ADAPTATION TO CLIMATE VARIABILITY AMONG THE DRYLAND POPULATION IN KENYA: A CASE STUDY OF THE TURKANA PASTORALISTS


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The Environmental Economics Group of Wageningen University and Research centre focuses at the economic analysis of national and international environmental problems, such as climate change, water management, biotechnology, and biodiversity. The aim is to contribute to a better understanding of these problems and to identify possible solutions, including policy recommendations.

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DECLARATION

I, Ekitela Ronald John Moru declare to the examination committee of Wageningen University that this thesis is my original work and all other materials therein which are not my own are duly acknowledged. This work has not been submitted to any other academic institution for an award of any academic degree.

............................................

Signature

June 2010
DEDICATION

I dedicate this work to my beloved children Collins Lokito (Asogol), Billy Moru (Ekasukout) and Joy Lemuya (Akimat).
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It is with great pleasure that I would like to thank the almighty God for his bounty and favour of life. It is by his grace and mercy that everything has been made possible!

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Ejok noi!
ABBREVIATIONS

ALRMP  Arid Lands Resource Management Project
APAR  Absorbed photosynthetic Active Radiation
CEWARN  Conflict Early Warning Network
CJPC  Catholic Justice and Peace Commission
CMR  Cereal –Meat Price Ratio
CSI  Coping Strategies Index
CV  Coefficient of Variation
DFID  Department for International Development
EWS  Early Warning System
FAO  Food and Agricultural Organisation
FEWSNET  Famine Early Warning System Network
GOK  Government of Kenya
GTZ  German Technical Cooperation
ICRC  International Committee of Red Cross
IGAD  Intergovernmental Authority on Development
ILRI  International Livestock Research Institute
IPCC  Intergovernmental Panel on Climate Change
IUCN  International Union of Conservation of Nature
NDVI  Normalized Deviation Vegetation Index
NOAA  National Oceanic and Atmospheric Administration
NPP  Net Primary Production
ODI  Overseas Development Institute
PAR  Photosynthetically Active Radiation
STEP  South Turkana Ecosystem Project
TLU  Tropical Livestock Unit
UNFCC  United Nations Framework on Climate Change
USAID  United States Aid
WMO  World Meteorological Organisation
TABLE OF CONTENTS

DECLARATION .................................................................................................................. iii
DEDICATION ..................................................................................................................... iv
ACKNOWLEDGEMENTS .................................................................................................... v
ABBREVIATIONS ............................................................................................................. vi
TABLE OF CONTENTS ..................................................................................................... vii
LIST OF TABLES ............................................................................................................... ix
LIST OF FIGURES ........................................................................................................... x
ABSTRACT ......................................................................................................................... xii
CHAPTER 1: ...................................................................................................................... 1
INTRODUCTION ............................................................................................................... 1
  1.0 Background information ......................................................................................... 1
  1.1 Description of the Turkana Pastoralism ................................................................. 3
  1.2 Research Objectives: ............................................................................................. 4
  1.3 Research Questions: .............................................................................................. 4
  1.4 Methods .................................................................................................................. 5
    1.4.1 Study Area ....................................................................................................... 5
    1.4.2 Data description ............................................................................................... 6
    1.4.3 Outline of the rest of the thesis ...................................................................... 9
CHAPTER 2: ...................................................................................................................... 10
THEORETICAL FRAMEWORK ......................................................................................... 10
  2.0 Introduction .............................................................................................................. 10
  2.1 Equilibrium and Non-Equilibrium theories ......................................................... 12
  2.2 Livelihoods framework ......................................................................................... 14
CHAPTER 3: ...................................................................................................................... 17
CLIMATE VARIABILITY AND LIVESTOCK PRODUCTION DYNAMICS .............. 17
  3.0 Introduction: .......................................................................................................... 17
  3.1 Equilibrium / Non-equilibrium theories and Turkana Pastoralism ..................... 17
  3.2 Methods. ............................................................................................................... 18
  3.3 Rainfall variability: ................................................................................................ 18
    3.3.1 Long term mean annual rainfall (mm) and coefficient of variation (%CV): 18
    3.3.2 Seasonal rainfall analysis .............................................................................. 20
    3.3.3 Mean Daily Temperatures (°c) at Lodwar (1981-2009) ................................. 23
Appendix 5: Turkana Livelihoods Zones................................................................. 82
Appendix 6: Drought occurrences in Turkana district........................................ 83

LIST OF TABLES

Table 1: Long term mean annual rainfall (mm) and coefficient of variation (CV %) in Turkana District........................................................................................................ 19
Table 2: Correlation between the mean seasonal rainfalls among the divisions .......... 20
Table 3: Variability, quantity and changes in seasonal rainfall across Turkana district. ...... 21
Table 4: Coefficient of determination ($R^2$) for relationships between annual rainfall(lagged), TLU and annual NDVI................................................................. 26
Table 5: Coefficients of determination ($R^2$) for relationships between different livestock species population (TLU) and annual rainfall(t-1)............................................... 26
Table 6: Coefficients of determination ($R^2$) for the relationship between Livestock production indicators(%) and mean annual rainfall............................................... 27
Table 7: Correlation coefficient (R) of the influence of livestock production indicators on the livestock species population (TLU)........................................................................ 28
Table 8: Summary of peace indicators(quantity) over six years (2004-2009).............. 35
Table 9: Summary of conflict outcomes (quantity) over six years (2004-2009)........ 36
Table 10: Summary of Environmental indicators for six years (2004-2009).............. 37
Table 11: Regression Summary of dependent variable Raids using peace, conflict and environmental indicators (N=32).................................................................................... 39
Table 12: Regression Summary of dependent variable Livestock losses using peace, conflict and environmental indicators (N=32).......................................................... 39
Table 13: Regression summary of dependent variable Livestock species losses using peace, conflict and environmental indicators (N=32).............................................. 40
Table 14: Regression Summary of dependent variable Human deaths and injuries using peace, conflict and environmental indicators (N=32)........................................ 40
Table 15: The average livestock holding (TLU) per division (interviews):.................. 46
Table 16: Correlation matrix of the relationship between livestock ownership and number of years the owner settled in one village......................................................... 46
Table 17: Correlation matrix to show relationship between livestock species and reasons for migration................................................................. 47
Table 18: Pastoralists’ perception of rainfall, drought and grazing pasture trends in the last ten years (% frequency)............................................................... 48
Table 19: Pastoralists perception on the livestock population trends in the last ten years (% frequency)........................................................................................... 49
Table 20: Coping strategies adopted at the household level to drought in three divisions across the district/Livelihood zones.................................................. 51
Table 21: Comparison between Turkana conditions and ideal environment for cattle...... 55
LIST OF FIGURES

Figure 1: Location of Turkana District .................................................. 6
Figure 2: Schematic framework of adaptation to climate change and variability ............ 11
Figure 3: Turkana Livelihoods Framework Source: Adjusted from Juma (2009) .................. 15
Figure 4: Turkana District Long term mean annual rainfall (mm) for 1969-2000 years. Source: Own compilation .............................................................. 19
Figure 5: The Turkana District annual deviation of rainfall based on 1969-2000 mean (285 mm). With reference to Kenya Meteorological department definitions of a normal and severe drought ,the normal drought (-25% line) and severe drought (-50%) are shown. Source: Own compilation .............................................................. 19
Figure 6 a & b. Lodwar- rainy season rainfall distribution and deviation from the 1969-2000 mean. With drought (-25%) and severe drought (-50%) Source: Own compilation ......... 21
Figure 7 a & b: Lokitaung- rainy season rainfall distribution and deviation from the 1969-2000 mean. With drought (-25%) and severe drought (-50%). Source: Own compilation ............... 22
Figure 8 a & b. Kapedo- rainy season rainfall distribution and deviation from the 1969-2000 mean. With drought (>25%) and severe drought (>50%). Source: Own compilation ......... 22
Figure 9: Mean Daily Temperatures (˚C) at Lodwar (1981-2009) Source: Own compilation ...................................................................................................................... 23
Figure 10 a & b: Mean monthly and annual Rainfall and NDVI-Turkana district. Source: Own compilation .............................................................. 24
Figure 11: Livestock population (TLU) Trends in Turkana district (1997-2004). Source: Compiled from Ministry of Livestock-Turkana data .......................................................... 24
Figure 12: Deviation of the Tropical Livestock units (TLU) from the long term mean (603813) for 1969-2000 period. Source: Own compilation .......................................................... 25
Figure 13 a-e: Trends of households’ livestock holding during 1979-2004 period. Source: Own compilation ...................................................................................................................... 26
Figure 14: Relationship between mean annual rainfall and Pastoralists purchasing power for 2004-2009 period. Source: Own compilation ........................................................................... 29
Figure 15: Relationship between mean annual rainfall and household milk consumption for 2004-2009 period. Source: Own compilation ........................................................................... 30
Figure 16: Relationship between Mean annual rainfall and household coping strategies index for 2004-2009 period. Source: Own compilation ........................................................................... 31
Figure 17: Relationship between Annual rainfall, Forage and incidences of raids during 2004-2009 period. Source: Own compilation ........................................................................... 41
Figure 18: Relationship between annual rainfall, forage and incidences of raids during 2004-2009 period. Source: Own compilation ........................................................................... 42
Figure 19: Relationship between annual rainfall, forage and incidences of raids during 2004-2009 period. Source: Own compilation ........................................................................... 42
Figure 20: Relationship between annual rainfall, forage and incidences of raids during 2004-2009 period. Source: Own compilation ........................................................................... 43
ABSTRACT

The challenges posed by global climate variability are now widely recognised in both the scientific and the policy domains. In many parts of the globe climate variability is resulting in major impacts on humans and the natural systems although there are uncertainties still about its link to climate change. Pastoralism as a production system is under scrutiny on its’ appropriateness and sustainability under the changing environmental conditions. This study attempts to understand how the Turkana pastoralists have adjusted their livelihood strategies to cope with this variability. Primary survey and analysis of secondary data from institutions working among the Turkana pastoralist was undertaken. Based on rainfall data for the years 1969-2000, rainfall in Turkana is considered highly variable and unpredictable, with the short rains contributing much of the variability. Drought is a common feature with multiyear droughts increasing since 1990 and this has added more challenge to resource management among the pastoralists. Declining household livestock holding is evident, it falls below 5 TLU the minimum threshold for subsistence in the pastoral sector. Besides environmental variability, Conflict in form of livestock raiding limits access to key resources. The pastoralists’ adaptation strategies have taken into consideration the insecurity brought by conflict alongside the livelihood adjustments. The choice of herd composition, resource access and diversification of income sources are some of the strategies that are configured by conflict in the Turkana case. This study proposes that conflict is embedded in adaptation as it restricts and shapes the coping strategies employed by the pastoralists. Therefore understanding of the Turkana situation from the livelihood security perspective is more realistic than as a resource scarcity discourse. Integration of both conflict and environmental indicators in the local Early Warning systems is an option that seems viable considering that already the pastoralist's adaptation strategies are shaped along the same direction. The local adaptation strategies require augmentation rather than imposition of new ones, utilization of the inherent local capacity would be cost effective. Marginalisation of pastoralists requires a political solution that addresses redistribution of power and resources. Development inputs should support the pastoralists’ mobility or their desire to remain in Pastoralism. The conflicting interests of players in livestock raiding and factors excluding or enhancing the specific players in adopting certain coping strategies must be given due consideration in the drawing of adaptation programmes. Promotion of formal education among the pastoralists can provide an opportunity to lend support to the moral economy which is threatened by loss of livestock. In the analysis of coping strategies in this study, remittances from kins and friends is considered an all time strategy and thus it emphasizes its’ importance to livelihood security. The increased number of dropouts from Pastoralism and emergence of sedentary life in the urban areas related to loss of livestock and inability to recover requires attention be paid to development of sectoral adaptation measures that would reduce vulnerability of the urban and periurban poor.

Key words: Turkana pastoralists; Climate variability; Livelihood strategies; Coping and adaptation strategies; Conflict; Livestock raiding
CHAPTER 1:
INTRODUCTION

1.0 Background information

Challenges posed by global climate variability are now widely recognised in both the scientific and the policy domains. In many parts of the globe climate variability is resulting in major impacts on humans and the natural systems although there are uncertainties still about its link to climate change (IPCC, 2001). There are many recent attempts to understand how communities are adjusting their livelihoods strategies to cope with this variability (Eriksen and Lind, 2009; Notenbaert et al., 2007; Stigter et al., 2005; Galvin et al., 2004).

The Sub-Saharan region of Africa experiences profound socio-economic and political problems, the most important being food crises and disruptive conflicts. The recent food shortages in the region have been linked to rainfall variability as most production systems are subsistence oriented and are dependent on the climatic conditions. Droughts and floods have become a common feature and the local capacities to cope with these phenomena have been eroded over time. Inter-annual variability of rainfall has been increasing and the chances of drought in parts of the Greater Horn of Africa have doubled from one in five years to one in three years (Meier et al., 2007). The Intergovernmental Panel on Climate Change (IPCC) report (2007) confirms that the atmosphere is warming, a trend that will have impact on the frequency and the severity of natural hazards. The report contends that the recent climate changes and variations are beginning to have effects on many natural and human systems (Watson & Binsbergen, 2008; Thornton et al., 2002). Africa is projected to be the most vulnerable region in terms of predicted decrease in water and food security because widespread poverty limits adaptive capacity (Cooper et al., 2008). This notwithstanding, it is becoming clear that adaptation to climate variability and change is no longer a secondary and long term response option only to be considered as a last resort but it is urgent imperative for those communities already vulnerable to present climatic stress. It is estimated that by 2080’s, parts of arid and semi-arid lands in Africa will likely increase by 5-8%. This is due to prolonged drought, shrinking lakes, drying rivers and aquifers and sinking water tables (Ogallo, 2007). The East African region is considered in several climate analyses that it will be drier, with reduction in the length of the growing season. This is expected to have the potential to make local livelihoods that depend on rainfall including Pastoralism more vulnerable (Galvin et al., 2004). Arid and semi arid lands cover 40% of the earth surface on which over one billion people depend for their livelihoods and two thirds of the African continent is dry and is home to more than 50 million people (Galvin et al., 2004). 80 percent of the Kenyan landmass is arid and semi-arid and most of the inhabitants are pastoralists who are dependent on the natural environment for their survival. These areas are home to approximately over 10 million people which are a third of Kenya’s population. Livestock production accounts for 26% of total national agricultural production (Orindi et al., 2007). Livestock is a key asset for pastoralists and is both a financial asset, source of food, income and storage of wealth and a social asset, as it forms the basis of social relationships through gifts, exchanges and fines (Watson and Cutley, 2008).

Pastoralism as a production system has recently come under scrutiny from both development practitioners and researchers on its appropriateness and sustainability under
the changing environmental conditions. Climate models project a substantial increase up to 5°C in the annual average temperature for Kenya by the end of the century which could lead to decrease in livestock population (Cooper et al., 2008). Drought is the most common consequence of current climate variability in the semi arid lands and as an intrinsic characteristic of the climate regime in these regions, variability defines the many decisions made by those who inhabit them (Ribot et al., 2009). Increased frequency of drought in Kenya is leaving pastoralists increasingly exposed to shocks as time needed to rebuild their herds (15-20 years) is longer than the intervals between the occurrence of drought (Longley and Wekesa, 2008). Unable to recover pastoralists become trapped in a downward spiral of vulnerability and destitution. Pastoralists adopt mobility as a strategy to manoeuvre their environment and make efficient use of the available natural resources; however this is becoming increasingly difficult due to frequent occurrence of disasters. According to Oba (1997); Akabwai (1992) the local Turkana economy has been weakened by changing climatic conditions, longer and more frequent droughts have led to destitution and vulnerability among the pastoralists. Impact of drought, increasing insecurity and famine has led to a growing emergence of sedentary Turkana and experimentation with alternative livelihoods (Lind, 2003; Watson & Binsbergen, 2008). The new and persistent environmental, political and social pressures can limit choices that have traditionally been available.

The Turkana pastoralists being knowledgeable of their environment they have been highly nomadic and this stems from the unpredictability of rainfall and grazing resources availability in the space and time. They consider many factors when making decisions on grazing but they usually base them on good understanding of ecology and animal behaviour (Ellis, 1995). Their grazing management is such that during the rainy season the plains in the interior of the district are utilized while the hills, mountains, riverine and areas on the borders are utilized for dry season grazing.

Underlying the Turkana pastoralists’ adaptation to the various disturbances that characterise their rangeland is spider-web of social interactions (Lind, 2003). With these social interactions the pastoralists could basically rely on constructed network of friends and kinsmen to rebuild a herd in the event of a raid or severe drought. According to Hendrickson et al.,(1998), Turkana pastoralists have pursued a complex range of conflict avoidance strategies to reduce vulnerability and confrontation with other resource users. The pastoralists have experienced devastating droughts and their strategies based on centuries of exposure to the droughts are not working due to partly an inability to implement them, it is likely that the nature of the climate variability that pastoralists are used to dealing with will itself change adding new variability to the system (IPCC, 2001). The short drought cycles being experienced of late means that the pastoralists do not have time to adequately recover before another drought incident occurs (Orindi et al., 2007). Livestock keeping has become less reliable over time, the pastoralists have sought alternative economic activities (Lind, 2003).

The extent to which a pastoral production system can support livelihoods depends on its ability to adapt to the changing environment. The pastoralists’ ability to cope with and recover from climate stress can be taken as an entry point to understand adaptation (Lind and Eriksen, 2006). In the pastoral systems which are reliant on rainfall as the source of pasture growth, seasonal rainfall variability is inevitably mirrored in both highly variable production levels as well as risk averse livelihood and coping strategies that have emerged overtime amongst the rural population (Cooper et al., 2008). Most of the pastoral adaptations
to climate variability are socio-cultural (i.e. changes in management), usually a series of reactive responses to climate events such as drought (Galvin et al., 2004).

This study analyses the rainfall variability in Turkana district and its effect on the pastoralists’ livelihood and continues to identify the traditional livelihood and coping strategies that the Turkana pastoralists have employed as adaptation to climate variability. It further explores whether environmental variability has any influence on the conflict prevalent in Turkana and the neighbouring communities. This is anticipated to bring a broader understanding of the pastoralists’ traditional adaptive mechanisms to climate variability and might contribute to the debate of whether Pastoralism will survive under the changing environmental conditions.

1.1 Description of the Turkana Pastoralism

Pastoralism as the principle livelihood for the Turkana people has existed for over 9000 years (Blench 2000 cited from Notenbaert et al., 2007). The district has the highest livestock population than any other district in Kenya. There are five livestock species being kept: cattle (zebu), camels, goats, sheep and donkeys. Social and economic pride has revolved around the cattle, which has been used as the main currency for exchange, dowry settlement and other traditional rituals.

The climate regime in Turkana is mainly erratic and unreliable and the Turkana pastoralists have developed complex and effective strategies to survive in the highly variable environment. Drought is a common feature and it has been accepted by the pastoralists as part of their life. There is much variation in the degree and timing of the seasonal changes and drought. Drought appears to occur in every 3-5 years, though recently the occurrence of back to back single year drought has increased. These periods of drought are associated with decrease in plant productivity which will require several years of recovery (Ellis, 1995). The Turkana pastoralists utilize multiple strategies for contending with the environmental uncertainty. Their social organisation is characterized by flexibility, opportunism and highly dynamic management. According to McCabe (2004) the social networks amongst the herders offer security and insurance that is part of this flexibility.

The Turkana people have 19 clans, each occupying a defined territory. No individual rights to forage exist and crossing to other territories requires permission from the elders and the “emuron” or seer of that territory. Each clan defends its territory and during periods of stress the elders may deny outsiders the access to the grazing area or impose a toll in livestock. However rights of access to pasture do not translate into utilization as some of the areas are not accessed due to threats of livestock raiding from neighbouring communities or the presence of livestock diseases. Pertaining to access to water, individual rights are restricted to wells dug by family members and unrestricted to open sources such as flowing rivers, pools or springs.

The pastoralists are highly mobile with no fixed residence or regular pattern of movement. A household referred to as “awi” consists of 9-15 people (McCabe, 1985). The individual awi would congregate together into several units called adakar (ngadakarin in plural). Movement and management decisions are made at the awi and adakar levels. During dry periods the ngadakarin, household members and the animals are dispersed in different orbits to spread risk and capture existing opportunities. The number of satellite kraals depends on the livestock characteristics and the available labour in the household. The arrangement is such that there is a wet and dry season grazing combined with the setting of specific dry season
grazing reserves (*epaka* or *amaire*). There are no fixed migration routes and the frequency varies; since each year represents a changing mosaic of forage conditions, water availability, labour requirements, herd sizes and security risks (Burrow and Mogaka, 2007).

The livestock species have different forage and water requirements and variable levels of resilience during drought periods. The strategies utilized for managing herds during droughts are not always appropriate for dealing with insecurity caused by livestock raiding (Pike, 2004). Changes that have occurred in the last 100 years have threatened these strategies (Notenbaert et al., 2007). Drawing of national and international borders, expansion of irrigated agriculture along the main rivers has limited the extent of traditional migration patterns of the pastoralists. Lack of pasture and water due to severe drought and encroachment of dry season by agro-pastoralists and growing human population have led to increased competition and less cooperation between clans within Turkana and also with the neighbouring ethnic groups in Pokot (Kenya), Uganda, Sudan and Ethiopia. Drought has become more frequent and long leading to catastrophic losses of livestock and because of its covariant nature those who loose entire herd, remain destitute. This is particularly acute for the poorer members of the community as they have few livestock and less developed social support networks.

The drought experienced in the 1990's pushed a big number of pastoralists deeper into abject poverty prompting huge flows of humanitarian aid. This has been argued to exacerbate poverty by maintaining unsustainable levels of human populations in settlements. Some research has also shown that introduction of famine relief challenges the continuity of pastoral social networks, the exchange and redistribution networks are undermined when the pastoralists join relief settlements (Pike, 2004).

1.2 Research Objectives:
The objectives of this Study are three fold; First, it aims at investigating the extent of climate variability and its effect on livestock production and the pastoralists' welfare. Secondly, it explores whether there is any influence between environmental variability and conflict activities in the Turkana region. Thirdly, it identifies livelihood and coping strategies employed by the Turkana pastoralists to cope with climate variability.

1.3 Research Questions:
To meet these objectives the following questions are explored in this study;
- How is the spatial-temporal variation of rainfall in the district?
- What is the influence of rainfall variability on the livestock production dynamics and the pastoralists' welfare?
- Does environmental variability influence the conflict activities in the district?
- What coping and adaptive strategies have the Turkana pastoralists adopted to contend with climate variability?
- What policy actions will be necessary for the Turkana Pastoralism to remain viable under variable environmental conditions?
1.4 Methods

1.4.1 Study Area
The study was conducted among the Turkana pastoralists who occupy the North western part of Kenya. The district was recently subdivided into six more administrative districts namely Turkana North, Turkana Central, Turkana South, Turkana West, Turkana East and Loima. For purpose of this study the district referred to herein is the original greater Turkana. The district is 77,000 Km² in size and it is mainly dry and hot. Temperatures range between 24°C and 38°C with a mean of 31°C (GOK, 2002). Rainfall ranges 120mm and 500mm per year (GTZ, 1994). Rainfall is erratic in distribution and timing. The intra-year coefficient of variation is more than 50% throughout the district with the peaks of 75% and more in the driest western areas (Hijmans et al., 2004). Rain falls in March-July and October-December. The vegetation cover is widely varied and ranges from annual grassland to upland forests but most parts of the district have dwarf shrubs, annual bushed and wooded grassland.

It has emerged from many studies that the most devastating droughts have occurred about every ten years and recently the trend seems to be changing (1925, 1930, 1942, 1952, 1960, 1970, 1980, 1990, 2000, 2005 and 2009). While the 1920s to 1950s were normal years, droughts became more common and severe from the late 1970s. Drought in the Turkana district is a common occurrence and has been accepted by most Turkana pastoralists as a normal part of life (Field, 2005).

The mainstay of the Turkana economy is Pastoralism, about 70% of the inhabitants benefit directly from this (Watson and Binsbergen, 2008). The major livestock types kept include cattle (Zebu), camels, donkeys, goats and sheep. The rest of the population depends on agro-Pastoralism, fishing and casual or formal labour in the urban areas. The population in 2005 was 509,286 people with a mean density of 7 persons per Km² (Notenbaert et al., 2007).

Fishing is an important activity along the Lake Turkana. Over the years, fish yields from the lake have been declining due to falling water levels and the state of insecurity in Todonyang (the entry point of river Omo from Ethiopia).

Crop production is practiced by agro-pastoralists mainly on pockets of arable land within flood plains and along riverine areas. The harvest is dependent largely on the amount of rain realized in a year, and the volume of water flowing in the two major seasonal rivers of Turkwel and Kerio. Indigenous fruits/foods are important sources of food particularly during dry spells. Of the wild fruits, doum palm is the most widely used. It is used for basket and mat making. Acacia tortilis is utilized for livestock feed, firewood and charcoal production.
1.4.2 Data description
The study relied on both primary surveys and secondary information and data. Stratified random sampling procedure was applied in identifying six divisions on which household interviews were conducted. The district was divided into three regions (North, south and central). Two divisions from each of these regions were selected randomly. These included Kaleng and Oropoi (North region); Kalokol and Turkwell (Central region); Lokori and Katilu (South region).

Data on Livelihood and coping strategies
The qualitative data on pastoralists’ traditional climate variability coping strategies, social and cultural considerations was gathered through household interviews by administration of semi-structured questionnaire. Sixty (60) heads of households were interviewed. This information was triangulated further through focus group discussions in every site visited. Six (6) focus group discussions with at least ten men or women in separate gender groups were achieved. The discussions were guided through a check list of open-ended questions with focus on how rainfall variability has affected the coping strategies, changes overtime on
migration and economic activities. Further clarity and validation of data was sought through interviews with key informants within the community ranks, administration officials and professionals working in the area. Fifteen (15) Key informants were interviewed.

Environmental data

Long term rainfall data for four stations; Lodwar (1969-2009), Kapedo (1969-2000), Kaputir (1969-2000) and Lokitaung (1969-2000) in the district was provided by the Kenya Meteorological department. The stations were selected because they had long term rainfall data and met the World Meteorological Organisation (WMO) criteria that a 30 year period rainfall data can be used to create a baseline climate for an area (NOAA, 2007). This period is deemed to likely contain wet, dry, warm and cool periods and is therefore considered long to define a region’s climate. Due to variations in rainfall records in the selected stations the rainfall data for the period 1969-2000 was used to define the district rainfall. The rainfall figures were normalized using the following formula;

\[
\frac{\text{seasonal rainfall totals} - \text{Long term mean}}{\text{Long term standard deviation}}
\] (Farmer, 1986).

Data on daily minimum and maximum temperatures for 1981-2009 for Lodwar (Central) station was provided by the Meteorological department and it is used to give a general trend of the temperature variations. No data was available for other stations. The daily minimum and maximum temperatures were averaged to determine the daily mean temperature.

Normalized deviation vegetation index (NDVI) data was obtained from the Famine Early Warning System Network (FEWSNET). The time series data was for all the 17 divisions of the district for the period 1996-2008. It is expressed as an index with limits (-1 and +1), higher NDVI indicates the denser the vegetation. It is used as a proxy to availability of forage in this study and its relationship with rainfall variability and conflict indicators are explored. The index for each dekad (10 days) is aggregated to get the monthly NDVI values. The monthly values for each division for every year are then aggregated to make the district annual NDVI values.

Livestock production data.

The long term livestock population data was provided by the department of Livestock Production –Turkana district. It covered the period 1997-2004. The livestock species included are cattle, camel, goats, sheep and donkey. The equivalence between different species is expressed in terms of Tropical Livestock Units (TLU). A TLU is 250 kilograms live weight of any domestic herbivore. The figures used in this study are; cattle=0.7 TLU; camel=1.0 TLU; donkey=0.4 TLU; sheep or goat=0.1 TLU. To simulate on household livestock holding in the district, the livestock populations’ data in literature were used to construct the trends for 1979-2004 with a five year period in between.
Pastoralists’ welfare data

The pastoralists’ welfare data was obtained from Arid Lands Resource Management Project in Turkana (ALRMP). The data covered the period 2004-2009. The indicators monitored through the Early Warning System (EWS) situated at ALRMP included; coping strategies index, Household milk consumption, pastoralists purchasing power. Coping strategies index is on Likert scale (0-10), with higher values indicating pastoralists’ vulnerability and participation in many coping options. Household milk consumption is an average of milk in litres consumed by all members of a household in a given period. Pastoralists Purchasing Power is expressed in cereal to meat price ratio. The Pastoralists depend on livestock as their main source of income and currency. Income in the context of the Turkana pastoralist reflects consumption, since Livestock are only turned into income when a purchase is needed. The small stock (goat and sheep) meat price is used as they are the main species sold and slaughtered by the pastoralists to meet their household food needs.

This ratio is calculated as:

\[ CMR = \frac{PC}{PM} \]

Where

\( CMR \) = Cereal-Meat price ratio
\( PC \) = Mean price of maize
\( PM \) = Weighted mean price per kg of meat (goat and sheep)

\( \%CMR \) = Pastoralists’ purchasing power.

Limitations of Data

The rainfall data for most of the stations was only up to the year 2000 and thus it was challenging to regress it with other variables whose periods of record were different. The EWS data for periods earlier than 2004 was not accessed and thus long term trends of some important welfare indicators could not be analysed. Overall a small sample of data was analysed and it returned high values of correlation with no significance in some instances meaning that a large sample would be required to make substantial inferences. Despite this, the analysis provides important direction in terms of the impact of climate variability to livestock production in Turkana district and can be a basis for suggesting ways of strengthening the adaptive capacity of the pastoralists.
Statistical Analysis

Several statistical analyses have been used in understanding the relation between dependent and independent variables. Descriptive statistics was used to determine the mean annual rainfall, standard deviation and coefficients of variation for three divisions and the whole district. Simple linear regression was used to find the relationship between mean annual rainfall on NDVI, the Livestock population and the production indicators. The mean annual rainfall was lagged in regressions with Livestock population and production indicators to infer on the implications of delayed rainfall. Correlation matrix was applied to determine the inter-relations between the livestock population and production indicators of the different livestock species. The correlations were considered significant at \( P<0.05 \).

The description of data and statistical analysis techniques used are explained further in the results chapters 3, 4 and 5.

1.4.3 Outline of the rest of the thesis

The rest of the thesis is structured in five chapters as follows;

Chapter 2 explores the various theoretical frameworks that form a background to understanding the basis of adaptation to climate variability. The adaptation concept as it is used in the climate variability and change debate is defined. Equilibrium and non-equilibrium theories and Livelihoods approach are explored in the local Turkana context.

Chapter 3 draws an understanding on both spatial and temporal variation of rainfall in Turkana rangeland. The rainfall figures from three divisions are used to generalize for the whole district on seasonal and inter-annual time scales. The impact of the same on livestock productivity and the pastoralists’ welfare is underscored.

Chapter 4 looks at whether there is any influence between climate variability and livestock raiding in the Turkana region. Conflict data from a local peace and conflict resolution organisation coupled with environmental data from FEWSNET is used to simulate the relations between the two phenomena.

Chapter 5 brings into perspective the local perceptions on climate variability, livestock raiding and how locally the populations adjust their livelihood strategies to the same. It draws its basis from interviews conducted in the field during the 2009 summer period.

Chapter 6 discusses the findings from the study and makes recommendations on the possible policy directions.
CHAPTER 2:
THEORETICAL FRAME WORK

2.0 Introduction
The concept of adaptation to environment draws its roots from population and ecology biology; where it has been used to explain the genetic characteristics that allow individuals to survive and reproduce in the environment they inhabit (Smithers and Barry, 2009). Other disciplines have also used the concept to explain various phenomena. Social Scientists on their part have defined cultural adaptation as adjustment by individuals to the collective behaviour of socio-economic systems.

In regard to climate change and variability diverse definitions have been put forth by different writers in reference to adaptation:

Adaptation to climate change and variability includes changes in management activities, institutional setting and infrastructure to enable effective response to the changes in climate that may occur (Cooper et al., 2008).

Adaptation refers to adjustment in practices, processes or structures of systems to projected or actual changes in climate. It can be spontaneous or planned (Watson et al., 1996).

Adaptation is an adjustment in the use of resources in relation to climate stress (Eriksen and Lind, 2006).

Adaptation is an adjustment in social or economic systems made in response to actual or expected climate to reduce the vulnerability of society to change in climate system (Galvin et al., 2004).

Adaptation refers to any adjustment in natural or human systems that take place in response to actual or expected impacts of climate change, and intended either to moderate harm or to exploit beneficial opportunities (IPCC, 2001).

These definitions are interrelated in their focus; they all refer to an adjustment in a system in response to climatic stimulus. It is recognised that societies adapt to a range of stimuli including but not limited to environmental stress. Figure (2) adopted from Smit et al., (2000) gives a clear a picture of how adaptation can be interpreted in diverse angles.

Stimuli

Variability may include shifts or changes in the shape of frequency / probability distribution of climate variables as well as variations or recurring anomalies associated with other forces (Smit et al., 2000).

System

Adaptation to climate change and variability can be specified in terms of climate characteristics that are relevant and their connection to the systems which adapts. Pastoral production systems response can be understood on the cycle of temperature and precipitation which influence pasture/forage growth.
According to the IPCC there are three broad types of adaptation:

- Anticipatory adaptation is adaptation that takes place before impacts of climate change are observed.
- Autonomous adaptation is adaptation that does not constitute a conscious response to climatic stimuli but is triggered by ecological changes in natural systems and by market or welfare changes in human systems.
- Planned adaptation is adaptation that is the result of a deliberate policy decision, based on an awareness that conditions have changed or are about to change and that action is required to return to, maintain, or achieve a desired state.

The inhabitants of the dry lands have for many decades been adjusting their livelihood strategies to large variations in climate; both in short and long term. Cooper et al., (2008) delineate short and long term strategies by referring to them as coping and adaptive respectively. Coping strategies are those strategies that have evolved overtime through long experience in dealing with the known and understood natural variation that people expect in season combined with their specific responses to the season as it unfolds. On the other hand, adaptive strategies are long term strategies that are needed for people to respond to a
new set of evolving conditions (biophysical, social and economic) that they have not previously experienced.

Various approaches have been advocated and applied on pastoral systems management and but are still drawing a lot of debate among scholars and development practitioners mainly on their practicality. In trying to understand how the pastoralists adjust their management and livelihood strategies to cushion against climate induced vulnerability, this thesis explores two theoretical frameworks; Equilibrium/ Non-Equilibrium and Livelihoods framework.

2.1 Equilibrium and Non-Equilibrium theories.

The carrying capacity concept was used in range management in the 1970’s and early 1980’s as a basis to design development interventions that ensure sustainable exploitation of rangelands. It is defined as the maximum possible stocking of herbivores that a rangeland can support on a sustainable basis (De Leeuw and Tothill, 1990). It was based on the premise that there are stocking rates at which sustainable grazing pressure is achieved (Behnke and Scoones, 1993). The idea was that an excessive number of animals above the calculated carrying capacity could lead to negative effects on vegetation or degradation of environment (Rietkerk and Ketner, 1998). This concept has also been used as a scientific standard to prove that Pastoralism is inefficient and environmentally destructive and thus the use of terminologies like ‘Tragedy of the commons’ to describe the system. Tragedy of the commons implies that individual interest will result in the abuse of commonly held resource (Hardin, 1968).

The Tragedy of the commons model identifies source of potential tragedy in the tenure arrangements and recommends limits to stocking levels or tenure reforms as desirable policy responses (Ellis, 1995). There is little evidence to support this notion in the East Africa as keeping multiple species herds not only contributes to systems stability but also averts risk and allows a herd owner to balance the need for long term security with the possibility of short term gain (McCabe, 1990). Oba (1997) argues that highly adaptive grazing systems steer the grazing strategies of the pastoralists in such a way that a socially optimal stocking rates are achieved. The pastoral rangelands are not open access as they are regulated by a variety of social institutions. Individual families are protected by social networks that facilitate livestock exchange while the resource base is protected by defences of territorial boundaries. Clans maintain access to different grazing resources through their own actions and through alliances with other clans, such alliances function as a mutual insurance mechanism. The clans usually adjust their grazing plans based on the relative rainfall impact to their territories and those of neighbouring clans and communities.

The equilibrium grazing models that have been advocated in the past do not take into account the high variability of rainfall. The models associated the spatial and temporal changes in vegetation in the arid areas of Sub-Saharan Africa with rangeland degradation (Oba et al., 2006). Equilibrium models assume predictable primary production, little inter-annual variation and thus a stable carrying capacity can be adopted.

During the past two decades, new understanding has supported an alternative view; which argues for variable carrying capacity, allowing stocking densities to vary over time and make maximum use of the vegetation without damaging range resources (Behnke and Scoones, 1993). According to Ellis and Swift (1988), their research among the Turkana pastoralists in
Northern Kenya revealed that the Turkana environment was a non-equilibrium ecosystem that is better exploited by flexibility and opportunism. Food and Agriculture organisation (FAO), reports that similar ecosystems in Australia, North and South America have proven that succession theory might not be applicable to unstable dry tropical ecosystems. Ellis and Swift (1988), Scoones (1994), Behnke and Scoones (1993) have argued that vegetation cover is largely determined by rainfall and not grazing. Ironically semi-arid grazing systems exhibit some of the worst examples of apparent degradation (Rietkerk and Ketner, 1998). They argue that vegetation changes in arid and semi-arid grazing systems have been found to be practically irreversible and this explains the dramatic decrease of perennial herbaceous biomass in a tree-shrub savannah like the Turkana environment.

Conversely, the non-equilibrium grazing models employ flexibility in resource management and combine climatic variability and grazing in the process (Oba et al., 2006). These models take into account the unpredictable, large inter-annual variation and greater spatial heterogeneity of primary production and thus the need for variation in livestock numbers depending on season. The theory argues that climate variability is the single largest cause of poverty in the pastoral area and it can be addressed by exploiting spatial heterogeneity and by managing use of key resources (Derry and Boone, 2010).

The extremes of these theories are challenged today as real ecosystems often behave in an intermediate way (Vetter, 2005). There may be other indirect effects which are not accounted for in both equilibrium and non-equilibrium models. According to Derry and Boone, (2010) there is evidence that lack of nutrients may reduce biomass production and herbivores may also detrimentally affect flowering, seed set and seedling establishment and thus cause changes in vegetation composition in the long run.

Pastoralists’ coping strategies to climate variability, access issues are more important in explaining the state of rangelands than stocking rates. According to Derry and Boone (2010), it is actions that pastoralists employ to cope with climate variability that shape the thinking of non-equilibrium systems and removal of these actions can only result in the strengthening of the plant-animal interactions at the core of equilibrium thinking. It is widely accepted that restricted mobility in semi-arid and arid pastoral areas systems increases the risk of degradation since it puts pressure on the grazing resources and reduces the opportunity of resting parts of the system (Vetter, 2005; Ellis and Swift, 1988). This understanding has contributed to a new thinking that both Equilibrium and non-Equilibrium approaches will be important in understanding the dynamics of Pastoral systems (Hein, 2005; Vetter, 2005). The previous suggestions that non-equilibrium dynamics predominantly occur in coefficient variation of rainfall around 33% are thought to be not accurately defining the systems dynamics. Derry and Boone, (2010) suggest that the system dynamics should be considered as gradual and continuous showing no limit between discrete states as expressed in equilibrium and non-equilibrium models.

The pastoralists’ decision making is critical in shaping the actions that will be undertaken to adjust to the changes in the system. These adjustments have direct or indirect impact on the livelihoods. To understand this clearly a livelihood framework is relevant.
2.2 Livelihoods framework
Livelihood concept emerged in the mid 1990’s as an integrated people centred approach to research and policy formulation (Cameron, 2006). It has been used as a tool to understand how communities organise their lives. Livelihood comprises capabilities, assets and activities required as means of a living and it is deemed sustainable when it can cope and recover from shocks or stresses and maintain or enhance its capabilities, assets and activities both now and in the future, while not undermining the natural resource base (DFID, 2001). The livelihoods approach places people and their priorities at the centre of analysis (Chambers, 1987). This approach helps to organise factors that constrain or enhance livelihood opportunities and aims to build on strengths.

To provide an in-depth analysis of the Turkana pastoralists coping and adaptive strategies, this thesis adopts a livelihood framework formulated by Juma (2009) with a few adjustments to explain the interaction of various factors that define the Turkana adaptation strategies to climate variability.

Vulnerability context
According to Scoones, (1998) vulnerability would cover from historical to current socio-economic trends such as policy settings, history, climate and culture. Recent studies on Turkana pastoralists point at conflict, frequent droughts and political marginalisation as contributing to their vulnerability (Eriksen and Lind, 2009; Lind 2003; Juma, 2009). This forms an entry point for understanding how the Turkana pastoralists adjust their livelihood options during a shock or stress. In this framework climate variability is understood as one of the factors that change the pastoralists’ food security situation by disrupting their assets or resources. The disruption of assets or resources can lead to destitution or even death if the livelihood outcomes are not positive.

Pastoralists’ perceptions
The pastoralists define the problem they face on the basis of their world view (e.g. norms, values, taboos and roles) and give a specific meaning before adopting a relevant livelihood strategy (Juma, 2009). A sustainable Livelihood framework developed by DFID recognises that strategies adopted by a household determine the livelihood outcome and these outcomes contribute to livelihood security and sustainability of natural resources (DFID, 2001). The outcome of the strategy determines in the long term whether a pastoralist will remain viable or quits Pastoralism.
**Social networks**

The interaction of pastoralists with their kins, stock friends, neighbouring communities and outsiders has been exploited for survival during times of crisis. These social networks have been utilized as insurance during the time of stress and increase their resilience and adaptability towards climate variability (Lind, 2003; Juma, 2009). The social networks thus have direct links with the livelihood strategies adopted by communities. The livelihood strategies adopted by a household or community can have positive or negative effects on existing social networks.

**Livelihood strategies**

Literature on adaptation demarcates the borders between coping and adaptation strategies. Coping refers to short term response to a crisis or stress which does not require adjustment to the livelihoods. On the other hand adaptation strategies require a long term shift in practices and choices to secure livelihoods and minimize risks of destitution (Scoones, 1998). Owing to frequent and long droughts the Turkana pastoralists are engaged in a range of coping strategies which reduce the level of food insecurity in situation of crisis. However achievement of sustainable income and food security livelihood outcomes is hinged on adaptive strategies. Adaptive strategies determine livelihood outcomes (the goal that
household or community pursues) Ellis, (2001). The outcome of a livelihood strategy will either have a positive or negative effect on the poverty level of the household or community which in turn determines whether the unit will remain resilient or vulnerable to shocks.

This framework therefore has the potential to enrich an understanding of how the Turkana pastoralists adjust their livelihoods strategies to remain viable under changing environmental conditions. It informs both this study and the debate of whether Pastoralism will survive under the Turkana environment.
CHAPTER 3:

CLIMATE VARIABILITY AND LIVESTOCK PRODUCTION DYNAMICS

3.0 Introduction:
The Horn of Africa region experiences highly variable climatic conditions both in space and time. Climate variability is reflected in both the mean annual rainfall and its seasonal distribution. The East Africa rainfall is bimodal but is characterized by uncertainty both spatially and temporally. Rainfall seasonality affects forage availability, livestock production and ultimately the livelihood of the pastoralists (Galvin et al., 2004). According to Orindi et al., (2007) in Kenya biomass productivity correlates with mean annual rainfall. Comparative studies in East Africa have also demonstrated that mean above ground net primary production (NPP) is strongly related with mean annual precipitation (Le Houreou, 1984). Rainfall records for Turkana district indicate that drought may occur as frequently as every 3-4 years (McCabe, 1990), Ellis and Swift (1988) on their studies on the Turkana rangeland stressed that variability of rainfall rather than the mean is critical in explaining the ecosystem dynamics. According to Oba (2001), rainfall variability in Turkana is extreme in both space and time with rainfall highly skewed in distribution when one part of the district receives rain, the other part may experience a drought. Drought has negative impact on natural pasture growth, often resulting in lack of fodder and consequent economic loss for the pastoralists that may reach disaster levels. Although the Turkana identify defined wet and dry seasons, it is impossible to predict when the rains will begin, how long they will last or how much will fall (McCabe, 1987).

3.1 Equilibrium / Non-equilibrium theories and Turkana Pastoralism.
Linkages between climate, plant and herbivores serve as ecological drivers that influence the dynamics of East African rangelands. Climate variability is the principal driver as it has direct impact on the variability of plant cover and biomass (Oba et al., 2000). According to McCabe, (1987); Ellis and Swift (1988), the Turkana pastoralists inhabit a non-equilibrium ecosystem driven by abiotic processes such as rainfall and water availability and because of its highly dynamic character, flexibility and opportunism characterizes Turkana social organisation. Non-equilibrium land use ensures that maximum utilization of heterogeneous variability in range resources through livestock and mobile tracking of rainfall and forage production. There is no empirical evidence that links the Turkana pastoralists grazing strategies to land degradation, though Ellis and Swift (1988) argue that the low rainfall experienced in Turkana has resulted in an annual community of grasses produced from seed in a "boom and burst" mode depending almost exclusively on annual rainfall. The Turkana pastoralists exploit the spatial heterogeneity of available grazing lands during dry periods not necessarily waiting for drought conditions before moving to dry season grazing areas. The mobility of the pastoralists has been restricted by conflict along the traditional dry season grazing areas. According to Ellis and Swift (1988) their study in South Turkana found degradation around the homesteads where small stock grazes throughout the year. While being confronted with this scenario it would be appropriate to consider the Turkana rangeland as having a gradual and continuous increase in decoupling and not limited between discrete states as expressed in equilibrium and non-equilibrium theories (Derry and Boone, 2010).
3.2 Methods.
The monthly rainfall for three divisions (Lokitaung-north, Lodwar-central and Kapedo-south) spread across the district was used to construct both the divisional and district annual rainfall for 1969-2000 periods. Mean seasonal rainfall was obtained by summing the monthly records; for long rains season (“akiporo”) monthly records for March, April, May, June and July were summed. Short rains season (“akicheres”) constituted records for the months of October, November and December.

To detect statistically significant changes in rainfall, rainfall (dependent variable) was regressed on time/year (independent variable). The parameter estimate of the slope was tested for statistical significance using the simple t-test at 0.05 level of significance.

With regards to NDVI, the dekad records were summed for each month and then monthly totals aggregated to annual values. The monthly and annual indices were correlated with monthly and annual rainfall figures correspondingly.

3.3 Rainfall variability:

3.3.1 Long term mean annual rainfall (mm) and coefficient of variation (%CV):
The mean annual rainfall for Turkana was 285mm for the period 1969-2000 (Table 1). There was high inter-annual variation in rainfall within the divisions, Lodwar(Central) with the highest CV of 56%, followed by Lokitaung(North) 52%, Kapedo(South) with the lowest 41%. The district CV was 43% (Table 1). According to Ellis (1995), above CV of 33% a rangeland is thought to exhibit non-equilibrium dynamic (This is explained further in chapter 6). The Lodwar (central) region of the district had more years below the long term mean annual rainfall (63%), with Kapedo returning a lower number (45%). Overall the district had 45% of the years being dry. The period 1969-1980 had 4 dry years (1969,1971-1973), the 1981-1990 period had 4 dry years (1983-1984,1986-1987,) and 1991-2000 had 6 dry years (1992,1994-1995,1998-2000).

The occurrence of multiyear droughts seems to have increased with time (Fig 4). The Kenya Meteorological department delineates normal and severe drought by percentage of rainfall amounts deviation from their long-term means. Severe drought is >-50% deviation from the long term mean rainfall while a normal drought is experienced with a deviation >-25%. 4 out of 14 drought years experienced in the district during 1969-2000 periods were severe in nature. Three quarters (75%) of the severe droughts were realized in 1990-2000 period (Fig 5). In the ‘district and divisional level analysis neither the district or either of the divisions were found to have experienced any significant changes in annual rainfall for the period 1969-2000 (Fig 6).
Table 1: Long term mean annual rainfall (mm) and coefficient of variation (CV %) in Turkana District

<table>
<thead>
<tr>
<th>Division</th>
<th>Years</th>
<th>Mean</th>
<th>Std.Dev.</th>
<th>CV (%)</th>
<th>% Years below mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lodwar</td>
<td>(1969-2009)</td>
<td>184</td>
<td>103</td>
<td>56</td>
<td>63</td>
</tr>
<tr>
<td>Lokitaung</td>
<td>(1969-2000)</td>
<td>269</td>
<td>140</td>
<td>52</td>
<td>50</td>
</tr>
<tr>
<td>Kapedo</td>
<td>(1969-2000)</td>
<td>432</td>
<td>178</td>
<td>41</td>
<td>45</td>
</tr>
</tbody>
</table>

CV >33 % Exhibits non-equilibrium system (Ellis 1995). Source: Own compilation

Figure 4: Turkana District Long term mean annual rainfall (mm) for 1969-2000 years. Source: Own compilation

Figure 5: The Turkana District annual rainfall deviation based on 1969-2000 mean (285 mm). With reference to Kenya Meteorological department definitions of a normal and severe drought, the normal drought (-25% line) and severe drought (-50%) are shown. Source: Own compilation
Figure 6: Scatter diagram of mean annual rainfall for Turkana district over 1969-2000 period. Source: Own compilation

### 3.3.2 Seasonal rainfall analysis

Overall, the correlation between the mean seasonal rainfalls among the divisions was all significant which indicates that the divisions are influenced by the same rainfall patterns.

Table 2: Correlation between the mean seasonal rainfalls among the divisions

<table>
<thead>
<tr>
<th>Division</th>
<th>Lokitaung</th>
<th>Kapedo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lodwar</td>
<td>$R^2=0.476^{**}$, $p=.002$</td>
<td>$R^2=0.632^{**}$, $p&lt;0.001$</td>
</tr>
<tr>
<td>Kapedo</td>
<td>$R^2=0.510^{**}$, $p=.001$</td>
<td></td>
</tr>
</tbody>
</table>

**Correlation significant at 0.01 level (1-tailed). Source: Own compilation

Linear regression analysis of the mean annual rainfall for all the divisions showed insignificant changes.

The rainfall season in Turkana is bimodal with long rains season (*Akiporo*) running from March-July and short rains season (*Akicheres*) in October-December (see Table 3). *Akiporo* constituted a majority of the annual rainfall realized in all the divisions for the years 1969-2000. *Akicheres* was characterised by high variability in all the divisions. The variability exceeds 100%, this is depicts high unpredictability. The seasonal rainfall variability is high in the central part of the district as compared to the north and southern regions. The change in rainfall is negative across the divisions except for the *Akiporo* rainfall in Kapedo which returned an increase of 0.12 mm during the 1969-2000 period. However there were statistically insignificant changes in both *Akiporo* and *Akicheres* rainfall for the years analysed. The distribution of rainfall across the season is not evenly spread in the central and northern parts except for south which has a ‘mound shaped’ distribution (Fig 6,7 & 8 ). The month of April was the peak rainfall time for all the divisions/regions.
Table 3: Variability, quantity and changes in seasonal rainfall across Turkana district.

<table>
<thead>
<tr>
<th>Division</th>
<th>season*</th>
<th>Number of years analyzed</th>
<th>mean seasonal rainfall (mm)</th>
<th>Change in Rainfall (mm/year)</th>
<th>P-value</th>
<th>Mean annual rainfall (mm)</th>
<th>% of mean annual Rainfall</th>
<th>CV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lodwar (Central)</td>
<td>Akiporo</td>
<td>41 (1969-2009)</td>
<td>109.7</td>
<td>-0.21</td>
<td>0.253</td>
<td>184</td>
<td>59.6</td>
<td>0.64</td>
</tr>
<tr>
<td></td>
<td>Akicheres</td>
<td></td>
<td>43.9</td>
<td>-0.04</td>
<td>0.817</td>
<td></td>
<td></td>
<td>23.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.52</td>
</tr>
<tr>
<td>Lokitaung (North)</td>
<td>Akiporo</td>
<td>31 (1969-2000)</td>
<td>174.1</td>
<td>-0.15</td>
<td>0.418</td>
<td>269</td>
<td>64.7</td>
<td>0.61</td>
</tr>
<tr>
<td></td>
<td>Akicheres</td>
<td></td>
<td>52.7</td>
<td>-0.01</td>
<td>0.972</td>
<td></td>
<td></td>
<td>1.02</td>
</tr>
<tr>
<td>Kapedo (south)</td>
<td>Akiporo</td>
<td>31 (1969-2000)</td>
<td>259.1</td>
<td>0.12</td>
<td>0.509</td>
<td>432</td>
<td>60</td>
<td>0.47</td>
</tr>
<tr>
<td></td>
<td>Akicheres</td>
<td></td>
<td>74.6</td>
<td>-0.09</td>
<td>0.631</td>
<td></td>
<td></td>
<td>1.05</td>
</tr>
</tbody>
</table>

*Rainfall season is bimodal. “Akiporo” is the long rains season consisting of March, April, May, June and July. “Akicheres” is the short rains season consisting of October, November and December. Source: Own compilation


Figure 6 a & b. Lodwar- rainy season rainfall distribution and deviation from the 1969-2000 mean. With drought (-25%) and severe drought (-50%) Source: Own compilation
Lokitaung seasonal rainfall

![Lokitaung rainfall graph]

Figure 7 a & b: Lokitaung- rainy season rainfall distribution and deviation from the 1969-2000 mean. With drought (-25%) and severe drought (-50%). Source: Own compilation

Kapedo seasonal rainfall

![Kapedo rainfall graph]

Figure 8 a & b. Kapedo- rainy season rainfall distribution and deviation from the 1969-2000 mean. With drought (>25%) and severe drought (>50%). Source: Own compilation
3.3.3 Mean Daily Temperatures (˚C) at Lodwar (1981-2009)

The daily mean temperature trend for Lodwar exhibits unpredictable fluctuation between the years (Fig.9). In 1980’s the temperature range was 29.2˚C- 29.9˚C with 0.7˚ difference, in the 1990’s the range exhibited an increase of 0.3˚ for both the lowest and the highest (29.5˚C-30.2˚C), although the intra-range difference was still 0.7˚ as it was in the 1980’s. The 2000’s temperatures returned the lowest and the highest in the whole period (1981-2009). They ranged from 28.4˚C-30.5˚C with a difference of 2.1˚. A third of the years in the 1980’s recorded temperatures above the long term mean while both in the 1990’s and 2000’s, 70% of the period recorded high temperatures above the long term mean. This shows high variability in temperatures in the area and also depicts a general trend of increased occurrence of high temperatures as from 2000.

![Trends of Lodwar mean daily temperature](image)

Figure 9: Mean Daily Temperatures (˚C) at Lodwar (1981-2009)  Source: Own compilation

3.3.4 Temporal NDVI-Rainfall relationships

Intra-annual CV of NDVI was 48% with mean monthly NDVI ranging from 0.40 in March and 0.53 in May (Fig 10 a). Seasonal analysis of NDVI and seasonal rainfall for the period 1996-2001 showed significant correlation (R=.365, p=.040). During the same period the mean annual NDVI was 0.47 and the inter-annual CV was 45%. There was no significant correlation between annual NDVI and rainfall. Though in figure(10.b) in years of low rainfall the NDVI responds correspondingly and resonates in the same way in the years of enhanced rainfall.

![Temporal NDVI-Rainfall relationships](image)
Adaptation to climate variability among the dryland population in Kenya: A case study of the Turkana pastoralists (2010)

Figure 10 a & b: Mean monthly and annual Rainfall and NDVI-Turkana district. Source: Own compilation

3.4 Rainfall Variability and Livestock Population dynamics:

3.4.1 Relationship between Livestock population (TLU) and rainfall variability

The Livestock population fluctuated over the years and could be related to climatic conditions variability. There is a steady increase in Livestock population from 1998 to 1999 and this can be associated with high rainfall experienced due to El-nino in the district in 1997-1998. This is followed by a decline in 2000 and recovery was not realized until 2004 (Fig 11 & 12). 1999-2001 periods were dry. The mean Livestock population for the district during the period 1997-2004 was 603813 TLU's.

Figure 11: Livestock population (TLU) Trends in Turkana district (1997-2004). Source: Compiled from Ministry of Livestock-Turkana data
The general household livestock holding from 1979 to 2004 shows a declining trend for all the livestock species except for small stock (goats and sheep) who exhibit a “saw toothed” growth (Fig 13 a-e) The pastoralists’ population has been estimated to be 70% of the total district’s population during the period (GOK,2002). Small stocks formed the majority livestock in the herd during the period under review, with an average of more than 8 per household. Small stocks are mainly used as currency for exchange and trade. They breed fast and thus can recover easily from a severe drought. Cattle experienced a sharp drop between 1984 and 1989; this could be attributed to drought and intensified livestock raiding during that period. During this period a whole division of Lomelo (Kapedo) was deserted due to persistent raiding from the Pokot pastoralists (Ebei and Ekitela, 2005). Lomelo is a dry season grazing area and its access has been limited by insecurity posed by livestock raiding. Pertaining to camels, there is a gentle decline from 1984 to 1999 and a slight increase in 2004. Donkeys’ numbers have declined sharply since 1979. Donkeys among the Turkana pastoralists are not herded with other livestock, they are left to roam the rangeland without much labour. The donkeys are being targeted by livestock raiders today than before (field interviews).
Figure 13 a-e: Trends of households’ livestock holding during 1979-2004 period. Source: Own compilation

3.4.2 Relationship between mean annual rainfall (lagged), TLU and NDVI
From Table 4; there is indication of positive relationship between amount of rainfall received in the previous season and the amount of plant biomass available in the following year. The 74% variation in vegetation density is explained by rainfall variability (Table 4). 83% of the variation in livestock population is explained by variation in rainfall amount received the previous year. There is also a correlation between the livestock numbers and the amount of plant biomass available, although this relationship is not very strong; other factors besides forage availability come into play to explain the livestock population trends. There is no significant relationship between specific livestock species and rainfall amount received in the previous year except for goats. Goats’ population appeared more sensitive to rainfall variability than other livestock species (Table 5).

Table 4: Coefficient of determination ($R^2$) for relationships between mean annual rainfall (lagged), TLU and annual NDVI.

<table>
<thead>
<tr>
<th></th>
<th>$TLU$</th>
<th>$NDVI$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rainfall $(t - 1)$</td>
<td>0.829</td>
<td>0.741</td>
</tr>
<tr>
<td>$TLU$</td>
<td>0.582</td>
<td></td>
</tr>
</tbody>
</table>

Table 5: Coefficients of determination ($R^2$) for relationships between different Livestock species population (TLU) and annual rainfall $(t-1)$:

<table>
<thead>
<tr>
<th>Livestock population</th>
<th>$R^2$</th>
<th>$P-value$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle (TLU)</td>
<td>0.677</td>
<td>0.087</td>
</tr>
<tr>
<td>Goats (TLU)</td>
<td>0.855</td>
<td>0.025*</td>
</tr>
<tr>
<td>Sheep (TLU)</td>
<td>0.650</td>
<td>0.099</td>
</tr>
<tr>
<td>Camel (TLU)</td>
<td>0.097</td>
<td>0.61</td>
</tr>
<tr>
<td>Donkeys (TLU)</td>
<td>0.741</td>
<td>0.061</td>
</tr>
</tbody>
</table>

*- significant at 0.05 level  
Source: Own compilation
3.4.3 Rainfall Variability and Livestock Production Indicators:
There are no significant correlations between death rate of all livestock species and delayed rainfall. Delayed rainfall influences significantly the birth rate of cattle and sheep but shows no relation with the birth rate for goats and camels (Table 6). It is only goats’ offtake that is linearly and significantly related to rainfall variation. Camels’ production indicators show no significant relation with rainfall variation. Varied against the mean annual rainfall of the current year, it is only goats’ offtake that shows significant relation (p, 0.032) < 0.05

Table 6: Coefficients of determination (R²) for the relationship between Livestock production indicators(%) and mean annual rainfall.

<table>
<thead>
<tr>
<th>Production indicator (%)</th>
<th>R²</th>
<th>P – value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death rate:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cattle</td>
<td>0.074</td>
<td>NS</td>
</tr>
<tr>
<td>Goats</td>
<td>0.004</td>
<td>NS</td>
</tr>
<tr>
<td>Sheep</td>
<td>0.001</td>
<td>NS</td>
</tr>
<tr>
<td>Camels</td>
<td>0.000</td>
<td>NS</td>
</tr>
<tr>
<td>Birth rate:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cattle</td>
<td>0.611</td>
<td>0.038*</td>
</tr>
<tr>
<td>Goats</td>
<td>0.084</td>
<td>NS</td>
</tr>
<tr>
<td>Sheep</td>
<td>0.782</td>
<td>0.008*</td>
</tr>
<tr>
<td>Camels</td>
<td>0.148</td>
<td>NS</td>
</tr>
<tr>
<td>Offtake:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cattle</td>
<td>0.276</td>
<td>NS</td>
</tr>
<tr>
<td>Goats</td>
<td>0.627</td>
<td>0.034*</td>
</tr>
<tr>
<td>Sheep</td>
<td>0.336</td>
<td>NS</td>
</tr>
<tr>
<td>Camels</td>
<td>0.035</td>
<td>NS</td>
</tr>
</tbody>
</table>

NS-Not significant    * significant at 0.05 confidence level.  Source: Own compilation

3.4.4 Livestock production indicators and their correlation with Livestock species population (TLU):
The results show that cattle population has a significantly strong linear correlation with goats’ population (Table 7a). The cattle birth rates have strong positive linear correlation with both the cattle and goats’ populations but a significantly negative linear correlation with its offtake rate (cattle). Death rates for all the species have no significant correlation with their populations and other production indicators. The sheep’s birth rate depicts a significantly positive linear correlation with the goats and cattle’s populations (Table 7c). Camel population and production indicators show no significant correlation with all the species populations and production indicators (Table 7d).
Table 7: Correlation coefficients (R) of the influence of Livestock production indicators on the Livestock species population (TLU):

(a) Cattle production indicators correlations matrix:

<table>
<thead>
<tr>
<th></th>
<th>Cattle(TLU)</th>
<th>Goat(TLU)</th>
<th>Sheep(TLU)</th>
<th>Camel(TLU)</th>
<th>Death rate</th>
<th>Birth rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goat(TLU)</td>
<td>1.000**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sheep(TLU)</td>
<td>0.729</td>
<td>0.724</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Camel(TLU)</td>
<td>0.623</td>
<td>0.815</td>
<td>0.615</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Death rate</td>
<td>−0.634</td>
<td>0.246</td>
<td>0.975</td>
<td>0.020</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Birth rate</td>
<td>0.963**</td>
<td>0.964**</td>
<td>0.715</td>
<td>0.479</td>
<td>0.169</td>
<td></td>
</tr>
<tr>
<td>Offtake rate</td>
<td>−0.868</td>
<td>−0.870</td>
<td>−0.603</td>
<td>−0.420</td>
<td>0.235</td>
<td>−0.806</td>
</tr>
</tbody>
</table>

(b) Goats production indicators correlations matrix:

<table>
<thead>
<tr>
<th></th>
<th>Goat(TLU)</th>
<th>Cattle(TLU)</th>
<th>Sheep(TLU)</th>
<th>Camels(TLU)</th>
<th>Death rate</th>
<th>Birth rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goat(TLU)</td>
<td></td>
<td>1.000**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cattle(TLU)</td>
<td>0.724</td>
<td>0.815</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sheep(TLU)</td>
<td>0.615</td>
<td>0.623</td>
<td>0.815</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Camels(TLU)</td>
<td>0.724</td>
<td>0.975</td>
<td>0.479</td>
<td>0.169</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Death rate</td>
<td>0.724</td>
<td>−0.768</td>
<td>−0.460</td>
<td>−0.351</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Birth rate</td>
<td>0.628</td>
<td>0.621</td>
<td>−0.044</td>
<td>−0.158</td>
<td>−0.474</td>
<td></td>
</tr>
<tr>
<td>Offtake rate</td>
<td>0.574</td>
<td>0.568</td>
<td>0.344</td>
<td>−0.163</td>
<td>−0.302</td>
<td>0.654</td>
</tr>
</tbody>
</table>

(c) Sheep production indicators correlation matrix:

<table>
<thead>
<tr>
<th></th>
<th>Sheep(TLU)</th>
<th>Cattle(TLU)</th>
<th>Goat(TLU)</th>
<th>Camels(TLU)</th>
<th>Death rate</th>
<th>Birth rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sheep(TLU)</td>
<td></td>
<td>0.729</td>
<td>1.000**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cattle(TLU)</td>
<td>0.724</td>
<td>1.000**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Goat(TLU)</td>
<td>0.815</td>
<td>0.623</td>
<td>0.615</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Camels(TLU)</td>
<td>0.815</td>
<td>0.623</td>
<td>0.615</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Death rate</td>
<td>−0.370</td>
<td>−0.714</td>
<td>−0.717</td>
<td>−0.724</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Birth rate</td>
<td>0.861</td>
<td>0.927*</td>
<td>0.927*</td>
<td>0.572</td>
<td>0.359</td>
<td></td>
</tr>
<tr>
<td>Offtake rate</td>
<td>0.531</td>
<td>−0.626</td>
<td>−0.626</td>
<td>−0.413</td>
<td>−0.062</td>
<td>−0.595</td>
</tr>
</tbody>
</table>
(d) Camel production indicators correlation matrix.

<table>
<thead>
<tr>
<th></th>
<th>Camel(TLU)</th>
<th>Cattle(TLU)</th>
<th>Goat(TLU)</th>
<th>Sheep(TLU)</th>
<th>Death rate</th>
<th>Birth rate</th>
<th>Offtake rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camel(TLU)</td>
<td>0.623</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cattle(TLU)</td>
<td></td>
<td>0.615</td>
<td></td>
<td>1.000**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Goat(TLU)</td>
<td>0.615</td>
<td>0.815</td>
<td></td>
<td>0.729</td>
<td>0.724</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sheep(TLU)</td>
<td>0.815</td>
<td>0.729</td>
<td>0.724</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Death rate</td>
<td>-0.535</td>
<td>-0.482</td>
<td>-0.479</td>
<td>-0.160</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Birth rate</td>
<td>0.155</td>
<td>0.804</td>
<td>0.807</td>
<td>0.317</td>
<td>0.057</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Offtake rate</td>
<td>-0.576</td>
<td>-0.618</td>
<td>-0.165</td>
<td>-0.723</td>
<td>0.116</td>
<td>-0.425</td>
<td></td>
</tr>
</tbody>
</table>

** Significant at 0.01 level  
* Significant at 0.05 level.  
Source: Own compilation

3.5 Rainfall variability and pastoralists welfare indicators.

3.5.1 The influence of mean annual rainfall to pastoralists’ purchasing power

The pastoralists’ purchasing power which is expressed as a percentage of the Cereal to meat ratio follows an inverse pattern to the mean annual rainfall (Fig 14). During the periods of low rainfall (2004-2005), the cereal-meat ratio shot up to 160% but as the rains improved in 2006 the ratio lowered in 2007 and another rise was realised during the dry periods of 2008-2009. The amount of rainfall received in the previous season has a direct influence on the pastoralists’ purchasing power in the following year. Comparatively it was only in 2007 during the six year period (2004-2009) that the cereal price fell below the price of meat. Higher ratio means a lower purchasing power for the pastoralists as it follows that they have to sell more livestock to meet their household food needs.

![Figure 14: Relationship between mean annual rainfall and Pastoralists purchasing power for 2004-2009 period. Source: Own compilation](image-url)
3.5.2 The relationship between Mean annual rainfall and milk consumption at the household level

The household milk consumption trend shows that there is decline in the amount of milk available for household consumption (Fig 15). The amounts have been linearly declining since 2004, except for the year 2007 which showed an exception. The mean annual rainfall for the previous season has an influence on the amount of milk available to the household the immediate following season. The livestock birth rates are expected to be high during a good rainy season. There could be other factors determining the amount of milk consumed by the household. Declining milk available for household consumption means pastoralists have to rely on non-livestock products for their household nutritional needs.

Figure 15: Relationship between mean annual rainfall and household milk consumption for 2004-2009 period. Source: Own compilation

3.5.3 Relationship between mean annual rainfall and household coping strategies

Coping strategy index (CSI) is a measure of the behaviour i.e. the things that people do when they do not have access to enough food. It measures the frequency and the severity of the strategies. It indicates the household’s food security status.

The household drought coping strategies show an inverse relation with annual mean rainfall (Fig 16). In years of drought the household increase the number of coping strategies. 2005 was the driest year in the six years period examined here (2004-2009) and the household coping strategies got a leap from 2 to 3. This seems to stabilize at 2 in the subsequent years despite the fluctuation in rainfall amounts. The stability can be associated with limited opportunities available to household to cope with frequent and long droughts.
3.6 Chapter Summary

There was high inter-annual variation in rainfall with coefficient of variation ranging from 41-56% across the district during the 1969-2000 period. However no statistically significant changes in annual rainfall for the same period were realized. There was positively significant correlation of the seasonal rainfall across all the divisions/regions indicating that regions might be experiencing the same rainfall patterns. The rainfall season is bimodal with the long rains (Akiporo) coming in March-July and short rains (Akicheres) in October-December. No significant changes in both Akiporo and Akicheres were realized during the years analyzed. Akiporo constituted a majority of the annual rainfall. There was high variation within the seasonal rainfall with Akicheres rainfall variation being above 100% depicting high unreliability and unpredictability. Though there was positive correlation between the seasonal rainfalls in the three regions studied, its distribution within the season varied with the region. The northern and central parts of the district experienced uneven distribution while the southern part had a "mound shaped" distribution.

The occurrence of drought varied between the regions. The central region had more severe drought years (10) than other two regions(4). It is only in 2000 that severe drought was common to all the divisions. The central region also had more multi-year droughts as compared to the rest of the district.

The assessment of mean daily temperature at Lodwar (central) for the period 1981-2009 showed that there was high variation in daily temperatures. The 2000's temperatures returned the lowest and the highest in the whole period analyzed.

Analysis of temporal NDVI and rainfall relationships indicated that annual and monthly NDVI were highly variable (CV 45-48%). Monthly NDVI and rainfall had significant correlation during the 1996-2000 period.

Total livestock population (TLU) and household livestock holding showed declining trends, except for small stock (goats and sheep) who exhibited a "saw toothed" growth. Small stocks formed majority of the herd with an average of 8 per household for the period between 1979-2004. Correlation of lagged rainfall, livestock population and NDVI indicate positive relations but there was weak relationship between livestock population and NDVI, thus the possibility
of other factors to explain the livestock population trends. Goats’ population was the only livestock that appeared more sensitive to rainfall variability.

With regard to livestock performance indicators, cattle birth rate, sheep birth rate and goat’s offtake are linearly and significantly related to rainfall variation. Cross correlation of livestock production indicators and livestock species populations (TLU) reveal that cattle population has strong positive linear correlation with goats’ population. The cattle birth rates have strong positive linear correlation with both cattle and goats’ population but a significantly negative correlation with cattle offtake. Sheep’s birth rate depicts a significantly positive linear correlation with the goats and cattle populations.

Pastoralists’ welfare measured through their purchasing power, amount of milk available for consumption and coping strategies index indicate a decline in the general pastoralists welfare during the 2004-2009 period. Pastoralists’ purchasing power which is expressed as the percentage of the cereal to meat price ratio has an inverse relationship with rainfall. During the 2004-2009 period, it is only in 2007 that the cereal price fell below the price of meat. Higher cereal and meat price ratio means a low pastoralists’ purchasing power. The household milk consumption trends show that there is a decline in the amount of milk available for household consumption, although no clear trend to link it to mean annual rainfall. Relating household coping strategies and rainfall showed that there is an inverse relationship between coping strategies index and rainfall. In years of severe drought the households engage in more coping strategies to remain viable as economic units.
CHAPTER 4:
CLIMATE VARIABILITY AND CONFLICT IN TURKANA

4.0 Introduction
The pastoralist conflict in the form of livestock raiding is not a new phenomenon but a feature of the pastoral societies of the Horn of Africa (Mkutu, 2007). This form of pastoral conflict has in the recent past received attention from many fronts, but most of the studies have largely been qualitative in nature and lack the empirical support (Eriksen and Lind 2009; Lind, 2003; Markasis, 2004; Mkutu, 2007). This has been so, due to lack of data on this form of conflict but Meier et al. (2007), Adano and Witsenburg (2009) are the recent exceptions that have tried to discern empirically the correlation between environmental variability and recalcitrant pastoral conflict in the Horn of Africa. Meier et al. (2007) used the data from the Inter-governmental Authority on Development (IGAD), Conflict Early Warning and Response Network (CEWARN) in the Karamoja cluster. Adano and Witsenburg (2009) compiled archival data from Marsabit (Kenya) using police and district security meetings records as from 1960.

Local level of conflicts on natural resources of which livestock raiding is one specific form are endemic in Africa’s pastoral and agropastoral systems (Hendrickson et al., 1996). The Karamoja cluster has suffered constant conflict among the pastoral groups inhabiting the region. Although livelihood vulnerability of these groups has not been associated with any singular phenomenon, the pastoralists themselves place emphasis on the role of armed conflict in the loss of livelihood and in extension improvement (Lind 2006). According to Lind (2003), the conflict in Turkana is low intensity, characterised by localised competitions, violent livestock raids, banditry and seemingly random violence. Owing to the pastoral groups inhabiting mercurial ecological systems, their influence on the pastoral interactions cannot be ignored (Meier et al., 2007).

Environmental variability results in high degree of political competition, ameliorated by periods of competitors relating to each other (Lind, 2003). Whether the occurrence and severity of such conflict can be associated with climate variability experienced in the region is the query that requires an empirical evidence. This study draws data from Turkana district to explain this.

4.1 Conflict and Livelihoods Approach
The pastoral conflicts have been associated with scarcity of resources (Meier et al., 2007; Swift, 1996; Oba, 1992; McCabe, 1990). However this seems to be insufficient to explain the intricacies that are ingrained in the pastoral conflict. The pastoral conflict is driven by myriad of factors and the resource scarcity is not the only one or even the most important (Meier et al., 2007). According to (Lind, 2003) the resource scarcity approach misleads by de-emphasizing the socio-economic and the political dimensions of the use and control of resources. The insecurity existing between the Turkana and the neighbouring communities is more on raiding of livestock than a conflict over resource use, according to Pike (2004) raids in the southern part of Turkana have taken a commercial dimension as the livestock acquired from a raid are transported to different markets for immediate slaughter. The involvement of networks outside the pastoral sector in livestock raids has driven the conflict to unprecedented levels. Contrasting with the former notions of balance and reciprocity, the frequency and intensity of raids in Turkana has increased. This has been associated with
increased incentive provided by commercialization of livestock raiding linked to external markets and proliferation of small arms (Hendrickson et al., 1996; Mkutu, 2007).

The conflict among the pastoral groups can thus be understood by recognising various factors coming into play at different angle and levels. According to Lind (2003), Livelihoods approach that accounts for adaptation offers an opportunity to understanding resource conflicts and is an alternative to the resource scarcity perspective to explain the origins and nature of conflict and cooperation between the pastoral groups. Pastoral groups sometimes pit against each other for different reasons and feuds are not uncommon both within and across pastoral lines (USAID, 2002). Scoones, (1988) observes that the vulnerability of the pastoral groups can be assessed through a range of socio-economic trends, politics and climate conditions. Conflict and Environmental variability either diminish or enhance the assets of the pastoralists and in extension their ability to adapt to the same phenomena.

Social relations and political forces shape different vulnerabilities, enlarging options to adapt for some while potentially limiting options for others (Lind, 2003). Livelihood strategy is useful in conflict settings where chronic factors of increasing insecurity, loss of economic base and escalation of violence play a key role in shaping people’s livelihood strategies (Nige, 2009).

In situations of protracted conflict like the livestock raiding in Turkana, people adopt mixed strategies that balance immediate needs and long term survival. Conflict not only affects the physical and material factors but also undermine the basic bond that enables social relations and networks to function. The implication of diminished social relations or networks on livelihood systems can be ruinous, given the role played by social institutions in regulating access to assets. Thus it is vital to account how the resources that underlie adaptation are continuously or increasingly being changed in response to climate variability, political and socio-economic forces.

4.2 Data

Conflict data

Data used in this study was retrieved from reports prepared by Riam Riam which is a forum for peace and conflict issues in Turkana district. It is an umbrella organisation which coordinates all peace building activities in the district. It collaborates with governments and other civil society organisations in the Karamoja cluster.

The Karamoja cluster comprises ethnic groups who occupy South-western Ethiopia, North-western Kenya, North-eastern Uganda and South-eastern Sudan. These groups share a common culture and language but they are in constant conflict under complex socio-economic and political circumstances.

Volunteer field monitors working for Riam Riam file weekly and monthly reports on situation and incidences of conflict. The monitors are stationed at the conflict prone corridors namely; Turkana–Pokot, Turkana–Nyangatom, Turkana–Dassenach, Turkana–Karamoja, Jie and Dodoth and Turkana–Toposa. The situation reports cover peace initiatives (Alliances, community and leaders meetings) and provocative actions (migrations, pre-raid blessing and traditional forecasting). The incidents reports comprise; occurrence of raids, human deaths, livestock losses and number of livestock recovered.
The data is aggregated at the corridor level as follows; Turkana-Pokot-Samburu (TUPO); Turkana-Uganda groups (TUUG); Turkana and Ethiopia groups (TUET) and Turkana and Sudan groups (TUSU). The data covered six years 2004-2009 and is grouped as follows; Peace indicators include alliances that communities form to mitigate against conflict and the initiatives they carry out to negotiate peace, we retrieved community meetings from Riam Riam reports as one of such initiatives.

Table 8: Summary of peace indicators (quantity) over six years (2004-2009)

<table>
<thead>
<tr>
<th>Corridor</th>
<th>Meetings Sum</th>
<th>Meetings Mean</th>
<th>Meetings Stdev</th>
<th>Alliances Sum</th>
<th>Alliances Mean</th>
<th>Alliances Stdev</th>
</tr>
</thead>
<tbody>
<tr>
<td>TUUG</td>
<td>21</td>
<td>3</td>
<td>2.8</td>
<td>7</td>
<td>1</td>
<td>1.2</td>
</tr>
<tr>
<td>TUSU</td>
<td>11</td>
<td>3.7</td>
<td>3.9</td>
<td>2</td>
<td>0.7</td>
<td>0.8</td>
</tr>
<tr>
<td>TUPO</td>
<td>94</td>
<td>14.5</td>
<td>8.9</td>
<td>18</td>
<td>2.8</td>
<td>1.8</td>
</tr>
<tr>
<td>TUET</td>
<td>19</td>
<td>2.4</td>
<td>1.8</td>
<td>9</td>
<td>1.1</td>
<td>1.3</td>
</tr>
<tr>
<td>OVERALL</td>
<td>145</td>
<td>4.5</td>
<td>6.1</td>
<td>36</td>
<td>1.1</td>
<td>1.4</td>
</tr>
</tbody>
</table>

Source: Own compilation from Riam Riam reports.

In the situation reports the Riam Riam monitors also give weekly reports on any suspicious behaviour that could trigger conflict. Such actions would include migration by only male members, raid blessing ceremonies and signs of planned revenge. Under conflict, we summarize these into two indicators provocative behaviour and recoveries of lost livestock. Recovery efforts can be forceful if carried by opposing group or even government.

Table 9: Summary of conflict indicators (quantity) over six years (2004-2009)

<table>
<thead>
<tr>
<th>Corridor</th>
<th>Provocations Sum</th>
<th>Provocations Mean</th>
<th>Provocations Stdev</th>
<th>Recoveries Sum</th>
<th>Recoveries Mean</th>
<th>Recoveries Stdev</th>
</tr>
</thead>
<tbody>
<tr>
<td>TUUG</td>
<td>36</td>
<td>5.1</td>
<td>5.4</td>
<td>641</td>
<td>91.6</td>
<td>187.8</td>
</tr>
<tr>
<td>TUSU</td>
<td>11</td>
<td>3.7</td>
<td>3.8</td>
<td>113</td>
<td>37.7</td>
<td>37.1</td>
</tr>
<tr>
<td>TUPO</td>
<td>174</td>
<td>26.8</td>
<td>12.4</td>
<td>4844</td>
<td>745.2</td>
<td>568.9</td>
</tr>
<tr>
<td>TUET</td>
<td>23</td>
<td>2.9</td>
<td>2.6</td>
<td>533</td>
<td>66.6</td>
<td>101.9</td>
</tr>
<tr>
<td>OVERALL</td>
<td>244</td>
<td>7.6</td>
<td>9.6</td>
<td>6131</td>
<td>191.6</td>
<td>390.3</td>
</tr>
</tbody>
</table>

Source: Own compilation from Riam Riam reports

The raids usually can be fatal and can be associated with certain outcomes. These are featured in this model as incidences of raids, human deaths and injuries and livestock loss. Human deaths and injuries are aggregated into one variable.
Table 10: Summary of conflict outcomes (quantity) over six years (2004-2009)

<table>
<thead>
<tr>
<th>Corridor</th>
<th>Raids</th>
<th>Livestock losses</th>
<th>Human deaths and injuries</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sum</td>
<td>Mean</td>
<td>Std.</td>
</tr>
<tr>
<td>TUUG</td>
<td>60</td>
<td>8.6</td>
<td>11.1</td>
</tr>
<tr>
<td>TUSU</td>
<td>41</td>
<td>13.7</td>
<td>14.7</td>
</tr>
<tr>
<td>TUPO</td>
<td>197</td>
<td>30.3</td>
<td>19.5</td>
</tr>
<tr>
<td>TUET</td>
<td>36</td>
<td>4.5</td>
<td>3.3</td>
</tr>
<tr>
<td>OVERALL</td>
<td>334</td>
<td>10.4</td>
<td>13.8</td>
</tr>
</tbody>
</table>

Source: Own compilation from Riam Riam reports

Environmental data

The environmental data comprises rainfall, vegetation (NDVI) and Forage. The monthly rainfall figures for the divisions situated in each corridor were aggregated to define the corridor rainfall. Rainfall influences vegetation and forage availability although soil fertility, land use and plant species determine the extent to which this happens. The NDVI for every dekad (10 days) is aggregated to a monthly and then yearly total.

Empirical formulas from literature were used to derive Net primary production (Forage) from NDVI. NPP estimation is based on “Production efficiency concept” first introduced by Monteith, (1972). He observed that plant production is correlated with the amount of photosynthetically active Radiation (PAR) absorbed or intercepted by green foliage (APAR).

\[
\text{NPP} = \varepsilon \int f\text{APAR} \times \text{PAR} \, dt \quad \text{(Amdihun et al., 2008)}
\]

Where:

\[
\text{APAR} = \text{Absorbed Photosynthetic Active Radiation}
\]

\[
\text{PAR} = \text{Incoming photosynthetic active radiation} (\text{mj} \text{ m}^{-2})
\]

\[
f\text{APAR} = \text{Fraction of APAR absorbed by canopy}
\]

\[
\varepsilon = \text{conversion efficiency of APAR into organic dry matter} \quad (g \text{ mj}^{-1})
\]

Ruimy et al.,(1994), Prince and Goward(1995) indicated that \( f\text{PAR} \) is linearly related to NDVI, and defined the relationship of \( f\text{PAR} \) and NDVI as;

\[
f\text{PAR} = a + b \times NDVI, \text{ where } a \text{ and } b \text{ are constants.}
\]

\[
f\text{APAR} = -0.025 + 1.25 \times NDVI.
\]

\( NDVI \) has limits -1 and +1, higher NDVI indicates the denser the vegetation.

The conversion efficiency \( \varepsilon \) is used as a constant over all biomes and equals \( 1.5 \text{ g mj}^{-1} \) (Ruimy et al.,1994).
The Annual NPP value is determined based on the yearly NDVI as:

\[ NPP = \sum_{i=1}^{12} [1.5(-0.025 + 1.25 \times NDVI) \times (NDVI \times 0.087)/0.798] \] (Amduhin et al., 2008).

Classifications of vegetation in different types that have similar yield values are based on work by Ruimy et al., (1994). And the values used here are those used by Amduhin et al., (2008) in their study in Awash region in Ethiopia which has similar vegetation type with Turkana.

Table 11: Summary of Environmental indicators for six years (2004-2009)

<table>
<thead>
<tr>
<th>Corridor</th>
<th>Rainfall (mm)</th>
<th>Vegetation (Ndvi)</th>
<th>Forage (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>sum</td>
<td>mean</td>
<td>std.dev</td>
</tr>
<tr>
<td>TUUG</td>
<td>2105</td>
<td>300.7</td>
<td>92.4</td>
</tr>
<tr>
<td>TUSU</td>
<td>1310</td>
<td>436.7</td>
<td>432.2</td>
</tr>
<tr>
<td>TUPO</td>
<td>3611</td>
<td>555.5</td>
<td>96.3</td>
</tr>
<tr>
<td>TUET</td>
<td>2386</td>
<td>298.3</td>
<td>119.4</td>
</tr>
<tr>
<td>OVERALL</td>
<td>9412</td>
<td>294.1</td>
<td>94.6</td>
</tr>
</tbody>
</table>

Source: Own compilation from Riam Riam reports

**BOX 1: Conflict terminologies definitions:**

- **Livestock raids**- violence associated with livestock rustling by rival pastoral groups or herdsmen. Involves group invasion or forceful attack on another pastoralist group with main objective of stealing livestock.

- **Livestock losses**- The number of livestock that one group losses from a raid either to the aggressors or death through violent attack.

- **Human deaths and injuries**- The number of people who are killed or injured as a result of an invasion by an opposing group.

- **Provocative behaviour**- Actions that cause tension and insecurity and usually trigger confrontations. Traditional forecasting, movement of male groups usually indicate an anticipated raid.

- **Alliances**- Inter-ethnic alliances formed by the pastoralists for the purpose of sharing grazing resources or defence against attacks from other groups.

- **Meetings**- Local community peace meetings where peace and the sharing of grazing resources are discussed.

**4.3 Methodology**

Multiple regression models (sum of squares) were employed to understand the temporal relations between peace initiatives, conflict indicators and environmental variables and the outcomes of conflict in Turkana district as provided for in the Riam Riam reports. The model had 10 variables in total; 7 independent variables \(X1 – X7\), 4 (peace and conflict indicators)
and 3 environmental factors; 3 dependent variables $Y_1 - Y_3$ — outcomes (human deaths and injuries, livestock losses and raids).

Peace and conflict indicators from Riam Riam reports;

$X_1$ - Alliances, $X_2$ - Meetings, $X_3$ - Provocations, $X_4$ - Recoveries

Environmental factors calculated from FEWSNET data;

$X_5$ - Rainfall, $X_6$ - Vegetation, $X_7$ - Forage

Conflict outcomes from Riam Riam reports;

$Y_1$ - Human deaths and injuries, $Y_2$ - Livestock losses, $Y_3$ - Raids

32 cases were included in the analysis. For each corridor (TUET, TUSU, TUPO and TUUG), data for the six years was included. The assumption of linearity and each independent variable having additive effect was considered. The peace and conflict indicators were entered first and then the environmental variables to check for the extra percentage of variance that is accounted for by the environmental variables in the conflict outcomes. The $R^2$ change ranged from 1.7-6.9%. The model was checked for the regression assumptions of non-zero variance and multicollinearity. No perfect correlation existed among the variables in the model. Durbin-Watson test was used to find any autocorrelation among the predictors but none was in the range of rejecting the hypothesis, thus the independence of the predictors was assured. Homoscedasticity assumption was also assumed to have been met as the residual plots of independent and outcomes in each analysis did not show unequal variance. The models with environmental variables as the only independent variable returned low $R^2$ values.

9 models in total were done; 1 for each of the 3 dependent variables with all the 7 independent variables; 1 for each of the 3 independent variables with the 4 peace and conflict variables and 1 for each of the dependent with the 3 environmental variables.

4.4 Results

Models with environmental indicators as independent variables were statistically not significant for all the conflict outcomes ($p<0.05$). However, the models having all the peace, conflict and environmental indicators as independent variables were statistically significant for all the conflict outcomes ($p<0.05$). Only one independent variable (provocative behaviour) was significant to the incidences of raids (Table 12). The model with livestock losses as the dependent variable with all the peace, conflict and environmental variables as the predictors was statistically significant in 5 independent variables (Table 13). Meetings, rainfall and forage were positively significant to livestock losses. On the other hand provocative behaviour and vegetation density were negatively significant to livestock losses.

Community alliances and meetings have significant relation with the human deaths and injuries experienced from the incidences of raids (Table 14).

The adjusted $R^2$ in the stastically significant models ranges from 63.6-94% and this indicates how well the models can generalize.
Some of the provocative behaviours which are signs of an anticipated raid include a group of men moving together, raid blessing ceremonies and migration of armed kraals. The pastoral communities carry constant surveillance within their territories and also spy across other territories to forestall eminent attacks or collect information that will help plan a raid. It can contribute to the success of a raid or avoidance of the same.

Table 12: Regression Summary of dependent variable Raids using peace, conflict and environmental indicators (N=32)

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>t</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>Std. Error</td>
<td>Beta</td>
<td></td>
</tr>
<tr>
<td>(Constant)</td>
<td>12.549</td>
<td>7.931</td>
<td>1.582</td>
<td>.127</td>
</tr>
<tr>
<td>Recoveries</td>
<td>.005</td>
<td>.005</td>
<td>.131</td>
<td>.996</td>
</tr>
<tr>
<td>meetings</td>
<td>.268</td>
<td>.406</td>
<td>.119</td>
<td>.660</td>
</tr>
<tr>
<td>Alliances</td>
<td>2.216</td>
<td>1.199</td>
<td>.226</td>
<td>1.849</td>
</tr>
<tr>
<td>provocations</td>
<td>.800</td>
<td>.266</td>
<td>.556</td>
<td>3.003</td>
</tr>
<tr>
<td>Rainfall</td>
<td>-.005</td>
<td>.014</td>
<td>-.031</td>
<td>-.323</td>
</tr>
<tr>
<td>vegetation</td>
<td>-2.176</td>
<td>1.378</td>
<td>-.446</td>
<td>-1.579</td>
</tr>
<tr>
<td>Forage</td>
<td>.048</td>
<td>.029</td>
<td>.451</td>
<td>1.637</td>
</tr>
</tbody>
</table>

*p <0.05  R=0.927,  R²=0.859; Adjusted R²=0.818 ;  F (7, 24) =20.858; p<0.05, standard error of estimate=5.91
Table 13:Regression Summary of dependent variable Livestock losses using peace, conflict and environmental indicators (N=32)

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>t</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Constant)</td>
<td>1384.213</td>
<td>1405.653</td>
<td>.985</td>
<td>.335</td>
</tr>
<tr>
<td>Recoveries</td>
<td>.551</td>
<td>.826</td>
<td>.050</td>
<td>.666</td>
</tr>
<tr>
<td>meetings</td>
<td>809.740</td>
<td>71.914</td>
<td>1.155</td>
<td>11.260</td>
</tr>
<tr>
<td>Alliances</td>
<td>325.836</td>
<td>212.456</td>
<td>.107</td>
<td>1.534</td>
</tr>
<tr>
<td>provocations</td>
<td>-144.182</td>
<td>47.201</td>
<td>-.323</td>
<td>-3.055</td>
</tr>
<tr>
<td>Rainfall</td>
<td>12.819</td>
<td>2.481</td>
<td>.283</td>
<td>5.167</td>
</tr>
<tr>
<td>vegetation</td>
<td>-984.618</td>
<td>244.303</td>
<td>-.650</td>
<td>-4.030</td>
</tr>
<tr>
<td>Forage</td>
<td>16.160</td>
<td>5.223</td>
<td>.487</td>
<td>3.094</td>
</tr>
</tbody>
</table>

*p <0.05; R²=0.954; Adjusted R²=0.940; F (7, 24) =70.956; p<0.05, standard error of estimate=1047.661

Table 14: Regression Summary of dependent variable Human deaths and injuries using peace, conflict and environmental indicators (N=32)

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>t</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Constant)</td>
<td>41.703</td>
<td>21.063</td>
<td>1.980</td>
<td>.059</td>
</tr>
<tr>
<td>Recoveries</td>
<td>-.002</td>
<td>.012</td>
<td>-.034</td>
<td>-.181</td>
</tr>
<tr>
<td>meetings</td>
<td>3.194</td>
<td>1.078</td>
<td>.752</td>
<td>2.964</td>
</tr>
<tr>
<td>Alliances</td>
<td>6.846</td>
<td>3.184</td>
<td>.370</td>
<td>2.150</td>
</tr>
<tr>
<td>provocations</td>
<td>-.357</td>
<td>.707</td>
<td>-.132</td>
<td>-.504</td>
</tr>
<tr>
<td>Rainfall</td>
<td>-.015</td>
<td>.037</td>
<td>-.053</td>
<td>-.392</td>
</tr>
<tr>
<td>vegetation</td>
<td>-5.736</td>
<td>3.661</td>
<td>-.624</td>
<td>-1.567</td>
</tr>
<tr>
<td>Forage</td>
<td>.114</td>
<td>.078</td>
<td>.567</td>
<td>1.456</td>
</tr>
</tbody>
</table>

*p <0.05; R²=0.848; R²=0.719; Adjusted R²=0.636;F (7, 24) =8.753; p<0.05; Standard error of estimate=15.699
Graphical representation of the relationship between the incidences of raids, amount of rainfall and forage available for grazing in a year in the different corridors across the district (Fig 17-20) indicates that there is no clear relationship. The intensity of raids varies from one corridor to the other. The 2004-2005 were drought years (annual rainfall below 285 mm) which is the districts’ long-term mean annual rainfall as indicated in table (1) in chapter 3, across the district but it was only the corridors along the Turkana-Sudan (TUSU) and Turkana-Uganda (TUUG) borders that experienced high incidences of raids despite the other corridors receiving very low rainfall. However, the year 2009 was exceptional as the raids increased across all the corridors despite the good environmental conditions, this could be explained by considering raids as being opportunistic such that when environmental conditions improve the more the need to raid. The key dry season grazing areas are usually on the fringes of the district which brings the Turkana pastoralists into contact with other groups. The Turkana-Pokot (TUPO) and the Turkana-Ethiopia (TUET) had the highest number of raids in 2009. There is a possibility of existence of other conflict triggers specific to each corridor.

TUUG Corridor

*Rainfall and forage data for 2007 is missing

Figure 17: Relationship between Annual rainfall, Forage and incidences of raids during 2004-2009 period. Source: Own compilation
Figure 18: Relationship between annual rainfall, forage and incidences of raids during 2004-2009 period. Source: Own compilation

Figure 19: Relationship between annual rainfall, forage and incidences of raids during 2004-2009 period. Source: Own compilation
4.5 Chapter Summary

This chapter sought to understand whether the occurrence and severity of conflict in form of livestock raiding in Turkana could be linked to environmental variability. Data retrieved from the reports of a local peacebuilding organisation in Turkana was used to simulate the relationships between the two phenomena.

Environmental factors in isolation were statistically insignificant to conflict outcomes. Provocative behaviour which usually includes migration of only males, raids blessing ceremonies and spying actions are significant to the incidences of raids. Community meetings, rainfall and forage contribute positively to livestock losses, while vegetation density and provocative behaviour negate livestock losses. Community alliances and meetings have significant relation with human deaths and injuries due to exposure to incidences of raids.

Graphical representation of the relationship between rainfall, forage and raid incidences does not show definite association of intensity of raids with rainfall and forage. There is high variability across the corridors. This would possibly mean that other factors beside environmental related ones would trigger livestock raiding.
CHAPTER 5:
LIVELIHOOD STRATEGIES AND ADAPTATION

5.0 Introduction
It is increasingly recognized that climate variability is exerting additional stress to the pastoral systems and the ability of the pastoralists to cope with this variability is undermined (Markasis, 2004). Climate variability introduces additional uncertainty into existing vulnerability in the arid and semi-arid lands (Orindi et al., 2007). Droughts are part of the natural cycle in Turkana and are for the pastoralists an acceptable pattern of life (Field, 2005). In that regard the pastoralists have had a variety of traditional and alternative strategies to enhance their adaptability and reduce the risk in the times of stress and shock. However, new and persistent environmental, political and social pressures have limited the choices that have traditionally been there (Galvin, 2004). The Turkana pastoralists have a distinguished knowledge of the complexities of their environment which enables them to cope with the unpredictable variations over space and time (Dyson-Hudson and McCabe, 1992; Bush, 1995). However, there is a common understanding in the literature that the vulnerability of the Turkana pastoralists amongst other pastoral groups is not only related to climate variability but is the result of complex and multidimensional political, economic and social processes (Markasis, 2004; Lind, 2005; Eriksen and Lind, 2009). Armed violence, development failures and economic decline have all weakened the Turkana production systems and eroded their adaptive capacity (Eriksen and Lind, 2009). This study explores how the Turkana have adapted their livelihood strategies to the complexities that are brought by a wider spectrum of factors.

5.1 Adaptation and Livelihoods Approach
According to IPCC adaptation refers to any adjustment in natural or human systems that take place in response to actual or expected climate conditions, and is intended either to moderate harm or to exploit beneficial opportunities. While vulnerability would mean the extent to which climate variation may affect a production system or the ability to adapt to new climate conditions. Climate variability is a defining feature of the pastoralists’ way of life in Turkana and adjacent areas, and local livelihoods are sensitively adapted to the expectation that the shock or the stress will come and be overcome (ODI, 2009).

Livelihood approach provides a baseline to probe adaptation to risks such as climate variability (Forsyth, 2007) for it can offer a guidance on how the exploitation of assets that underpin adaptation are continuously changed in response to social relations, political and economic forces (Lind, 2003; Juma, 2009). The impacts of climate variability can be linked to various elements of the livelihood framework such as assets change in livelihood strategies and outcomes (Allison and Ellis, 2001). The livelihood approach emphasizes access and utilization of the capital assets through different adaptation strategies which may help reduce vulnerability. Chambers and Conway (1992), some of the pioneer advocates of livelihood approach argue that poverty and vulnerability can be reduced by increasing livelihood

<table>
<thead>
<tr>
<th>BOX 2: Pastoralists’ Livelihood assets.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human: Education, health, nutrition</td>
</tr>
<tr>
<td>Natural: Grazing land, water source</td>
</tr>
<tr>
<td>Social: Livestock, community social support</td>
</tr>
<tr>
<td>Physical: Livestock herd, infrastructure</td>
</tr>
</tbody>
</table>
options especially in times of economic or environmental stress. To attain positive livelihood outcomes the Turkana pastoralists rely on some specific strategies to manage their livestock herds. They constantly switch between normal livelihood activities pursued when climatic conditions are good and a set of coping strategies which are handy during the times of stress.

5.2 Methods
A field survey was conducted in the larger Turkana district. The division was the sampling unit of this study. The district has seventeen divisions. Stratified random sampling technique was used to select six divisions across the district and distributed among the main livelihood activities. The major livelihood activities in the district include Pastoralism, agropastoralism and fishing. The district was divided into three regions namely north, central and south. Within the divisions there are locations and sub locations. Each sub location is occupied by a group of families that pursue similar socio-economic activities. The Turkana refer to this arrangement as an “adakar”. The divisions selected for survey were Kaleng and Oropoi (north); Kalokol and Turkwell (Central); Katilu and Lokori (south). In each division a list of “ngadakarin”(plural for adakar) were randomly picked. 60 household interviews were conducted in the “ngadakarin”. Focus group discussions were also held in the same “ngadakarin” involving at least 10 men or women in separate groups. The interviews were guided by a check list of open-ended questions. The analysis of responses is given in simple frequencies and chi-square test was used to assess for homogeneity or similarity on categorical response variables between the study divisions. All statistical differences are presented as significant at p<0.05 level.

5.3 Results
5.3.1 Choice of livestock species at the household level.

The goats were the most common livestock kept by the households interviewed. They accounted to 32.5% of the total herd (Table 15). They were followed by camels (22.8%), Cattle (18.1%), sheep (16.2%) and donkeys (9.3%). The reasons given by the respondents on why goats are preferred to other animals are : (i) they breed faster as they can give birth twice in year (78.3%) (ii) They can browse on the readily available acacia trees (38.2%) (iii) easily acquired as bride wealth and gift from Kins and friends (56%) and (iv) they pose difficulty to livestock raiders as they disperse when rushed (25.6%). The camel are also recognised as being important to the household livelihood as it can provide milk throughout the year and they can survive in relatively dry conditions as compared to the other species. The cattle are mainly concentrated along the permanent rivers and mountain areas where they can access grazing resources. These areas include Katilu, Kaleng, Turkwell and Oropoi divisions. The average household TLU was lowest in the central part of the district and high in the north. Except for Katilu, all other divisions had an average household TLU less than 5, which is considered as the minimum for subsistence in a pastoral set up where there are no other sources of income and asset types (Little, 2006)
Table 15: The average livestock holding (TLU) per division (interviews):

<table>
<thead>
<tr>
<th>Divisions</th>
<th>cattle</th>
<th>camels</th>
<th>Goats</th>
<th>Sheep</th>
<th>Donkeys</th>
<th>Total TLU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kalokol</td>
<td>0</td>
<td>1.2</td>
<td>1.0</td>
<td>0.2</td>
<td>0.2</td>
<td>2.5</td>
</tr>
<tr>
<td>Turkwell</td>
<td>0.8</td>
<td>1.5</td>
<td>0.3</td>
<td>0.6</td>
<td>0.3</td>
<td>3.5</td>
</tr>
<tr>
<td>North</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oropoi</td>
<td>1.4</td>
<td>0.6</td>
<td>1.2</td>
<td>0.7</td>
<td>0.6</td>
<td>4.5</td>
</tr>
<tr>
<td>Kaleng</td>
<td>1.0</td>
<td>0.3</td>
<td>1.8</td>
<td>1.0</td>
<td>0.2</td>
<td>4.3</td>
</tr>
<tr>
<td>South</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lokori</td>
<td>0.3</td>
<td>0.6</td>
<td>1.2</td>
<td>0.7</td>
<td>0.6</td>
<td>3.4</td>
</tr>
<tr>
<td>Katilu</td>
<td>0.8</td>
<td>1.2</td>
<td>2.2</td>
<td>0.6</td>
<td>0.3</td>
<td>5.1</td>
</tr>
<tr>
<td>Totals</td>
<td>4.3</td>
<td>5.4</td>
<td>7.7</td>
<td>3.8</td>
<td>2.2</td>
<td>20.6</td>
</tr>
</tbody>
</table>

Source: Own field work 2009

5.3.2 Relationship between livestock species owned and number of years the respondent settled in one village.

There is significant difference in the number of years a household settled in one village across the divisions ($x^2=43.268,DF=24,p=.009$). Cattle were significantly correlated to less than five years of settlement (Table 16). The other livestock species were not significantly correlated to any period of settlement. Poultry were statistically significantly correlated to settlement of 16 or more years. This might mean poultry are mainly kept by people who are settled for a longer period as they can exploit the settled population market for the sale of poultry and eggs. Cattle are sensitive to quantity and quality of pasture available and thus cannot be in one region for a long period. Their survival is hinged on mobility and tracking of good pastures by the herders.

Table 16: Correlation matrix of the relationship between livestock ownership and number of years the owner settled in one village.

<table>
<thead>
<tr>
<th>Livestock/No. of years</th>
<th>&lt;5</th>
<th>6-10</th>
<th>11-15</th>
<th>&gt;16</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle</td>
<td>.399**</td>
<td>-.081</td>
<td>-.118</td>
<td>-.069</td>
</tr>
<tr>
<td>Camels</td>
<td>-.144</td>
<td>-.003</td>
<td>.105</td>
<td>.247</td>
</tr>
<tr>
<td>Goats</td>
<td>-.155</td>
<td>-.094</td>
<td>-.008</td>
<td>-.015</td>
</tr>
<tr>
<td>Sheep</td>
<td>-.105</td>
<td>-.031</td>
<td>-.024</td>
<td>.007</td>
</tr>
<tr>
<td>Donkeys</td>
<td>-.019</td>
<td>-.213</td>
<td>.008</td>
<td>.007</td>
</tr>
<tr>
<td>Poultry</td>
<td>-.225</td>
<td>-.044</td>
<td>-.054</td>
<td>.265*</td>
</tr>
</tbody>
</table>

* Significant at 0.05 level ** significant at 0.01 level Source: Own compilation.
5.3.3 Relationship between livestock species and reasons for migration:

The respondents identified pasture, livestock raids, livestock diseases and seeking employment at the urban centres as some of the reasons why they migrate from their traditional homes (“ere”). There was no significant difference between the divisions across the district on reasons why the households migrate ($x^2=21.815$, DF=24, $p=0.590$). No livestock species showed any significant relationship with any of these reasons (Table 17). Livestock raids have significant correlation with the search of pasture. The livestock diseases are also significantly linearly correlated with search for pastures and incidences of livestock raids. While the number of the households who seek employment in the urban areas could be related to loss of livestock through lack of pasture, livestock raids or diseases. Employment as a reason of migration is strongly correlated with livestock diseases incidences. The sheep movement is significantly correlated with that of goats and donkeys. The pastoralists usually split their livestock during the dry season and they consider the animals feed requirements amongst other reasons. The small stock usually remains with the main household while cattle are herded at the satellite kraal.

Table 17: Correlation matrix to show relationship between livestock specie and reasons for migration.

<table>
<thead>
<tr>
<th>pasture</th>
<th>Raids</th>
<th>Disease</th>
<th>employment</th>
<th>cattle</th>
<th>camels</th>
<th>goats</th>
<th>sheep</th>
<th>donkeys</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raids</td>
<td>0.749</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diseases</td>
<td>0.535</td>
<td>0.714</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employment</td>
<td>0.535</td>
<td>0.714</td>
<td>1.000**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cattle</td>
<td>.014</td>
<td>-0.137</td>
<td>0.082</td>
<td>0.82</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Camels</td>
<td>.039</td>
<td>0.160</td>
<td>.008</td>
<td>-.008</td>
<td>-.012</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Goats</td>
<td>-.030</td>
<td>.065</td>
<td>.094</td>
<td>-.094</td>
<td>-.133</td>
<td>-.178</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sheep</td>
<td>.237</td>
<td>.114</td>
<td>.066</td>
<td>.066</td>
<td>-.010</td>
<td>-.002</td>
<td>.326*</td>
<td></td>
</tr>
<tr>
<td>Donkeys</td>
<td>0.213</td>
<td>0.111</td>
<td>0.213</td>
<td>0.213</td>
<td>0.212</td>
<td>.91</td>
<td>0.153</td>
<td>0.028*</td>
</tr>
</tbody>
</table>
| Poultry | -.152 | -.158   | .124       | .124   | .077   | .187  | -.044 | .036    | .028*

** Significant at 0.1 level  * significant at 0.05 level  Source: Own compilation

5.3.4 Perceptions of the pastoralists on the rainfall, drought and grazing pasture trends for the last ten years:

The pastoralists strongly perceive that rainfall has decreased in amounts and the length of the wet season which is usually expected to run from the month of March to July has decreased or varies with each year. The drought cycle is such that there are frequent droughts and pastoralists think this has affected the availability of grazing pasture as there is not enough recovery period. Over 70% of the household heads interviewed think the grazing pastures have decreased considerably in the last ten years (Table 18). They associated the changes with loss of pasture seed due to frequent droughts, invasion of pasture land by
prosopis juliflora which undermines undergrowth and restricted movement of livestock due to conflict mainly at the fringes of the district. Prosopis juliflora is an invasive tree species which is a native of South America, Central America and the Caribbean and was introduced to Turkana in early 1980’s by development agencies. It is an evergreen tree, fast growing and tolerant to arid and saline conditions. It is unpalatable to livestock except for its’ pods.

Table 18: Pastoralists’ perception of rainfall, drought and grazing pasture trends in the last ten years (% frequency)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Regions</th>
<th>Increased</th>
<th>Decreased</th>
<th>Same</th>
<th>Fluctuates continuously</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rainfall</td>
<td>North</td>
<td>_</td>
<td>77.3%</td>
<td>_</td>
<td>22.7%</td>
</tr>
<tr>
<td></td>
<td>Central</td>
<td>_</td>
<td>82.4%</td>
<td>_</td>
<td>17.6%</td>
</tr>
<tr>
<td></td>
<td>South</td>
<td>_</td>
<td>72.7%</td>
<td>9.1%</td>
<td>13.6%</td>
</tr>
<tr>
<td>Length of wet season</td>
<td>North</td>
<td>-</td>
<td>45.5%</td>
<td>13.6%</td>
<td>40.9%</td>
</tr>
<tr>
<td></td>
<td>Central</td>
<td>-</td>
<td>47%</td>
<td>17.6%</td>
<td>35.3%</td>
</tr>
<tr>
<td></td>
<td>South</td>
<td>-</td>
<td>52.4%</td>
<td>19%</td>
<td>28.6%</td>
</tr>
<tr>
<td>Grazing pastures</td>
<td>North</td>
<td>_</td>
<td>72.7%</td>
<td>_</td>
<td>27.3%</td>
</tr>
<tr>
<td></td>
<td>Central</td>
<td>_</td>
<td>76.5%</td>
<td>_</td>
<td>23.5%</td>
</tr>
<tr>
<td></td>
<td>South</td>
<td>_</td>
<td>71.4%</td>
<td>_</td>
<td>28.6%</td>
</tr>
<tr>
<td>Drought occurrence</td>
<td>North</td>
<td>81.8%</td>
<td>_</td>
<td>_</td>
<td>18.2%</td>
</tr>
<tr>
<td></td>
<td>Central</td>
<td>100%</td>
<td>_</td>
<td>_</td>
<td>_</td>
</tr>
<tr>
<td></td>
<td>South</td>
<td>85.7%</td>
<td>_</td>
<td>_</td>
<td>14.3%</td>
</tr>
</tbody>
</table>

a North comprises Kaleng & Oropoi divisions (N=22), b Central comprises Kalokol & Turkwell divisions (N=17), c South comprises Katilu & Lokori divisions (N=21). Source: Own Fieldwork 2009.

5.3.5 Trends of livestock populations in the last ten years as perceived by the pastoralists:

No significant differences existed between the perceptions of pastoralists across the regions on the trend of cattle population (x²=2.641, DF=2, p=0.267). About 90% of the respondents perceived the cattle population to have declined in the last ten years. However, there existed significant difference in the perceptions of the pastoralists in different regions about the camels population trends in the district during the same period (x²=30.157, DF=6, p=0.00). 51.7% of the pastoralists perceived that the camel population had decreased while 18.3% thought it had increased and another 21.7% perceived it as having fluctuated continuously (Table 19). In addition, no significant differences existed between the perceptions of pastoralists from different regions within the district on the trend of goats population in the last decade (x²=2.029, df=4, p=0.730). 80% of the respondents thought the goats population decreased, while 16.7% perceive it to have fluctuated continuously (Table 19). For the sheep
population, it was perceived to have decreased, though there existed significant differences between the perceptions of pastoralists across the regions ($\chi^2=7.233$, DF=2, $p=0.027$). 76.7% of the respondents perceived the population to have declined, while 23.3% think it had fluctuated (Table 19). On the donkeys population trends, significant differences existed between the perceptions of pastoralists across the district ($\chi^2=12.699$, df=6, $p=0.049$). 30% thought it had decreased, 30% perceive it to be the same and 31.7% thought it fluctuated continuously during that period (Table 19).

The pastoralists attributed the general decline of livestock holding in the last decade to; frequent and long droughts, emergence of pandemic diseases especially for small stock and restricted mobility due to conflict along the dry season grazing areas. (This is expounded under the discussion chapter).

Table 19: Pastoralists perception on the livestock population trends in the last ten years (% frequency).

<table>
<thead>
<tr>
<th>Livestock specie</th>
<th>Region(^a)</th>
<th>Increased</th>
<th>Decreased</th>
<th>Same</th>
<th>Fluctuates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle population</td>
<td>North</td>
<td>0</td>
<td>18(81.8%)</td>
<td>0</td>
<td>4(18.2%)</td>
</tr>
<tr>
<td></td>
<td>Central</td>
<td>0</td>
<td>17(100%)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>South</td>
<td>0</td>
<td>18(85.7%)</td>
<td>0</td>
<td>3(14.3%)</td>
</tr>
<tr>
<td>Camels population</td>
<td>North</td>
<td>9(40.9%)</td>
<td>2(9.1%)</td>
<td>4(18.2%)</td>
<td>7(31.8%)</td>
</tr>
<tr>
<td></td>
<td>Central</td>
<td>2(11.8%)</td>
<td>11(64.7%)</td>
<td>0</td>
<td>4(23.5%)</td>
</tr>
<tr>
<td></td>
<td>South</td>
<td>0</td>
<td>18(85.7%)</td>
<td>1(5.9%)</td>
<td>2(9.5%)</td>
</tr>
<tr>
<td>Goats population</td>
<td>North</td>
<td>0</td>
<td>17(77.3%)</td>
<td>0</td>
<td>5(22.7%)</td>
</tr>
<tr>
<td></td>
<td>Central</td>
<td>0</td>
<td>14(82.4%)</td>
<td>1(5.9%)</td>
<td>2(11.8%)</td>
</tr>
<tr>
<td></td>
<td>South</td>
<td>0</td>
<td>17(81%)</td>
<td>1(4.8%)</td>
<td>3(14.3%)</td>
</tr>
<tr>
<td>Sheep population</td>
<td>North</td>
<td>0</td>
<td>15(77.2%)</td>
<td>0</td>
<td>7(31.8%)</td>
</tr>
<tr>
<td></td>
<td>Central</td>
<td>0</td>
<td>17(100%)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>South</td>
<td>0</td>
<td>14(66.7%)</td>
<td>0</td>
<td>7(33.3%)</td>
</tr>
<tr>
<td>Donkeys population</td>
<td>North</td>
<td>3(13.6%)</td>
<td>4(18.2%)</td>
<td>10(45.5%)</td>
<td>5(22.7%)</td>
</tr>
<tr>
<td></td>
<td>Central</td>
<td>2(11.8%)</td>
<td>3(17.6%)</td>
<td>5(29.4%)</td>
<td>7(41.2%)</td>
</tr>
<tr>
<td></td>
<td>South</td>
<td>0</td>
<td>11(52.4%)</td>
<td>3(14.3%)</td>
<td>7(33.3%)</td>
</tr>
</tbody>
</table>

\(^a\)North comprises Kaleng & Oropoi divisions (N=22). 
\(^b\)Central comprises Kalokol & Turkwell divisions (N=17). 
\(^c\)South comprises Katili &Lokori divisions (N=21). 
Source: Own field work (2009)
5.3.6 Household drought coping and adaptation strategies

The range of opportunities available to household to cope with climate variability varies within different localities. The coping strategies are a delicate balance between food management and herd management. The household strive to obtain sufficient food for all the household members and maintaining a breeding stock to ensure recovery when the rains return. High prevalence of diversification as a livelihood strategy indicates how the households try to manage vulnerability by increasing reliability of the livelihood assets. The attachment of household to livestock despite engaging in other activities is evident in all the divisions. The involvement of households in many survival strategies may also be a sign of stress. Diversification can at times be interpreted to mean a thriving local economy and robust household livelihoods. The nature of livelihood diversification depends on the context in which it takes place.

The households out of mainstream Pastoralism seem to engage in more survival strategies than those who remain as pure pastoralists (Table 20). The reduction of consumption and reliance on food aid seems to occur in all the divisions, although households in Kaleng division tend to rely on food aid all the time. The reliance on food aid can be argued to be a strategy by the pastoralists to avoid selling their livestock rather than a dependency syndrome. The readily availability of food aid also can be attributed to its incorporation into the survival strategy by the pastoralists. The social networks are crucial to the survival of the pastoral economy, support and exchange of livestock by kins and friends is relied on in all the divisions.

Crucial also to the pastoral households is peace that can make them manoeuvre and utilize different ecological landscapes. In the southern and northern part of the district peace negotiation with other communities is in the seasonal calendar of the pastoral households. The burning of charcoal and collection of firewood has been adopted as an all the time activity across the divisions.
Table 20: Coping strategies adopted at the household level to drought in three divisions across the district/Livelihood zones

<table>
<thead>
<tr>
<th>Division/Strategy</th>
<th>Kalokol (Central)</th>
<th>Kaleng (North)</th>
<th>Katilu (South)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fishing</td>
<td>x</td>
<td>_</td>
<td>_</td>
</tr>
<tr>
<td>Farming</td>
<td>_</td>
<td>_</td>
<td>xxx</td>
</tr>
<tr>
<td>Sale of livestock</td>
<td>xxxx</td>
<td>x</td>
<td>xx</td>
</tr>
<tr>
<td>Slaughtering animals</td>
<td>xxxx</td>
<td>xxx</td>
<td>xxx</td>
</tr>
<tr>
<td>Gifts from kins/friends</td>
<td>x</td>
<td>xxx</td>
<td>x</td>
</tr>
<tr>
<td>Sell fish bones</td>
<td>x</td>
<td>_</td>
<td>_</td>
</tr>
<tr>
<td>Basketry</td>
<td>x</td>
<td>_</td>
<td></td>
</tr>
<tr>
<td>Rely on food aid</td>
<td>xxx</td>
<td>x</td>
<td>xxx</td>
</tr>
<tr>
<td>Blacksmith</td>
<td>x</td>
<td>_</td>
<td>_</td>
</tr>
<tr>
<td>Charcoal/firewood</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Wild fruits</td>
<td>xx</td>
<td>xx</td>
<td>xx</td>
</tr>
<tr>
<td>Sell Acacia pods</td>
<td>_</td>
<td>_</td>
<td>xx</td>
</tr>
<tr>
<td>Splitting herd/family</td>
<td>_</td>
<td>xxx</td>
<td>xxx</td>
</tr>
<tr>
<td>Reduce consumption</td>
<td>x</td>
<td>x</td>
<td>xx</td>
</tr>
<tr>
<td>Migration</td>
<td>_</td>
<td>xxxx</td>
<td>xxxx</td>
</tr>
<tr>
<td>Casual labour</td>
<td>x</td>
<td>_</td>
<td>x</td>
</tr>
<tr>
<td>Petty trade</td>
<td>x</td>
<td>_</td>
<td>x</td>
</tr>
<tr>
<td>Animal exchanges</td>
<td>xxx</td>
<td>xxx</td>
<td>xxx</td>
</tr>
<tr>
<td>Peace negotiation</td>
<td>_</td>
<td>xxx</td>
<td>xxx</td>
</tr>
</tbody>
</table>

x- All the time; xx-Early dry season: xxx-Late dry season: xxxx-Only during severe drought; – Not mentioned by respondents.  Source: Own field work (2009).

5.3.7 Adjustments to livelihood strategies and their limitations:

While the Turkana pastoralists have embraced a variety of coping strategies to climate variability and other risks, it is evident that some of the livelihood strategies have had to be adjusted overtime to reduce vulnerability. The adjustments are based on climatic, socio-economic and political circumstances under which an household or community finds itself. The responses by the pastoralists to the question “what strategies have changed over time?” are summarized in Table 21 below.
Table 21: Adjustments to livelihood strategies at the household level

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Emerging trend</th>
<th>Limiting factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Herd maximization - Keeping large herd of different species to maximize on the available grazing resources.</td>
<td>Camel-goats strategy - most pastoralists are shifting from having cattle in their herd to herding mainly browsers.</td>
<td>Conflict limits mobility and frequent droughts spread covariant risks.</td>
</tr>
<tr>
<td>2. Split of herd/family during periods of stress. The herd is split depending on their grazing characteristics and moved to different ecological gradients suitable to their survival. The family is also dispersed depending on the labour demands by the various herd units.</td>
<td>The herd and family are separated for longer periods. Most members of the family are settled in the market centres to access other services and support the other household members in the satellite kraals.</td>
<td>Conflict and limited capacity to access opportunities at the urban sectors.</td>
</tr>
<tr>
<td>3. Mobility - exploit the heterogeneity of the Turkana rangelands and the neighbouring areas both in space and time.</td>
<td>Restricted mobility within the interior parts of the district. Most of the dry season grazing not accessed.</td>
<td>Conflict restricts mobility and access to grazing resources.</td>
</tr>
<tr>
<td>4. Moral economy - Inter-household livestock transfers exploits the kinship networks, reciprocity and remittances and support from relatives and friends</td>
<td>There is limited access to the social networks. The high rate of drop out from Pastoralism has excluded the poor from the social networks. The networks are defined by possession of livestock</td>
<td>Conflict and frequent droughts affect a wider segment of the community, the social networks are hindered from functioning properly.</td>
</tr>
<tr>
<td>5. Traditional grazing and conflict regulation - The “tree of men” regulated the sequence of grazing in their territories. They could negotiate for grazing rights with other clans or ethnic groups.</td>
<td>The emergence of “Arum rum” strategy to enable access to prime grazing resources in insecure areas. “Arum rum” is also used as a military safeguard against livestock loss through raiding.</td>
<td>Frequent droughts and predatory livestock raids</td>
</tr>
<tr>
<td>6. Livelihood diversification - pastoralists diversify their activities so as to remain economically viable. The main complementary activities have been irrigated agriculture and fishing</td>
<td>The involvement of pastoral household in many activities, requires that they exploit the environment extensively.</td>
<td>Frequent droughts and lack of capacity to capture opportunities existing in the market centres. Most of the activities are of low income.</td>
</tr>
<tr>
<td>7. Utilization of livestock and the livestock products. The pastoralist would sundry meat “ngatosa” and milk “edodo” to be useful in periods of scarcity</td>
<td>The market for livestock does not offer good producer prices and livestock products are short in supply. The pastoral household rely on purchased grain. This means shift of dietary habits and the household resort to reducing their consumption levels.</td>
<td>Lack of supportive livestock market infrastructure and frequent droughts.</td>
</tr>
</tbody>
</table>

Tree of men refers to as “ekitoe a ngikiliok” by Turkana is a local decision making body that governs the management and utilization of the community resources. Arum rum refers to a group of nuclear families under a single leader usually armed to safeguard livestock and people from attack from neighbouring groups. Ngatosa refers to sundried meat fillets. Edodo refers to dried milk.
5.4 Chapter summary

The focus of this chapter has been to understand the coping and adaptive strategies that the Turkana pastoralists have employed to cushion themselves from stress associated with climate variability. The most common livestock species kept throughout the district are camels and goats. Cattle are more sensitive to climate variability as compared to other livestock species and thus the need to move them regularly to search for pastures. While mobility and tracking of pasture is critical, it is evident that there is positive correlation between incidences of raids, livestock diseases, pasture availability and the number of pastoralists who seek employment in the urban centres.

The pastoralists strongly perceive that there has been reduction in rainfall amounts, shortened length of wet season, diminished grazing pastures and frequent droughts. This has consequently contributed to decline in livestock population in the district in the last ten years. To cope with these changes the pastoralists have employed several strategies namely; mobility, extensive exploitation of the environmental resources, camel-goat strategy, use of social networks and diversification of survival activities. However, the performance of these strategies is being undermined by frequent droughts, armed conflict and lack of adequate capacity to take advantage of the available opportunities at the local level.
CHAPTER 6: DISCUSSION, CONCLUSION AND POLICY RECOMMENDATIONS

6.0 Climate variability
Rainfall in Turkana varies both in spatial and temporal scales as indicated by the rainfall variation between divisions and years. Interannual rainfall variation ranges from 41-56%, with the lowest in the southern part of the district and highest in the central region. The central part of the district had low rainfall and more dry years as compared to the rest of the district. These results concur with other studies that noted that low rainfall sites tend to experience high rainfall variability (Cheung et al., 2008; Illus and O’Connor, 1999; Ellis and Galvin, 1994). During the 1969-2000 period the central region experienced ten (10) severe droughts and other regions recorded four (4) each. The intrannual rainfall variation is higher than the interannual variation, thus the need to pay attention to the seasonal rainfall variation. The short rainy season (Akicheres) depicted higher variability (102-152%) than the long rains (Akiporo) (47-64%). The long rains contribute a larger part of the rainfall across the district (60%). These findings seem to agree with other studies on the Kenyan climate (Nicholson, 1996; Ogallo, 1988; Mutai et al., 1998; Pohl and Camberlin, 2006) which found out that the long rains being more abundant and short rains to be more variable. The largest portion of the rainfall variability is accounted for by the short rains (Akicheres) of October to December (Nicholson, 1996; Pohl and Camberlin, 2006; Mutai et al., 1998). Linear regression analyses for each of the three regions show that there are no significant changes for both the Akiporo and Akicheres rainfall for the years analyzed; it is only the southern part of the district which recorded a positive change in Akiporo rainfall albeit insignificantly.

The distribution of rainfall within the season is critical for livestock productivity. Apart for the southern region, other regions experience uneven distribution of the seasonal rainfall. According to pastoralists interviewed during the field survey of this study, the best years for livestock production are not necessarily those with high rainfall, rather those with moderate rainfall extending several months. Other studies have attested that the seasonal patterns of rainfall in Kenya follow the Indian Ocean processes and atmospheric features such as the inter-tropical convergence zone (ITCZ), it is beyond the scope of this study to examine the validity of those hypotheses (Ogutu et al., 2007; Ogallo, 1988). The high interseasonal and interannual rainfall variation implies that drought is a common occurrence in Turkana. This is further corroborated by the departure of rainfall amounts from the long term mean, which indicate that during the 1969-2000 period 52% of the years were drought years. Therefore, there is a possibility that the livestock population will follow non-equilibrium dynamic. Research among the Ngisonyoka clan of Turkana in 1980’s revealed that they occupied a non-equilibrium ecosystem which can profitably be exploited by flexibility and opportunism (Ellis and Swift, 1988). According to Ellis (1985) rainfall CV around 33 per cent marks the critical value where non-equilibrium dynamics begin to emerge. Non-equilibrium ecosystems are unpredictable and sometimes undergo complex dynamic behaviour like occurrence of severe droughts that can decimate more than 50% of the livestock population. This therefore implies that the Turkana rangelands can optimally be exploited by employing flexible management practices that allow livestock to vary with rainfall and forage production (Oba et al., 2000). The rainfall variation among the regions and between the years supports the argument that the Turkana ecosystem has an heterogeneous range productivity and thus variability in grazing resources (Scoones, 1995). This in effect means pastoralists should be mobile to allow optimal use of the heterogeneous environment.
The mean daily temperatures in Lodwar fluctuated throughout the year and the highest temperature was recorded in 2009. The range for the period 1981-2009 analyzed in this study was 28.4-30.5°C and an increase of 0.4-0.5°C from the 1961-1990 range of 28-30°C (Kenya Meteorological department). Statistical analyses of the change of mean temperature show that there is an increase of 0.12°C during this period although it is statistically insignificant. This rise in surface temperature seems to be consistent with trends for Kenya. Future projections suggest that the annual mean temperature will continue to increase, making the country warmer by 2-6°C on average by 2100 (Ogutu et al., 2007). According to IPCC (2001), increases in temperature could open new areas for cultivation but also increase the risk of heat or drought stress. Some plant and animal species might be seriously affected or disappear because they might be unable to adapt (Notenbaert et al., 2007). The central part of Turkana district has the lowest number of cattle (see Table 15) as it receives low rainfall as compared to other areas. Livestock have a “climate envelope” under which they perform optimally beyond which their productivity declines (ICRC, 2005). Cattle are sensitive to temperature changes, as the limits are reached they stop feeding, restrict their movement, interrupt breeding and drop in milk production (Field, 2005). The comparison in Table 22 indicates that the Turkana environmental conditions are far from the ideal environment for cattle rearing.

Table 22: Comparison between Turkana conditions and ideal environment for cattle

<table>
<thead>
<tr>
<th>Variable</th>
<th>Turkana conditions</th>
<th>Ideal environment for cattle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean annual rainfall (mm)</td>
<td>184-432</td>
<td>&gt;500</td>
</tr>
<tr>
<td>Temperature (°C)</td>
<td>24-38</td>
<td>13-18</td>
</tr>
<tr>
<td>Wind speed(Kph)</td>
<td>40-80</td>
<td>5-30</td>
</tr>
<tr>
<td>Solar radiation</td>
<td>High</td>
<td>Medium</td>
</tr>
<tr>
<td>Potential evaporation(mm/year)</td>
<td>&gt;2000</td>
<td>500-1000</td>
</tr>
</tbody>
</table>

aTurkana conditions were constructed from this study and literature. bIdeal environment for cattle adopted from Notenbaert et al., (2007).

This supports the findings from this study that there is a shift from cattle dominated multispecies herd strategy to herding of mainly the browsers (camel and goats). The presence of the perennial woody trees and shrubs in the Turkana rangeland allows better response to bimodal rainfall pattern. Since these plants are deep rooted they maintain the biomass without desiccating for long period thus favouring the abundance of browsing camels and goats (Ellis and Galvin, 1994). Vegetation (NDVI) and rainfall relationships analysis indicated that there is significant correlation at the seasonal level (R=.365, p=.040) and insignificant at the annual time level. These results suggest that any changes in long term rainfall distribution during the year are likely to have a major impact on vegetation production. East African region results from Davenport and Nicholson(1993) suggest that rainfall control over vegetation production could be stronger at the seasonal level than at the annual level. When regressed with lagged rainfall, the annual vegetation production is found to be positively correlated and weakly correlated to livestock population. Numerous other studies which have discussed the lag between rainfall and NDVI accentuate that rainfall characteristics may not be the only factor that influences NDVI values. The local factors such as soil characteristics, topography and land management practices should be considered in order to explain climate effect on the vegetation cover (Davenport and Nicholson, 1993). The presence of the evergreen and
prolific *Prosopis Juliflora* ("etirae") in the Turkana grazing fields can give inflated NDVI values in some instances. The plant is highly invasive but unpalatable and is spread through livestock feeding on the pods.

6.1 Climate variability, livestock production and pastoralists welfare

*Rainfall variability and livestock population dynamics*

There was general decline of livestock population both at district and household level during the period analyzed (1979-2004). All livestock species household holding depicted a decline except of small stock whose growth had “a saw toothed” trend. The household livestock unit dropped from 3.5 in 1979 to 1.8 in 2004, this is far below the recommended TLU per household (4.0-7.1) for subsistence (Notenbaert et al., 2007). According to Little et al., (2002) a pure pastoral household would require a herd size around 3.5-4.5 TLU to maintain pastoral viability in the absence of other income sources and asset types. Gulliver(1951) found out that an average Turkana household had 27.5-36 TLU in 1948. This decline would be associated with increase in the human population that has been realised in the district in the last 50 years and fluctuating livestock numbers depending on the prevailing climatic conditions and losses through livestock raiding.

Many other studies report that the average per capita herd holdings in the East African region have declined considerably in the past 20 years and that the social networks that involve local distribution mechanisms and livestock exchanges are largely inadequate to deal with widespread losses associated with the most severe disasters (Lind 2005; Orindi 2007). Livestock populations are modulated by frequent droughts and subsequently never reaching equilibrium (Ellis and Galvin, 1994). Falling household livestock holding can be viewed as a sign of vulnerability of the Turkana pastoralists as Pastoralism is their principal livelihood. The overall district poverty level was estimated to be 74% which is far above the national average of 54% (GOK, 2002). The pastoralists’ high levels of vulnerability and low adaptive capacity have been linked to high reliance on natural resources, limited ability to adapt financially and institutionally, high poverty levels and lack of safety nets. Pressure on resources due to increased human and declining livestock productivity, the pastoralists make more use of the available natural resources in non-drought times, leaving fewer resources to cope with drought conditions (Notenbaert et al., 2007). Decline in livestock holding within the pastoral system increases the pressure to the pastoralists to raid to rebuild their herds (Hendrickson et al., 1998).

The results from this study indicate that goats were more sensitive to delayed rainfall than other livestock species. Many studies have reported goats to be resilient to harsh conditions and increasingly preferred by the pastoralists because they are suited for the browse species that survive extended dry conditions (Nyarki 2004; Toulmin 1996). South Turkana Ecosystem Project (STEP) among the Ngisonyoka clan, found out small stock died of starvation because they could not forage away from the homesteads or water sources as other livestock species (McCabe 1987). The threat from livestock raiding has necessitated the herding of small stock around settlements thus limiting their access to more grazing resources. Small stock though they are more vulnerable to diseases as compared to larger stock they have high reproductive rates and lactate even during dry periods, and thus can act as a buffer during times of drought (Omosa, 2005).

Camels have a low R² value (0.097) indicating that they are less affected by delayed rainfall. Past studies have reported that camels are least affected by drought as they survive better on the remaining browse which lasts longer and provides high quality feed in drought times (Burrow and Mogaka, 2007; McCabe 1987). The gradual but steady increase in the camel population in the district could reflect a shifting management strategy by the Turkana pastoralists as an adaptation mechanism to increased dryness, livestock raiding and the
relative importance of browse. The respondents interviewed during the fieldwork of this study, contended that the livestock raiding has now shifted focus from cattle to camels. Whereas the camels were considered safe from livestock raiding previously the need to adapt to changing environmental conditions dictates that the herd structure changes to accommodate more browsers. The Pokot community were not known to own camels in the past but they now acquire camels through raiding from Turkana and other neighbouring communities (interviews). A study among the Borana pastoralists by Adano and Witsenburg, (2009) attests to this, following frequent droughts there has been a tendency towards an increased demand for camels instead of cattle. It is informative then to think of the conflict among the pastoral groups as an adaptation mechanism rather than as an impediment to adaptation. The consequences of the conflict are what stand in the way of the people to develop capabilities. The negative socio-economic consequences of conflict and insecurity have wider spill over effects on adverse aspects of the pastoralists (Adano and Witsenburg,2009).

**Rainfall variability and livestock production performance**

There were no significant correlations between the mortality rate of all livestock species and delayed rainfall. This goes against various studies which have found changes in livestock numbers to be linked proportionally to changes in annual precipitation (IPCC 2001; McCabe 1987). The explanation could be that the pastoralists increased their mobility to avoid loss of livestock through starvation. The high frequency of movement by the Turkana pastoralists also serves as an important response to livestock raiding (Pike,2004). Vries et al., (2006) found out during the 1991-1992 drought in Turkana raids by the pokot accounted for a significant loss of livestock among the Ngisonyoka clan.

The birth rates for cattle and sheep were significantly related to rainfall, meaning that they varied during the years. The cattle and sheep are grazers and thus are sensitive to variation in pasture availability. According to the Turkana pastoralists, cattle and sheep are usually the first species to be taken away from the homestead to the higher elevations or the riverine to graze on grasses that grow in the more mesic conditions. To avoid calving or lambing during times of stress the pastoralists separate males from females until when conditions improve. This is a risk management strategy to avoid loss of livestock.

In addition it is only goats’ offtake that is significantly related to variation in rainfall. 62.7% of variation in goats’ offtake is explained by variation in rainfall. The pastoralists mostly sell goats to meet their food requirements during the start of a dry season. It is only in long periods of drought that they resort to slaughtering or sale of big stock (Watson and Binsbergen,2006). This emphasizes the importance of goats in the livelihood strategy of the Turkana pastoralists. It provides both the opportunity to remain in pastoral economy as its fast breeding and meet immediate household needs as they are easy to sell. Goats and camels contribute most to the livelihood of the pastoralists (Little,2001; Bett et al., 2009). According to Omosa (2005) goats and camels survive longer periods than cattle and sheep. This supports the assumption that the pastoralists objective revolves around maintaining their livelihood and not to maximize profit as market rationality will dictate.

**Relationships between livestock production performance and livestock species populations**

The results of correlation between livestock species population and their performance indicators show that goat’s population have a strong linear correlation with cattle’s population. This could be explained by the feeding habits of these species and the management strategies employed by the pastoralists. Cattle are mainly grazers while goats are both grazers and browsers, thus they can complement each other. Some studies have reported that goats reduce bush encroachment through their browsing ability and thus open space for grass growth to support cattle population (Oba and Frost, 1999). The pastoralists
while splitting their herds during periods of scarcity usually take cattle to high elevations while maintaining goats near homesteads (McCabe, 1987).

The cattle offtake has a significantly negative correlation with its birth rate. This would mean that cattle offtake is higher than the herd's accumulation through birth. The pastoralists mainly sell small stock and thus sale could not be the main reason for the imbalance. It is then possible that livestock raiding and death through starvation reduce the number of cattle in the herd and in effect limit reproduction. Sato (1997) reports that among the Rendille pastoralists of Kenya, the kind of livestock kept at the time of drought depends on the cultural value attached to it. The higher the cultural value of the livestock specie, the more the effort is made to keep it. The analysis of trend of cattle household holding (1979-2004) in this thesis reveals that there has been a deep decline. This is corroborated further by the perception of the pastoralists interviewed during the field study, over 80% reported that cattle population has declined (see section 5.4.5). Drought induced die-offs of cattle population negatively affect breeding female and young calves more than immature animals and mature males (McCabe, 1987; Oba, 2001). Moreover mortality may be aggravated by disease outbreak further delaying regeneration of cattle population (Scoones, 1992). Cattle have been the main target during livestock raiding as they are usually grazed on the fringes of the district where pasture can be accessed and because of the cultural value attached to it by the groups involved in raiding.

Further results from this study show that sheep's birth rate was significantly positively correlated with the cattle and goats populations. Sheep are grazers and are therefore expected to be in competition with both cattle and goats for grazing resources. The Turkana pastoralists usually herd sheep and cattle or with goats together. This results would mean that as the pastoralists move the cattle or goats to high elevations the sheep also benefit from that.

Camels population did not respond to any production performance indicators. These indicators did not fluctuate with rainfall. Camels are considered drought tolerant as compared to other livestock species (Field, 2005; Burrow and Mogaka, 2007). Coppock et al.,(1986) however noted that cattle, sheep and goats were useful in exploiting ephemeral flashes of vegetation and suggest that this justifies the Turkana practice of maintaining multispecies livestock herd.

Rainfall variability and pastoralists welfare indicators

The pastoralists market participation is a coping strategy rather than a conscious commercialization, they sell livestock when there is need for cash. They mostly sell during the start of the dry season but are sometimes reluctant to sell stock because they have to maintain a certain level of production for subsistence. They wait until the milk production level drops and grain requirement is unavoidable, that is why herd owners would wait until the dry period to sell animals even though they are aware that the terms of trade are less favourable as compared to other periods (Musimba and Nyariki, 2003). During times of drought or low rainfall livestock grain terms of trade often collapse.

Analysis of the influence of rainfall to pastoralists' purchasing power for the years 2004-2009 presented in this study shows that there is an inverse relationship between the two. During periods of low rainfall(2004-2005;2008-2009) the mean cereal to meat price ratio shot up to 160%. It was only in the 2006-2007 season that meat price was higher than cereal price, this could be attributed to good environmental conditions prevailing after higher rainfall experienced during the 2005-2006 season. A higher cereal to meat price ratio (CMR) means a lower pastoralists' purchasing power thus pastoralists have to sell more livestock to meet their household food needs. Besides the subsistence orientation of the pastoralists the livestock trade in Turkana is mainly dominated by cartels and brokers who distort the market in their favour (Watson and Binsbergen, 2006). The pastoralists social networks have
traditionally been hinged on livestock and as a way to support household members left behind in settlements, they rely on the mutual and reciprocal relationship with the livestock dealers (Sato, 1997). They purchase necessities on credit for a while and in the rainy season when their livestock are back in the settlements, they repay the debt with their livestock. In this arrangement the livestock dealers have the market information and the pastoralist usually get a raw deal.

Access to milk from livestock is an important determinant of pastoralist nutrition and overall health. Results from this study show that there has been decline in the amount of milk available for household consumption during the 2004-2009 period. There are no clear trends of how rainfall is affecting the amount of milk consumed at the household level. The falling household livestock holding could be associated with this, with few animals to sell without endangering the herd capital the poor pastoralists have no viable alternative but to sell milk in order to raise cash to buy cereals. Milk is sold even when there is no surplus and this is symptomatic of increased poverty (Behnke 1987; Swift et al., 1996). Higher rates of malnutrition have been documented in settled pastoral groups with few or no animals to nomadic households with larger herds (Pike et al., 2010; Corbett et al., 2003). Turkana have become increasingly dependent upon maize as a dietary source of energy (Galvin 1992). The households no longer practice drying of milk (“edodo”) even during times of surplus (field interviews).

Coping strategies index

Coping strategy index is mainly a tool for monitoring categories of households’ adjustments to food stress. Changes in the number or intensity of strategies and their adoption can indicate a deteriorating or an improving food situation overtime. The findings from this study show that the index has an inverse relation with the annual rainfall. In years of low rainfall, the higher the index and vice versa. The index in the context of this study only covers concurrent indicators which primarily base on access or entitlement to food. These indicators include inter alia; level of dependence on non-livestock foods e.g. wild fruits, participation in markets, level of reliance on interhousehold exchanges, number of family members seeking employment in urban centers. During the period analyzed (2004-2009) the coping strategy index was high in 2004 but assumed a stable trend between 2006 and 2009 despite low rainfall received, this would probably indicate that the opportunities available to individuals are limited. According to Notenbaert et al., (2007) due to frequent and long droughts the pastoralists make more use of the available natural resources on a constant basis leaving fewer resources to cope with in subsequent periods. Pastoralists’ low formal education level limits their capacity to compete and take up opportunities in urban sectors.

6.2 Climate variability and conflict

Livestock losses are the only dependent variable significant to environmental factors, whereas incidences of raids and human deaths and injuries are significant to some peace and conflict indicators. There is a possibility of interrelation between the three conflict outcomes. Rainfall and forage would have been expected to have influence on the intensity of the raids, bearing their variation in space and time. Many studies point at scarcity of grazing resources as the trigger of conflict in pastoral areas. This was not realised in the models may be because of rainfall being used as water availability proxy and forage being estimated from satellite data. Forage availability is a function of land use, soil fertility and plant species. Surface water data would have been appropriate in place of rainfall. Measurement errors can also account for the unexpected results, the data collected by the
This may be explained that environmental variables alone cannot be the only factors that may be influencing conflict or cooperation in the Turkana case.

Rainfall and forage have a significantly positive relation with livestock losses through raids. The possibility is that most livestock losses occur during wet years when the range resources are in adequate supply. During wet periods water and forage are readily available and the animals are strong to be trekked for long distances by the raiders. A study carried by Adano and Witsenburg (2009) among the pastoralists in Northern Kenya supports this argument. They found out that in the rainy season rangeland resources are adequate in supply, there is always labour surplus that makes it easy for young men to engage in raiding. This negates the theory advanced by many other studies that the conflict in the pastoral areas is resource based. Some pastoralists interviewed during the field work of this study explained that scarcity of water especially would make people to stop their feuds until a drought or famine is over. Meier et al., (2007) suggest that raiding is strategically tied to opportunities presented by the environment. Rainfall and forage availability may prompt migrations and influence competition between different pastoral groups and may lead to the use of violence to get these resources. The Lomelo corridor in the southern region of Turkana is a deserted area due to conflict between Turkana and Pokots pastoralists, and it usually pits the two groups when there is need for dry season grazing. Results presented in this thesis show that this region has a lower variability in rainfall and its distribution in the season is more even as compared to other regions (see chapter 3). According to a study by Ecosystem (1985), 47% of the Turkana district including much of the best grazing lands was not used in the 1982-1984 period due to mere threat of raiding. McCabe(1990) estimated that up to ¼ of the Ngisonyoka territory comprising the best highland grazing areas was rarely used for threat of raiding. Pastoralists interviewed during this study corroborated this thinking as they confirmed that most raids do not happen during dry spells but intensify with availability of grazing resources. The aggressors usually would want to make efficient use of the opportunity presented by wet periods to acquire livestock for building their herd’s numbers or drive to external markets to earn good price.

Further analysis in this study indicates that vegetation density and provocative behaviour are significantly negatively related to livestock losses. Dense vegetation is good for both scouting and obscuring the presence of livestock to raiders. In addition to this, the growing trend of the Turkana pastoralists to keep goats is both a drought and conflict coping strategy as goats can be hidden among the bushes and they also pose difficulty to livestock raiders as they disperse when rushed (This thesis). Regarding provocative behaviour, the conflict surveillance systems in the pastoral setup involve scouts being sent to spy on other groups. The spying trips can either contribute to the success of a planned raid or can send a signal to the opposite group about an impending raid. Being knowledgeable of the consequences that follow a raid, the pastoralists usually practice avoidance mechanisms, this helps to reduce both human and livestock losses.
Provocative behaviour is statistically significant to the incidences of raids. The livestock raiding among the pastoralists is usually characterised by surveillance systems that involve scouts being sent to spy on the other groups. These scouting trips precede any raid. The loss of livestock can be through direct drive by the rustlers or through starvation as the threat of a raid drives the pastoralists to interior parts of the district which are drier, thus squeezing the pastoralists lower down the ecological gradient. According to Lind (2003), it is not much the raids themselves as the uncertainty from the threat of raids, along with the measures taken to cope with uncertainty which undermine herders livelihood strategy the most. Loss of livestock is considered loss of identity and destitution (Broch-due, 1999) and thus it is encouraging cyclic raiding to safeguard livelihoods.

Peace initiatives through meetings have a positive relationship on livestock losses and the incidences of human deaths and injuries. This looks an unlikely outcome but literature has it that the peace initiatives in the Karamoja cluster fostered by civil society and governments are viewed with scepticism by the pastoralists. Many Turkana herders rightly perceive peace structures established in recent years as initiated by outside actors and are under the control of individuals eager or carry favour with higher powers (Lind, 2006). According to Eaton (2008), peace meetings which take place near the conflict zones often end up in disaster. The Catholic Justice and Peace Commission (CJPC) in Kenya (cited in Eaton, 2008) once remarked that communities’ meetings organised by non-governmental organisations and government administrators are always synonymous with raids and killings either during the meeting or immediately after. Eriksen and Lind (2005) cite a case of a failed peace agreement brokered by a non-governmental organisation among the Turkana and Dodoth pastoralists in 2003. The agreement was that the Turkana pastoralists would migrate to Dodoth territory across in Uganda to access pasture and water but when they migrated they were attacked by the Dodoth and many human lives and livestock were lost. The focus of many agencies working among the Turkana pastoralists has been to import new techniques of managing conflicts ignoring the resolution mechanisms embedded in the local cultural and institutional norms. Making peace meetings at an inappropriate time creates tensions on communities, this can entrench differences between ethnic groups more firmly. According to Mkutu (2007), livestock raiding has been a customary activity among the pastoralists which has been explained both as an in-built cultural tendency and an economical coping strategy that was regulated by the elders. The Turkana indigenous conflict management uses the “tree of men” as a judicial and decision making body to manage and resolve conflicts within or without the community. Today the Turkana societal norms, cultures and values that regulated human life and local governance have greatly been diminished and demeaned by the emergence of nation state concept, outsiders’ influence and religion.

Alliances between conflicting groups in the pastoral areas are forged and broken depending on prevailing relationships. Alliances are an insurance mechanism against uncertainty in the resource availability and insecurity associated with conflict. When a balance of power between groups shifts, relationships based on peaceful exchange can be quickly replaced by reciprocal raiding. The results from this study indicate that intertribal alliances have a statistically significant relation with human deaths and injuries. Following the frequent and long droughts the pastoralists tend to increase mobility to areas with adequate grazing resources and in the process get into contact with other groups. They may form alliances that enable them access areas that are not under their jurisdiction. Turkana (Kenya) and Matheniko (Uganda) have formed an alliance that enables the Turkana to access grazing resources.
resources in Uganda but this in turn brings them into conflict with Dodoth and Jie groups (Interviews). These alliances also enable the groups to carry out raids together and this has increased the severity of raids as they result in increased damages on the other opposing party. Traditionally women and children were not targeted during raids but with shift of focus from distributive form of raiding to predatory, there are more human deaths and injuries encountered during raids. The raids are also common in settlements where the populations are high. The entry of cartels including well connected traders, politicians and government officials into livestock raiding has made it to be predatory as the motives range from economic gains to political expediencies (Pkalya, 2003; Hendrickson, 1996). The emergence of livestock warlord rivalry is now common among the Turkana and Pokot and has perpetuated acquisition of sophisticated weapons which are used (Pkalya, 2003).

6.3 Livelihood strategies and adaptation
The key results from the analysis of the livelihood and adaptation strategies among the Turkana pastoralists can be grouped into three categories;

- That livestock keeping is the principal activity and livelihoods adjustments are made to ensure maintenance of household food security and a breeding stock to ensure viability in the pastoral sector.
- Complementary activities can change to being principal livelihood strategies depending on the constraints and opportunities that households face.
- Lack of a principal livelihood strategy makes an household participate in multiple complementary activities for survival.

*Pastoralism as a principal livelihood*

Livestock keeping remains the principal activity across the district with all areas participating in sale or slaughtering of livestock as a coping measure to lack of food. The government records show that pure pastoralists are about 70% of the district population (Longley and Wekesa, 2008). The households maintain their viability through strategies that allow them to have a productive herd that allows recovery after a catastrophe. Following frequent and long droughts coupled with insecurity associated with livestock raiding the pastoralists have adjusted some of their traditional strategies. Some of the emerging strategies include;

(i) Camel-goat strategy:- There is a shift from an old strategy that was centred on socio-cultural cattle Pastoralism to new livelihoods that are dependent on camel and small stock. Whereas ownership of a variety of species allowed the pastoralists to survive any catastrophic event, the emergence of predatory conflict and frequent climate anomalies have necessitated the shift. However both the strategies represent past investments in animal genetic resources which can provide insurance against future food demands, environmental changes, diseases and associated changes. According to the respondents interviewed during the fieldwork of this study goats are the most valued animal in the herd. Goats breed faster and usually can give birth twice a year, thus can provide milk quickly besides being handy in building a herd after a catastrophe. The goats can easily be acquired as bride wealth and gift from kins and friends, so it can
perpetuate the social networking and keep the not so rich members of the community in the relation. Goats can be zero grazed in the homesteads implying that the owners are not required to go to insecure grazing areas. In addition goats are considered to cause difficulty to livestock raiders as they disperse when rushed. When considering environmental aspects, goats being both browsers and grazers can make efficient use of the heterogeneous rangeland in Turkana. They can browse on the readily available acacia trees. Camels are also considered as being important to the household livelihood as it can provide milk throughout the year as they have a slow reproduction rate. Though they are rarely slaughtered at home, when slaughtered the meat could be shared by several families. Camels can survive in relatively dry conditions as compared to other livestock species though they can die in numbers after some critical point (Field, 2005). The choice of livestock maximizes both environmental and conflict characteristics as the household is interested in remaining viable socially and economically.

(ii) “Arum rum” strategy:- Mobility is an important and rational practice that enable pastoralists to access the grazing resources which are spatially and temporally variable. The Turkana pastoralists have traditionally moved 10-15 times per year in search of patchy rainfall zones and pockets of high potential rangelands for their livestock (Hendrickson et al., 1996). They have resided and moved in small units known as ngadakarin (plural) during wet season and in the dry season as individual households (adakar). Owing to frequent droughts and conflict, mobility is both restricted in space but at the same time increased in frequency. Raids and threat of violence both restrict access to resources in borderlands and deplete livestock vital to maintain social ties (Eriksen and Lind, 2009). The Turkana pastoralists have responded to this challenge by adopting a model borrowed from the Karamojong group in Uganda. The arum rum strategy has necessitated a shift in the social organisation of resource use and the emergence of new forms of authority (Lind, 2005). Arum rum is usually a group of nuclear families under a single leader and move across territories to access grazing resources in insecure areas. They can range from a few hundreds to thousands. They share herding responsibilities and gain some measure of protection through increased numbers of men to guard livestock and people from attack from other groups. These conglomerates enable the pastoralists access pasture and water in conflict prone or threatened areas. The leader will usually be an emuron (seer), a sharp shooter or a respected man and he provides direction on issues related to security and grazing. This is a departure from the traditional resource governance structure where the “tree of men” has been instrumental in resource management and utilization. These changes all the same have allowed continuity in pastoralists movement in some areas.

The pastoralists interviewed during this study agree that this model is an arrangement that has limitations but necessary for their survival. Concentration of animals and people in safe areas leads to ecological degradation and increasing the risk of new disputes. This is also confirmed by Riamriam conflict data that showed that provocative behaviour perpetuates livestock raiding. According to Pike (2004), frequent movement with all members of the household allows access to livestock products but the higher the mobility and inability to access cereals at
the trading centres leads to a decline in overall nutrition status and heavy workload for women. However the Turkana pastoralists would be in more precarious state if mobility were not an option.

(iii) Dispersion of household and herds:- The pastoralists manage risk of losing livestock completely through keeping a large number of animals and maintaining more productive females to ensure that animals lost are easily replaced when climatic conditions improve. During dry season the herds are separated and sent on different orbits depending on the specific forage requirements. The emergence of *arum run* has necessitated that most of the household members are left behind in settlements. This is profitable in the sense that they access other opportunities available in the urban sectors so that they can support those in the satellite kraals. Women will engage in petty trade or charcoal burning to earn some cash. During the 1969-1971 study period of the Royal Geographical Society, South Turkana expedition women used to regularly accompany men to the cattle camps during the dry season (Dyson-Hudson and McCabe ,1982). This was also found by Ellis and Swift (1988) while studying the Ngisonyoka clan in South Turkana. This arrangement allows spread of risk as those in settlements can access services offered by different agencies and in turn support the other members in the kraals and on the other hand livestock from the kraals can be sold to support both ends with cash. The women and children are also left behind in settlements to safeguard them from attacks from livestock raiders.

It is quite evident from the foregoing discussions that livestock raiding and other forms of conflict in Turkana are central to the adaptation process. They cannot be viewed as an impediment to the adaptation strategies but as part and parcel as they shape the adjustments. They affect the social organisation and cultural attachments which are important to maintaining viability of Pastoralism. The social networks are important avenues for recovering from brink of destitution due to loss of livestock. Direct loss of livestock in raids can in certain cases impoverish entire social network as it excludes certain individuals from the livestock exchanges (Eriksen and Lind, 2009).

**Complementary livelihoods**

Fishing in Lake Turkana and irrigation along the two key rivers of Kerio and Turkwell are as result of large-scale relief efforts by Government and Aid agencies. After 1960-1970 drought period, the destitute pastoralists were resettled in these schemes. According to Eriksen and Lind (2009), these schemes did not have ecological and societal considerations in their planning and thus have worsened the vulnerability of the people intended to help. The persons already settled seem to engage in more survival activities than those in mainstream pastoralism, this might be a sign of stress. Disconnection from mainstream pastoral economy and having few assets to share the sedentary population cannot maintain important social ties in the pastoral economy requiring exchange of animals (Eriksen and Lind 2009). This is summarized in the words of one respondent in Kalokol; “I am here because I lost livestock and it has been difficult to acquire any since”. They subsist on assortment of activities which earns them meagre income. These activities include subsistence fishing, basketry, collection of firewood and charcoal. Though some still hold connections
with their relatives in the pastoral sector, they rarely participate in the animal exchanges which are critical in cultivating ties and enhancing livelihood security. When they acquire animals they mainly keep small stock which is zero grazed at the homesteads. This has resulted in opening of markets for acacia pods. Previously dry dehiscent acacia pods were dry season staple. Whereas this will seem an opportunity of utilizing the available natural resources, it has set the settled populations and pastoralists who have traditionally utilized the riverine areas as dry season grazing reserves into a conflict course. According to Stave et al., (2007) the indigenous conservation of ekwar is under pressure from sedentarisation process combined with a strong population growth. This represents a serious challenge to the conservation of riverine grazing lands. 

Ekwar (ngikwarin-plural) is a system of tree ownership along the riverine where an household has a control over a number of trees. Ekwar provides browse for livestock during dry season and food to humans throughout the year. Those populations engaged in complementary livelihood activities close ties with their kins and friends in the pastoral would not necessarily be on livestock exchange but on reciprocal support for survival. This connection was shared by a participant of a focus group discussion in Kaleng who put it as:

“ When the Dassenach attacked our people who were fishing in the lake, we got infuriated as they interfered with their survival and ours too. We undertook a revenge attack on the Dassenach”.

The import of this statement is that the people in the fishing or irrigation activities are still in link with their kins or friends in the pastoral sector. These links would be along blood relations or based on reciprocal support. Conflict can also be thought along fortification of livelihoods other than on scarcity of resources. Involvement in complementary livelihoods is directly related to offsetting threats to livelihoods and survival.

Coping/ survival strategies

In the absence of a principal livelihood an household can engage in diverse activities to survive. Limitation of opportunities precipitated by several stressors can be associated with the vulnerability of the population and involvement in multiple activities to meet basic needs. The coping capacity of an individual or household can directly be linked to entitlement or consumption in the face of an adverse event (Eriksen et al.,2005).

The urban poor and sedentary pastoral household members engage in all time firewood collection and charcoal burning as a means to meet their cash requirements. Though this is an important contribution to their survival, it undermines the viability of Pastoralism and sustainable environmental management through the externalities associated with the production process e.g. loss of trees, grazing, browse and ecosystem resilience (Burrow and Mogaka, 2007).

Most insecure households make use of food aid distribution from government and aid agencies. Usually the vulnerable households are targeted by these organisations. Many studies have argued that food aid has increased poverty amongst the Turkana through creation of dependency and maintenance of unsustainable human and livestock populations in the district (Blench 2000;Notenbaert et al., 2007). Food aid if used as a short term measure and
Adaptation to climate variability among the dryland population in Kenya: A case study of the Turkana pastoralists (2010)

directed to the vulnerable populations at the appropriate time can be positive. The pastoralists interviewed at Kaleng reported that they rely on food aid all the time but this does not mean that they are dependent on food aid. They consider food aid as an opportunity not to make a withdrawal from their pool of herd capital. The reliance on food aid challenges the persistence of pastoral social networks which is an important strategy to ensure recovery after a disaster or a catastrophe.

In situations of severe drought or disaster the population adjust their dietary consumption habits. They rely on one or no meal per day and / or give preference to children and the aged in case of acute shortage of food. The old individuals stay at settlements while the youth are dispersed to satellite herding. Milk diet is substituted with cereal. Some of the individuals rely on wild fruits especially doum palm which is readily available in Central and Southern part of the district. Participation in some of these survival responses e.g. cutting of trees for firewood and charcoal making may undermine an individual or household capability to cope with disasters in future.

6.4 Conclusion and Policy recommendations

The results from this study confirm that rainfall in Turkana is highly variable and unpredictable both in time and space. The seasonal variation is higher than the interannual variation with the short rains (Akicheres) accounting for a larger portion of the variability. The central region of the district experiences more dry spells as compared to the other parts. Drought is a common occurrence and the multi-year droughts have increased since 1990’s. Over 50% of the droughts experienced in 1969-2000 are severe in nature. There is a general declined household livestock holding falling below the subsistence recommended levels of 5 TLU. This implies that the pastoralists are more vulnerable now, as livestock is their principal livelihood.

There is a strong correlation between rainfall variation and vegetation in the region but a weak relation between livestock and vegetation. Not all the grazing areas in the district are accessed by the pastoralists and this is linked to threat or incidences of conflict. Though most studies have referred to the Turkana ecosystem as non-equilibrium, it is evident that there exist other factors outside vegetation, livestock and rainfall interactions as ecological drivers that influence the dynamics of the Turkana rangelands. These factors could include lack of nutrients, changes in vegetation composition and people’s actions on the environment. It might be more accurate then to consider the rangeland system as gradual and continuous in decoupling rather than a discrete state of equilibrium or non equilibrium.

Conflict in form of livestock raiding makes movement between key resources untenable and areas themselves inaccessible. Displacement and corresponding changes in pastoralists’ mobility configures access to food, social networks and overall welfare. The Riam Riam data suggests that livestock raiding may not be related to scarcity of resources but may be strategically planned and tied to opportunities presented by the environment. It is not so much the raids but the uncertainty stemming from the threat of raids along with the measures that are taken to cope with this uncertainty which undermine the pastoralists’ livelihood strategies. This study proposes that conflict is embedded in adaptation as it restricts the coping strategies adapted by the pastoralists. The pastoralists adaptation strategies have to
take into consideration the insecurity brought by conflict alongside the livelihood adjustments. The choice of herd composition, resource access and diversification of income sources are some of the strategies that are configured by conflict in the Turkana case. The participation of the Turkana pastoralists in many coping strategies might be a sign of vulnerability which is precipitated by variability in rainfall and livestock raiding. Most of the coping strategies have insufficient returns such that they cannot help households rebuild their livelihoods assets. Survival by any means could involve extensive utilization of the environment and this would have negative impact on to the environment. This sets the poor members of the pastoral group into a vicious cycle of poverty. Understanding of the Turkana situation from the livelihood security perspective is more realistic than as a resource scarcity discourse.

Based on the foregoing discussions some specific policy implications would suffice;

- The Local Early warning systems (EWS) can integrate both conflict indicators and environmental variables in their surveillance and analysis to enhance understanding of the complexity of the relationships between conflict and climate variability in the region especially now that climate change is anticipated to bring more uncertainty to the systems. The EWS can make use of the diverse traditional knowledge existing to be more grounded and relevant. The tree of men commonly referred to as “ekitoe a ngiki” is an institution with wealth of information about environment and conflict. It usually updates it’s understanding on constant basis which can be crucial for coping with stress associated with climate variability and conflict. The EWS information would only be useful if it is shared with the communities as active participants, since their knowledge and involvement will ensure sustainability of proposed actions.

- Enabling autonomous adaptation would be an economically and socially acceptable approach to tackle the Turkana case. The pastoralists have working strategies that have enabled them to survive and remain in Pastoralism for decades. These strategies can be enhanced without necessarily imposing new ones. Utilizing the local inherent capacity could be cost effective and also provides an opportunity for government to provide freedom to pastoralists to decide and liberate themselves from poverty. The United Nations Framework on Climate Change (UNFCC) in article 4.9 recognises the specific needs and situations of LDC countries. To enable them cope, their National Adaptation Programme Actions (NAPA) are supported through funding and technology transfer. Kenya though a non-LDC needs to draw an adaptation plan considering the future climate prognoses. The plans must incorporate local adaptation strategies if there are going to be useful. Incorporating the views from the vulnerable is the first step to achieving meaningful adaptation options that can improve livelihood resilience. People are active agents rather than passive victims of circumstances. Their own strategies other than interventions such as food aid are critical in managing climate variability.

- Conflict in form of livestock raiding is inherently a cultural adaptive strategy to environmental uncertainty which has been altered in response to socio-political marginalisation. Marginalisation by successive governments has
rendered the pastoralists vulnerable to many stressors. To address this, political solutions that address redistribution of power and resources will be required. The development inputs should support the pastoralists’ mobility or their desire to remain in Pastoralism. The conflicting interests of players in livestock raiding must be given due consideration in the drawing of adaptation programmes. Factors excluding or enhancing the specific players in adopting certain coping strategies should be given due consideration in all respects.

- Promotion of formal education among the pastoralists can provide an opportunity to lend support to the moral economy which is threatened by loss of livestock. In the analysis of coping strategies in this thesis, remittances from kins and friends is considered an all time strategy and thus it emphasizes its importance to livelihood security. This is in line with a study by Little et al., (2009) among the Illchamus pastoralists in Kenya which argues that education should figure prominently in the discussions of contemporary pastoral risk management strategies since engagement in labour markets currently is a critical component of pastoral livelihoods and this is facilitated by education. However education provision should not compromise mobility of the pastoralist. Mobile schools being piloted in Kenya and boarding schools could be some of the examples which accommodate the two aspects without conflict. Boarding schools allow the families to be mobile while the children get education.

- The emergence of increased dropouts from Pastoralism and sedentarisation in the urban areas related to loss of livestock and inability to recover requires attention be paid to development of sectoral adaptation measures that would reduce vulnerability of the urban and periurban poor. The dropouts from Pastoralism have low capacities and experience to compete for opportunities available from the urban sectors. The urban and periurban poor engage in survival strategies that undermine their future to exist as viable units.
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APPENDICES

Appendix 1: Household Questionnaire

Questionnaire No:
Sample Area/Village:
Division:
District:
A. source of livelihood:
   1. Main source of livelihood
      - Livestock (Pastoralism)
      - Agropastoralism
      - Fishing
      - Other (specify)
   2. Other sources of income
   3. Livestock owned
      Number
      - Cattle
      - camels
      - Goats
      - sheep
      - Donkeys
      - Other
B. Ecological Issues:
   4. How long have you been in this village?
      - Less than five years
      - 5-10 years
      - 11-15 years
      - over 16 years
   5. Do you stay here permanently?
      - Yes
      - No
   6. If No how is your stay?
      - Semi-permanent (Household stays, animals and herdsmen move)
      - Nomadic (Animals and whole household move)
   7. Who migrates (Aramakin)?
8. Where did you come from before?

9. Why do you move?
   - Search for pastures
   - Search for water
   - Conflicts
   - Culture
   - Disease outbreak
   - Others (specify)

10. Have you noticed any changes in rainfall in the area since you settled here?
   - Yes
   - No

11. If yes, how would you describe the changes?
   - Rainfall amounts: increased, decreased, same, fluctuated
   - Rainfall spacing: widened, narrowed, same, cannot tell
   - Rainfall time (season): shortened, extended, same, cannot tell

12. Have you noticed any change in the availability of pasture in the past 10 years?
   - Yes
   - No

13. If yes, how would you describe the change in the availability of pasture?
   - Increased
   - Decreased
   - Same
   - Varies continuously

14. What would you associate the changes with (reason for change)?

15. Have you noticed any changes in the livestock numbers in this area in the last 10 years?

16. If Yes, how would describe the change (Tick the appropriate)
   
<table>
<thead>
<tr>
<th></th>
<th>Increased</th>
<th>Decreased</th>
<th>Same</th>
<th>Fluctuated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Camels</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sheep</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Goats</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Donkeys</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

17. What would associate these changes with (Reason for change?)
C. Coping and Adaptation Strategies.

18. How have the changes in rainfall characteristics affected the following livestock productivity indicators?
   - Death rate: increased, decreased, same, fluctuated
   - Birth rate: increased, decreased, same, fluctuated
   - Off take: increased, decreased, same, fluctuated

19. Do you sell your livestock in the local market?
   - Yes
   - No

20. If, yes what time do you mostly sell?
   - Start of wet season
   - End of the wet season
   - Start of the dry season
   - Any time

21. What consideration do you make as to when to sell livestock?
   - Prices
   - Availability of pasture
   - Insecurity/banditry.
   - Household food requirements.
   - Other (specify)

22. What safeguards do you and your family put in place against drought (Explain).

23. What safeguards do you put in place against floods (Explain?)

24. How effective are these strategies today?

25. Are there strategies that you have changed overtime?
   - Yes
   - No

26. If, yes which ones?

27. Are you able to move your livestock to all the traditional grazing areas?
   - Yes
   - No

28. If No, why? Explain

29. Do you think your activities to cope with drought and floods affect natural resources?
   - Yes
   - No

30. If Yes, how? (Explain)
31. Which traditional practices (Laws) help you to adapt to drought in relation to?
   - Water and pasture management
   - Food management
   - Livestock management.

32. What in your own opinion limits your ability to cope with drought?

33. What services do Government and other development agencies extend to you as a pastoralist?

34. Which of these interventions in your opinion are helpful in cushioning against climate variability?

35. In your own opinion, what Government laws/actions affect your ability to cope with droughts and floods (positively/negatively).

Thank you for your time and valuable contributions

Appendix 2: Focus Group Discussions Guidelines
1. How have the rain patterns been in this area for the last ten years?

2. Which years was drought experienced?

3. Which years were floods experienced?

4. What is the impact of drought/floods on the livelihoods? (livestock, pasture, water availability, other household assets)

5. How have you tried to cope /adapt to impact of drought (short term/long term)

6. How has rainfall variability affected your coping strategies?

7. Changes in your migration patterns?

8. What is the role of conflict in shaping your adaptation strategies?

9. What economic activities do you engage in?
Appendix 3: Key Informants Interview Guide
Name of respondent............
Name of organisation.........

1. How long have you worked among the Turkana pastoralists?
2. What activities does your organisation undertake among the Turkana people?
3. What does your organisation intend to achieve through this(these) intervention(s)?
4. What in your opinion are the main factors that have contributed to the vulnerability of the Turkana pastoralists? (Explain)
5. Is climate variability an important consideration in the planning and implementation of your programmes? Yes/No
6. If yes, how is it factored in your programmes?
7. Which aspect of climate variability is profound in the Turkana region?
   - Rainfall variability
   - Drought
8. What are the main effects of drought on the Turkana pastoralists' livelihoods? (Explain)
9. What adaptive mechanism in your understanding have the Turkana pastoralists employed against climate variability?
10. Do you think these adaptive mechanisms are working in cushioning the pastoralist from effects of drought/rainfall variability? Yes/No
11. If No, why?
12. If Yes. How?
13. How are the traditional mechanisms linked with your interventions? (Explain)
14. With the current trends in climate variability, what management strategies do you think will enable the Turkana pastoralists to remain viable?
15. Any other contribution you will like to make

Thank you for your time and valuable contributions.
Appendix 4: Kenya’s Production / Livelihoods systems

Figure 1: Kenya’s Production/Livelihood Systems
Appendix 5: Turkana Livelihoods Zones

Source: ALRMP-Turkana.
### Appendix 6: Drought occurrences in Turkana district

<table>
<thead>
<tr>
<th>Year</th>
<th>Local name (Turkana)</th>
<th>Pastoralists’ perceptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1925</td>
<td>Ekwakoit</td>
<td>Widespread drought that decimated livestock</td>
</tr>
<tr>
<td>1930</td>
<td>Abrika</td>
<td>Widespread famine</td>
</tr>
<tr>
<td>1942</td>
<td>Lolewo</td>
<td>Cholera epidemic</td>
</tr>
<tr>
<td>1943</td>
<td>Ekuwam Lonyang</td>
<td>Brown dry wind</td>
</tr>
<tr>
<td>1949</td>
<td>Ngilowi</td>
<td>Drought that left behind only skins and hides</td>
</tr>
<tr>
<td>1952</td>
<td>Lotiira</td>
<td>Long drought that seemed not to end.</td>
</tr>
<tr>
<td>1953-1954</td>
<td>Lokulit</td>
<td>Whipping drought</td>
</tr>
<tr>
<td>1960</td>
<td>Namotor</td>
<td>High starvation</td>
</tr>
<tr>
<td>1966</td>
<td>Etop</td>
<td>Drought associated with a shooting star</td>
</tr>
<tr>
<td>1971</td>
<td>Lolewo</td>
<td>Cholera epidemic</td>
</tr>
<tr>
<td>1979-1981</td>
<td>Loukoi, Lopiar, Atanayanaye</td>
<td>Widespread Contagious pleuropneumonia</td>
</tr>
<tr>
<td>1984</td>
<td>Kilejok, Kidiirik</td>
<td>Widespread livestock raiding</td>
</tr>
<tr>
<td>1990-1992</td>
<td>Lopiar</td>
<td>Many skins everywhere, cleared many animals</td>
</tr>
<tr>
<td>1997</td>
<td>Etop</td>
<td>Drought associated with a shooting star.</td>
</tr>
<tr>
<td>2005-2006</td>
<td>Kumando</td>
<td>Drought that terminated everything</td>
</tr>
<tr>
<td>2009</td>
<td>Lomoo/Lonoo</td>
<td>Widespread PPR disease</td>
</tr>
</tbody>
</table>

Source: Juma (2009) and Own field interviews (2009)