ◯ Wochino Abdulahi
- ◯ Hassan Ali
- ◯ Zainab Omar
- ◯ Fatuma Abubakar
- ◯ Moses Okoth

My name is Dinah Ogara, a graduate student with the Faculty of Geo-Information Science and Earth Observation of the University of Twente, The Netherlands. As part of the study programme, students are expected to engage in a field research and produce a thesis covering their areas of interest. I am, therefore, conducting a study to understand reasons why former pastoralists have moved out of pastoralism and settled in urban centres like Marsabit. I guarantee that the information gathered in this exercise will be strictly used for academic purposes, and the respondents' confidentiality will be respected. I would like to request for your participation in this exercise.

- ◯ Yes, Continue with interview.
- ◯ No, Thank respondent and close interview.

A2. GPS Coordinates

GPS coordinates can only be collected when outside.

latitude (x.y °) longitude (x.y °) altitude (m) accuracy (m)

Section A. Dynamics of Migration [Now I am asking you a few sentences to the way how you came to Marsabit. This is includes time and stop-vers of migration. Under migration I regard your moving to Marsabit to start living here.]

Q1. When did you move to this urban centre?

yyyy-mm-dd

Q1a. What was your reason for leaving the original place of residence?

- [ ] Poverty
- [ ] Lack of water for livestock
- [ ] Lack of pasture for livestock
- [ ] Lack of rain
- [ ] Inter clan conflict - Clashes and cattle rustling
- [ ] Flooding
- [ ] No reason
- [ ] Drought
- [ ] Other (specify)

Q2. If drought is mentioned in q1, what was the name of the drought?

Q3. Which year was this drought (rain shortage)? (specify by season)

- [ ] Long Rains (March-April-May):2009
- [ ] Shorty Rains (October-November-December): 2009
- [ ] Long Rains (March-April-May):2010
- [ ] Shorty Rains (October-November-December): 2010
- [ ] Long Rains (March-April-May):2011
- [ ] Shorty Rains (October-November-December): 2011
- [ ] Other (specify)

Q3a. Other drought

Q4. How were you affected by the drought?

- [ ] Decline in forage production
- [ ] Food shortage
- [ ] Grains prices rose
- [ ] Livestock prices reduced
- [ ] Livestock died
- [ ] Received food aid
- [ ] Migrated to other locations in search of pasture and water
- [ ] Migrated to. urban centers after loosing livestock
- [ ] Other (specify)

Q4a. Other effects of drought

Q4b. Where were you leaving originally before migrating? (Location, Sub County)

Q5. What were the routes followed during migration?

Q5a. Where did you stop over (last) before coming to Marsabit Town?

Q6. Have you ever heard of traditional rainmakers?

- ○ Yes
- ○ No
- ○ Don't Know

Q6a. If Yes in q6, who is/was the most famous rainmaker you know/knew?

Q6b. If Yes in q6, how accurate were the rainmakers in predicting drought patterns?

- ○ Very Accurate
- ○ Acurate
- ○ Inaccurate
- ○ Very Inaccurate

Q8. Are you aware of the 2009 -2011 drought?

- ◯ Yes
- ◯ No
- ◯ Don't Know

Q8a. If Yes, were you affected by the 2009-2011 drought?

- ◯ Yes
- ◯ No
- ◯ Don't Know

Q8b. If yes in q8a above how were you affected by 2009-2011 drought?

- ☐ Decline in forage production
- ☐ Food shortage
- ☐ Grains prices rose
- ☐ Livestock prices reduced
- ☐ Livestock died
- ☐ Received food aid
- ☐ Migrated to other locations in search of pasture and water
- ☐ Migrated to. urban centers after loosing livestock
- ☐ Other

Q8c. Other effects of drought

____

Q9. If was affected in q8a, what was the effect of drought on livestock ownership before drought? (No of livestock before)

____

Q9a. If was affected in q8a, what was the effect of drought on livestock ownership after drought? (No of livestock after)

____

Q9b. If yes in 8a, could you describe in terms of rainfall distribution why the particular drought before you migrated was bad?" (or 2 consecutive seasons that had drought)

- ☐ Amount of rainfall
- ☐ Seasonality of rainfall
- ☐ Duration of rainfall
- ☐ Deforestation
- ☐ Other - Specify

Q9c. Other reason for bad drought

____

Section B. Effects of Migration [Now am going to ask you a few questions about effects of migration]

Q10. What is your current main source of income?

- ◯ Businessman/woman
- ◯ Farmer
- ◯ Carpenters
- ◯ Fisherman
- ◯ Casual work/ manual labour
- ◯ Other (specify)

Q10a. Other sources of income

____

Q11. What is your current income (Kshs.)?

- ☐ <5000
- ☐ 5001-10,000
- ☐ 10,001-15,000
- ☐ 15,001- 20,000
- ☐ 20,001-25,000
- ☐ 25,001-30,000
- ☐ >30,000
- ☐ No income

Q12. Are there organizations that supported you during and after drought?

- [ ] GOK-NDMA
- [ ] Dorcas Aid
- [ ] WFP
- [ ] GIZ
- [ ] World Vision
- [ ] Food for the Hungry
- [ ] Concern Worldwide
- [ ] VSF Germany
- [ ] PACIDA
- [ ] HN Plus
- [ ] Red Cross Kenya
- [ ] GOK-CLIP
- [ ] GOK-National Gov
- [ ] GOK-County Government
- [ ] PISP
- [ ] Other Specify

Q12a. Other organizations

____

Q13. Are there organizations that supported you to settle after migration ?

- [ ] GOK-NDMA
- [ ] Dorcas Aid
- [ ] WFP
- [ ] GIZ
- [ ] World Vision
- [ ] Food for the Hungry
- [ ] Concern Worldwide
- [ ] VSF Germany
- [ ] PACIDA
- [ ] HN Plus
- [ ] Red Cross Kenya
- [ ] GOK-CLIP
- [ ] GOK-National Gov
- [ ] GOK-County Government
- [ ] PISP
- [ ] Other Specify

Q13a. Other organization

____

Q13a. What kind of assistance did they give? (Organization and Assistance given)

____

Q14. How satisfied were you with your quality of life before migration?	Very Dissatisfied	Dissatisfied	Neither	Satisfied	Very Satisfied
Level of satisfaction	○	○	○	○	○

Q14a. How satisfied are you now with your quality of life after migration (Today)?	Very Dissatisfied	Dissatisfied	Neither	Satisfied	Very Satisfied
Level of satisfaction	○	○	○	○	○

Q15. When you migrated, did you come along with the whole of your household?

- ○ Yes
- ○ No
- ○ Don't Know

Q15a. If no to q15, do you know where the rest of your household live today?

- Yes
- No
- Don't Know

Q15b. Where do they live currently? (Name of Sub County and Location)

____

Q15c. Are you still in connection with your household?

- Yes
- No
- Don't Know

Q15d. If Yes in 15c, how do you remain connected to your household?

- Send remitances
- Visit regularly
- Remote pastoralism
- Running village business
- We are living together currently
- We are living together currently

Q16. When you migrated, did you come along with the whole of your extended family?

- Yes
- No
- Don't Know

Q16a. If no to Q16. do you know where the rest of your extended family live today?

- Yes
- No
- Don't Know

Q16b. Where do your extended family live currently? (Name of Sub County and Location)

____

Q16c. Are you still in connection with your extended family?

- Yes
- No
- Don't Know

Q16d. How do you remain connected to your extended family?

- ◯ Send remitances
- ◯ Visit regularly
- ◯ Remote pastoralism
- ◯ Running village business
- ◯ We are living together currently
- ◯ We are living together currently

Q17. Do you intend to move back to your rural area?

- ◯ Yes
- ◯ No
- ◯ Don't Know

Q18. Do you intend to move back to pastoralism?

- ◯ Yes
- ◯ No
- ◯ Don't Know

Q19. Why?

____

Section C: Demographics. [Now I am going to ask you a few personal questions.]

Q20. Sex of respondent

- ◯ Male
- ◯ Female

Q21. Age of respondent

____

Q22. Are you head of Household?

- ◯ Yes
- ◯ No
- ◯ Don't Know

Q23. If No, what is your relationship with head of this household?

- Spouse
- Son
- Daughter
- Parent
- Other relative
- Other non relative

Q24. How many people live in this household? (Total household population?)

____

Q24a. Male Children (0-5 years)

____

Q24b. Female children (0-5 years)

____

Q24c. Male children size (6-18 years)

____

Q24d. Female children size (6-18 years)

____

Q24e. Male adults (19-55 years)

____

Q24f. Female adults (19-55 years)

____

Q24g. Male adults (over 55 years)

____

Q24h. Female adults (over 55years)

____

Q25. What material was used to construct roof of your previous housing before you migrated to Marsabit Town?

____

Q25a. What material was used to construct wall of your previous housing before you migrated to Marsabit Town?

____

Q25b. What material was used to construct floor your previous housing before you migrated to Marsabit Town?

____

Q26. Current Housing type building material (Please observe and note - Roof)

____

Q26a. Current Housing type building material (Please observe and note - Wall)

____

Q26c. Current Housing type building material (Please observe and note - Floor)

____

Q27. Education level of respondent

- ○ No education
- ○ Primary incomplete
- ○ Primary complete
- ○ Secondary incomeplete
- ○ Secondary Complete
- ○ Vocational
- ○ College
- ○ University

Q28. What is your District of birth

- ○ Sololo
- ○ Moyale
- ○ Marsabit North
- ○ Marsabit
- ○ Marsabit South
- ○ North Horr
- ○ Loyangalani

Q29. What is your Sub-Location f birth

____

Q30. What was your main occupation before migrating?

- ◯ Farmer
- ◯ Pastoralist
- ◯ Businessman/Woman
- ◯ Other Specify

Q31. Household assets owned?

- ☐ Radio
- ☐ TV
- ☐ Mobile Phone
- ☐ Water tank
- ☐ Bicycle
- ☐ Motor Bike
- ☐ Car
- ☐ Livestock (Specify types of livestock)
- ☐ Other specify

Q32. Is there anything else you would like to add and suggest?

____

Thank you for your time

<u>Expert opinion</u>

<u>Guiding Questions for County Physical Planner</u>

1. Planner

1. What are the key locations and sub locations within the boundary of Marsabit Town? What is the extent of the boundary of Marsabit Town (Please provide a map or a document with built-up town boundary)?
2. What is your opinion on pastoralist drop out migration into Marsabit Town? What is the migration trend of these communities?
3. What are the locations in which pastoralist-drop outs reside in Marsabit Town? Are you undertaking any spatial plans to accommodate these vulnerable groups in the Town?
4. What are the types and locations of ongoing spatial plan projects may you have on pastoralist migrants in this Town?
5. What is your opinion on future development of Marsabit Town in light of pastoralist in migration?

2. NGOs

1. What has been the trend of Drought in this county over the last 30 years? What are the main drought-hotspot areas?
2. How do the communities in Marsabit Town earn their livelihood?
3. What is the communities' perception towards the effects of drought on their livelihood?
4. What conflicts exist in the area with neighboring communities?
5. In your opinion, does rural to urban migration of pastoralists into Marsabit Town exist? If yes, what do you think are the causes of rural to urban migration of pastoralists into Marsabit Town? What are the locations where pastoralist drop-out who have migrated, settlement most within the town?
6. How permanent is the urban migration of pastoralists?
7. Do you have any gender tailored initiatives for migration?
8. How do the communities in this county cope with drought?
9. What migration and drought initiatives does your organization have towards pastoralist drop-outs?
10. Is there any additional information you would like to provide with regard to drought and migration of pastoralists strategies for adaptation?

THANK YOU FOR YOUR TIME

FORESTRY OFFICER

1. Kindly provide information on Forest Resources in the County.

Forest coverage
Major catchment areas
Human activities and trends of deforestation.
Major threats and possible solutions to forested areas

2. What is your opinion about pastoralist drop-outs into Marsabit Town?
3. How is migration of pastoralists into urban areas affecting Mt. Marsabit Forest?
4. What is the impact of this migration on the natural environment?
5. In your view, what is a sustainable way to manage the forest?

THANK YOU FOR YOUR TIME