ASSESSMENT OF THE IMPACT OF CLIMATE CHANGE ON LIVESTOCK DISEASES IN KAJIADO DISTRICT, KENYA

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DECLARATION

This thesis is my original work and it has not been presented for any degree at any other university.

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To my Wife Hellen and children Edward, Eliud and Ruth for their tranquility, encouragement and support.

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TERMS

MAASAI NAMES FOR VARIOUS DISEASES

A. CATTLE DISEASES

CONVENTIONAL NAME	MAASAI NAME
Foot and Mouth Disease (FMD)	*Oloirobi*
Lumpy Skin Disease (LSD)	*Errirri*
Blackquarter (BQ)	*Empuruo*
Anthrax	*Entemelua*
East Coast Fever (ECF)	*Oltikana*
Trypanosomoses	*Ntorobo*
Contagious Bovine PleuroPneumonia (CBPP)	*Olkipei*
Anaplasmosis	*Lipis*
Sleeping sickness	*Kububuo*
Rinderpest	*Oloudua*

B. SHEEP AND GOAT DISEASES

Contagious Caprine PleuroPneumonia (CCPP)	*Olkipei*
Enterotoxaemia	*Olbus*
Goat and sheep Pox (S/G Pox)	*Errirri*
Orf	*ilturoto*
Foot rot	*Eleilei*
Peste des Petit Ruminantis (PPR)	*Oloudua*
Diarrhoea	*Enkorotik*
Foot and Mouth disease (Sheep / Goats)	*Oloirobi*
Emaciation	*Enkinyot*

C. OTHER TERMINOLOGIES

Ngishu	Cattle over 2years
Oloramu	Cattle 1-2 years old
Ilasho	Cattle 0-1years old
Ntare	Mature Sheep/ goats
Ilkuo	Kids /Lambs 0-6 month

Acronyms

ANOVA	- Analysis of variance
ASAL	- Arid and semi -arid lands
ASDS-	- Agricultural Sector Development Strategy
CBOs	- community based organizations
DVO	-District Veterinary Officer
ENSO	- El-Nino Southern Oscillation
GoK	-Government of Kenya
HP	-Hewlett Packard
IPCC	-Intergovernmental Panel for Climate Change
ITCZ	- Intertropical Convergence Zone
NIA	- Neighbors Initiative Alliance
PEFA	- Pentecostal Evangelical Fellowship Assemblies
PPR	- Peste des Petits Ruminants
PRA	- Participatory Rural Appraisal
RVF	- Rift valley fever
SPSS	- Statistical Package for Social Sciences
SRA	- Strategy for Revitalizing Agriculture
SSI	- semi structured interviews
SST	- sea surface temperatures
UV-B	- ultraviolet B

ABSTRACT

Climate comprises many factors including temperature, rainfall, humidity, winds and altitude that can have both direct and indirect effects on animal production and health. It can also affect the quality and quantity of feedstuffs such as pasture, forage and grain and the severity and distribution of livestock diseases and parasites.

Livestock is very critical as source of food and livelihoods in the ASAL areas which are occupied by pastoralists. Animal diseases contribute to poverty globally particularly in the developing world. Climate change might be associated with these diseases. This study investigated associations between livestock disease occurrence and climatic variability/change in a selected location of Kajiado District of Kenya.

The broad objective of this study was to establish whether climate variability has any influence on livestock health in Kajiado District. Specific objectives were to determine the community knowledge, attitudes and practices in connection with diseases and climate change in Kajiado District; to assess prevalence of key livestock diseases in the study area; determine the trend of climate changes in Kajiado District; to investigate associations between livestock disease occurrence and climatic variability; and to recommend appropriate disease management practices and policies to mitigate against livestock diseases associated with climate variability.

This study was done in Enkaroni Location, Central division, Kajiado District which is an ASAL area. The area is characterized by frequent droughts due to climatic changes which lead to migration of pastoralists with their livestock. A cross-sectional survey using participatory rural

appraisal (PRA), key informant meetings, transect walks and semi structured interviews was carried out. A semi-structured questionnaire was also administered to 177 households to collect data on the effects of climate change on livestock disease outbreaks. Desk-top data on climate (weather elements of temperature, humidity, rainfall, wind direction and speed) for the previous 30 years from five meteorological stations close to the study site (Dagoretti, Magadi, Narok, JKIA and Wilson Airports) was obtained from the Kenya Meteorological Department. Livestock disease data for the previous 10 years was obtained from the Divisional Veterinary Office. The data was processed and analysed using (SPSS) version 16.0 Statistical package.

The study found out that humidity and wet bulb temperature had changed over a 30 year period while climate factors within the five stations had variations. Climate variability had significant effect on the occurrence of livestock diseases. Individual disease outbreaks were positively or negatively correlated with certain weather elements. For example rainfall had a significant relationship with the overall aggregate of all reported cases with a positive correlation coefficient of $r=0.469$, ($p<0.05$). Rainfall was negatively correlated with FMD ($r= -0.525$, $p>0.01$). Temperature and humidity had a significant positive correlation with; Helminthiasis ($r= 0.486$, $p<0.05$), FMD($r=0.448$, $p<0.05$) and ECF($r=0.529$, $p<0.01$). Wind direction and speed had a significant influence on livestock disease outbreaks ($p< 0.001$ and $p< 0.05$ respectively).

The study concluded that there has been a significant change in climate in Kajiado over the last 30 years (1967-2007) and the change had influence on livestock diseases, pasture and water availability, which in turn affected Livestock productivity.

The study recommends initiation of an early warning system, targeted and strategic disease management interventions, extension education on management of livestock diseases, construction of water holding reservoirs and establishment of a national contingency pasture reserve in order to mitigate the effects of climate change.

Extension education should be enhanced in pastoral areas so as to prevent livestock diseases which lead to food insecurity. Efforts should also be made to create a national pasture reserve in order to assist pastoralists during adverse climate changes while an early warning system should be put in place to warn and advice pastoralists of climatic variations and the attendant disasters.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the Study

Livestock plays a critical role in the livelihood of the pastoralists who inhabit the arid and semi- arid lands (ASAL) areas of Kenya. The ASALs constitute 80% of the country's land mass and carry over 60% of the livestock resources (MOLD strategic plan 2008-2012). Despite the enormous livestock potential, development in these areas has lagged behind the rest of the country and is usually characterized by low productivity, poor infrastructure for marketing of livestock and delivery of services, chronic food and water shortage and widespread animal diseases (Strategy for revitalizing Agriculture (SRA), 2004).

Kajiado District is one of the ASAL districts of Kenya, with a population whose main economic activity is nomadic pastoralism. The district experiences erratic and unreliable rainfall that is interspersed with frequent droughts resulting in difficulties in accessing surface water for livestock and human consumption. The communities depend on ground water sources which include water pans, dams and shallow wells. In most parts of the district, the droughts are severe, resulting in complete loss of vegetation, death of livestock, frequent food shortages and high degree of poverty estimated at 51% (Republic of Kenya, 2001). Droughts frequently reach disaster levels due to climate variability/change that require the communities to spend many hours trekking in pursuit of pastures and water instead of concentrating on income generating activities. During these movements, vulnerable groups such as women, children and the old are left without food, which is mainly derived from livestock sales and products. The mass movement of livestock causes land degradation, massive erosion during floods, pasture scarcity and the attendant poor body condition and weakened immunity in the animals. During these periods, disease outbreaks are common

especially when animals congregate and are moved from areas of low to high disease challenge. Thus, substantial livestock and livestock production losses occur, further worsening food security.

Climate comprises many factors including temperature, rainfall, humidity, winds and altitude. These factors can have both direct and indirect effects on animal production and health (Adams et al., 1999; McCarthy et al., 2001). Climate can also affect the quantity and quality of feedstuffs such as pasture, forage and grain, and the severity and distribution of livestock diseases and parasites. Perry (2002), argued that animal diseases contribute to poverty globally particularly in the developing world and that Climate change / global warming might be associated with these diseases. Several studies (Cook, 1992; Harvell *et al.*, 1999); and Harvell *et al.*, 2002) have been conducted to investigate the effects of climate change / variability or global warming on the occurrence of animal diseases.

In pastoral communities, livestock is very critical as source of food and livelihoods and is considered important as a source of wealth (bank account), for cultural functions, for draught power, as an indicator of social status, and as source of raw materials. This study investigated hypothesized associations between livestock disease occurrence and climatic variability/change. The findings of the study would generate information and packages that can assist the pastoralists, extension systems, and policy makers to make informed decisions on disease management in ASAL areas. The knowledge generated could be replicated in other ASAL areas in empowering the pastoralists to better deal with livestock diseases.

1.2 Problem Statement

Kajiado District is semi-arid and experiences erratic and unreliable rainfall that is normally interspersed by long and frequent droughts. The inhabitants of the district are nomadic

pastoralists whose livelihoods depend on livestock production. They practice communal grazing systems. As a result of climatic variability, the district experiences severe droughts. When these droughts reach disaster levels, communities trek with their livestock to distant places in search of pastures and water. This movement of livestock usually coincides with high incidences of livestock diseases that result in losses in productivity and increased mortalities. Loss of dependable livelihood assets impoverishes the communities in Kajiado and exposes them to the vagaries of food insecurity.

1.3 Broad Objectives of the Study

The broad objective of this study was to establish whether climate variability has any influence on livestock health in Kajiado District.

1.3.1 Specific objectives:

- Determine the community knowledge, attitudes and practices in connection with diseases and climate change in Kajiado District;
- Estimate prevalence of key livestock diseases in the study area;
- Determine the trend of any climate changes in Kajiado District;
- To investigate associations between livestock disease occurrence and climatic variability; and
- To recommend appropriate disease management practices and policies to mitigate against livestock diseases associated with climate variability.

1.4 Hypotheses of the Study

Two null hypotheses were tested:

- Climate change does not influence the occurrence of livestock diseases in Kajiado District; and

- There were no climatic changes in Kajiado District.

1.5 Scope of the Study

This study was designed to create an understanding of the relationship between climatic Change/variability and livestock disease outbreak. Climatic variability leads at times to massive movement of animals to other areas in search of pasture and water. It involved characterization of climatic changes in Kajiado District over time, documentation of livestock disease prevalence across the seasons and losses in livestock productivity. The study was carried out in Enkaroni location in Central Division of Kajiado District.

Assumptions of the Study

This study was conducted under the following assumptions:-

1. The pastoralists would report their true experiences on the occurrences of drought and livestock diseases in the district over several years;
2. The weather elements in the five weather stations of Dagoretti Corner, Wilson Airport, Narok, Jomo Kenyatta International Airport (JKIA) and Magadi are similar to those in Enkaroni location;
3. Enkaroni location has the same physiographic characteristics with the five weather stations; and
4. The livestock diseases reported in Central Division are representative of those of Enkaroni location.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Overview of Infectious Diseases

The impact of infectious animal diseases seems as great at the start of the 21st Century as it was at the start of the 20th Century. In the developing world, these diseases continue to limit productivity, constrain development and exacerbate poverty through financial loss as well as being zoonotic (Perry, 2002). Governments spend colossal sums of money in the control of these diseases.

The global impact of infectious animal diseases is likely to be affected by many factors that cannot be predicted with confidence including, changes to livestock management practices, changes to the physical environment, developments in animal genetics, new scientific or technological advances, and influence from climate change. There is widespread scientific agreement that the world's climate is warming at a faster rate than ever before owing to anthropogenic activities (Intergovernmental Panel for Climate Change (IPCC), 2001), with concomitant changes in precipitation, flooding, winds and the frequency of extreme events such as *El Niño*. How we should react to predicted changes in animal diseases ascribed to climate change depends on the relative impact of the disease, whether the disease changes in incidence or spatiotemporal distribution, on the direction of change, on the animal populations and human communities affected.

There is need to focus on the possible effects of climate variability/change, by the 2020s and the 2080s, on the diseases that 'matter most', i.e. diseases that cause the greatest economic losses thus impacting most on the poor (Perry, 2002). Domestic livestock play a central role in many African cultures. Cattle and camels, in particular, have an importance that goes

beyond the production of meat in the ASALs. Their value is based on the full set of services they supply (milk, meat, blood, hides, draught power), their asset value as a form of savings, and their cultural symbolism. It would be difficult and damaging for these cultures to abandon pastoralism in the event that it becomes climatically, environmentally, or economically unviable.

2.2 Overview of Climate Change / Variability

Climate is the composite of all many varied, day-to-day weather conditions in a region over a considerable time. This time period should be ideally long enough to establish the entire relevant statistical infrastructure necessary to describe the variations in a regions' weather including absolute extremes, mean values and the frequency of departures from the mean. Climate depends on other components of the global climatic systems such as the ocean, the polar ice sheets, and land surfaces with their varied vegetations.

Climate Change refers to any significant change in measures of climate (such as temperature, precipitation, or wind) lasting for an extended period (decades or longer) or variation in the earth's global climate or in regional climates over time. It describes changes in the variability or average state of the atmosphere over time scales ranging from decades to millions of years. This may result from:

- Natural factors, such as changes in the sun's intensity or slow changes in the Earth's orbit around the sun (external forces to the earth) ;
- Natural processes within the climate system (e.g. changes in ocean circulation)- processes internal to the earth; and

- Human activities that change the atmosphere's composition (e.g. through burning fossil fuels) and the land surface (e.g. deforestation, reforestation, urbanization, desertification, etc.).

Climate variability is the manner in which climatic variables (such as temperature and precipitation) depart from some average state, either above or below the average value even between short periods. The term denotes deviations of climate statistics over a given period of time (such as specific month, season or year) from a longer period mean of the same variable. Climate variability is measured by the magnitude of anomalies of climate timescale variables from a long term mean.

Climate is an integral part of ecosystems and organisms have adapted to their regional climate over time. Climate change is a factor that has the potential to alter ecosystems and the many resources and services they provide to each other and to society. The change could benefit certain plant or insect species by increasing their ranges. The resulting impacts on ecosystems could be positive or negative depending on whether these species were invasive or were valuable.

Climate change disruptions are causing large losses to natural habitats and wildlife in developing countries. These disruptions create environmental refugees ("people fleeing from environmental crises, whether natural or anthropogenic events, and whether short or long term."). Reasons for displacement include land degradation, drought, deforestation, natural disasters, and other environmental changes that interact destructively with poverty and population pressure.

2.3 Climate and Animal Diseases

Many important animal diseases are affected directly or indirectly by weather and climate. These links may be *spatial*, with climate affecting distribution, *temporal* with weather affecting the timing of an outbreak, or related to the *intensity* of an outbreak. Many animal diseases of significant impact are influenced by climate. Vector-borne diseases, certain directly transmitted diseases, food/waterborne and aerosol-transmitted diseases are affected by climate variability or change. Non-vector-borne diseases affected by climate have the pathogen or parasite spending a period of time outside of the host, subject to environmental influence.

The following are examples of some diseases associated with climate:

2.3.1 Bacterial diseases

Anthrax is an infectious disease of warm-blooded animals, including humans, with worldwide distribution. Temperature, relative humidity and soil moisture all affect the successful germination of anthrax spores. Outbreaks are often associated with alternating heavy rainfall and drought, and high temperatures (Parker et al., 2002). Blackleg, an acute infectious clostridial disease mainly affecting young cattle, which is also spore-forming, is associated with high temperature and heavy rainfall (Hall, 1988). Certain bacterial infections such as dermatophilosis and haemorrhagic septicaemia (pasteurellosis) are associated with areas of high humidity and occur during rainy seasons (Hall, 1988).

2.3.2 Viral diseases

Foot-and-mouth disease is a highly contagious, viral infection with considerable economic importance to Africa. Transmission is mainly by contact between infected and susceptible animals, or contact with contaminated animal products or equipment. However, spread by

wind occurs since the virus survives well at relative humidity below 60% (Donaldson, 1972), which makes wind-borne spread favorable in humid, cold weather. In warmer drier regions, wind-borne spread of FMD is considered unimportant (Sutmoller et al, 2003).

Peste des Petits Ruminants (PPR) is an acute, contagious, viral disease of small ruminants, of great economic importance in parts of Africa. It is transmitted mostly by aerosol droplets between animals in close contact. Appearance of clinical PPR is often associated with the onset of the rainy season or dry cold periods (Wosu et al., 1992), a pattern that may be related to viral survival.

Rift Valley Fever (RVF) is a zoonotic viral disease transmitted by Aedes and Culex mosquitoes. Epizootics of RVF are associated with periods of heavy rainfall and flooding (Davies et al., 1985; Linthicum et al., 1987; Linthicum et al., 1999) or, in East Africa, with the combination of heavy rainfall following drought associated with *El Nino* Southern Oscillation (ENSO) (Linthicum et al, 1999; Anyamba et al, 2002).

Bluetongue, is a viral infection of ruminants transmitted by a vector (Culicoides biting midges) (Purse et al., 2005) whose distributions are largely dependent on environmental variables such as temperature, moisture and wind (Mellor et al., 2000).

2.3.3 Helminths

Haemonchosis, an infection with the nematode *Haemonchus contortus,* occurs worldwide. Infection is mainly through ingestion of eggs and larvae from the environment. Survival of the eggs and larvae depends on temperature and moisture, until they are ingested by another

animal. Under appropriate conditions of warmth and moderate humidity, the larvae can survive for weeks or months.

Diseases transmitted directly between animals in close contact have few reported associations with climate. Climate appears to be more frequently associated with the seasonal occurrence of non-vector borne animal diseases than their spatial distribution. By contrast, the associations of vector-borne diseases with climate are equally apparent in time and space - a reflection of the strong influence of climate on both the spatial and temporal distributions of the intermediate vectors.

Climate change can occur due to an increase in the atmospheric carbon dioxide leading to global warming because of the green house effect. Environmental scientists believe that global warming will lead to the melting of the polar ice caps. This will cause the rise in sea levels, submersion of islands and flooding of low delta countries. The Intergovernmental Panel on Climate Change (IPCC) projects an increase in global mean temperature of 2.0°c with a range of 1.0 to 3.5° c by the year 2100.

The African climate is diverse, ranging from snow-capped mountains to deserts. Major influences are the surrounding oceans and Mediterranean Sea, different types of land cover, lakes, and varied topography. The Intertropical Convergence Zone (ITCZ) primarily controls the rainy seasons. Mean annual rainfall ranges from 10 mm in parts of the Sahara Desert to >2,000 mm in the tropical regions and other parts of West Africa. Inter-annual variability in rainfall depends on sea surface temperatures (SST), atmospheric winds, *El-Nino* Southern Oscillation (ENSO), and regional climate fluctuations in the Indian and Atlantic Oceans.

Africa is generally warm, with mean daily temperatures >25°C with the exception of the extreme north and south, and areas of higher altitude which experience some cooler weather (mean daily temperature <20°C). Continent-wide changes in temperature and rainfall, for the period 2020-2080, have been modeled (Hulme *et al.*, 2001) based on low or high carbon-emission scenarios showing an increase of 0.6 – 2.4 °C or 1.2 - 7 °C, relative to the 1961-1990 baselines. Rainfall predictions indicate that Central Africa and Southern West Africa will become wetter in both the December-February (DJF) and June-August (JJA) seasons, while North and Southern Africa will be drier in both seasons. East Africa and the Sahelian West Africa will become wetter in DJF but drier in JJA. Some global climate models predict that ENSO will become more frequent as a result of climate change (Hulme *et al.*, 2001).

2.4 How Climate Change Affects Animal Diseases

Many processes have been proposed by which climate change might affect infectious diseases. These processes range from the clear and quantifiable to the imprecise and hypothetical. They may affect pathogens/parasites directly or indirectly, the hosts, the vectors (if there is an intermediate host), epidemiological dynamics or the natural environment. Only some of these processes can be expected to apply to any single infectious disease.

2.4.1 Effects on Pathogens

Higher temperatures resulting from climate change may increase the rate of development of certain pathogens or parasites that have one or more life cycle stages outside their animal host. This happens through shortened generation times and, increased number of generations per year (Harvell *et al.*, 2002). Conversely, some pathogens are sensitive to high temperatures and their survival may decrease with climate warming. Some pathogens/parasites and many vectors experience significant mortality during cold winter conditions (Wittmann and Baylis,

2000; Harvell *et al.*, 2002). Pathogens and parasites that are sensitive to moist or dry conditions may be affected by changes to precipitation, soil moisture and the frequency of floods. Changes to winds could affect the spread of certain pathogens and vectors.

2.4.2 Effects on Hosts

Mammalian cellular immunity can be suppressed following heightened exposure to ultraviolet B (UV-B) radiation - an expected outcome of stratospheric ozone depletion (Aucamp, 2003). There is depression of the immune response to intracellular pathogens (viruses, rickettsia such as *Cowdria* and *Anaplasma*, and some bacteria, such as *Brucella).* Many animals have evolved a level of genetic resistance to some of the diseases to which they are commonly exposed. Local breeds of Zebu cattle, show some degree of trypanotolerance whereas recently introduced European cattle breeds are highly susceptible. Certain tick-borne diseases of livestock, such as anaplasmosis, babesiosis and cowdriosis, show a degree of endemic stability (Eisler *et al.*, 2003). If climate change drives such diseases to new areas, non-immune individuals of all ages in these new regions will be exposed, and severe disease outbreaks could follow.

2.4.3 Effects on Vectors

Biting midges, brachyceran flies (e.g. tabanids, muscids, myiasis flies, hippoboscids), ticks and tsetse all dominate as vectors of livestock diseases. There are several processes by which climate change might affect disease vectors.

2.4.3.1 Vector distribution:

Temperature and moisture frequently impose limits on vector distribution. Changes to temperature and moisture will lead to increases or decreases in the abundance of many disease vectors (Kovats, 2000; Anyamba *et al.*, 2002).

2.4.3.2 Vector competence:

The ability of some insect vectors to become or remain infected with viruses varies with temperature. An increase in temperature may alter the balance between lifespan and the extrinsic incubation period (EIP), increasing or decreasing the proportion of infected vectors that live long enough to transmit the infection. The extrinsic incubation period (EIP) is the time period between a vector feeding on an infected host and being able to transmit the infection onward to a susceptible host. The EIP lengthens at lower temperatures. In colder areas, some short-lived vectors, such as mosquitoes and biting midges, tend to die before the EIP is complete and transmission does not occur (Reeves *et al.*, 1994).

2.4.3.3 Vector infectivity:

The feeding frequency of arthropod vectors increases with rises in temperature. Many vectors must feed twice on suitable hosts before transmission is possible - once to acquire the infection and, after the EIP, once to transmit it (Wittmann and Baylis, 2000).

2.4.3.4 Vector dispersal:

Change in wind patterns may be important in vector dispersal (Sellers and Maarouf, 1993).

Important properties in the transmission of vector-borne diseases include:

- Survival and reproduction rate of the vector;
- Time of year and level of vector activity, specifically the biting rate; and

• Rate of development and reproduction of the pathogen within the vector.

Vectors, pathogens, and hosts each survive and reproduce within certain optimal climatic conditions which can modify greatly properties of disease transmission. The most influential climatic factors for vector-borne diseases include temperature, precipitation and wind.

2.4.4 Effects on Epidemiology

Climate change may alter transmission rates between hosts by affecting the survival of the pathogen/parasite or the intermediate vector, but also by other, indirect, forces that may be hard to predict with accuracy. Climate change will lead to changes in future patterns of international trade, local animal transportation and farm size - all of which may affect the chances of an infected animal coming into contact with a susceptible one. For example, a series of droughts in East Africa between 1993 and 1997 resulted in pastoral communities moving their cattle to graze in areas normally reserved for wildlife. This resulted in cattle infected with a mild lineage of *Rinderpest* transmitting disease both to other cattle and to susceptible wildlife, causing severe disease, in buffalo, lesser kudu and impala (Kock *et al.*, 1999).

2.5 Other Indirect Effects

No disease or vector distribution can be fully understood in terms of climate only. The supply of suitable hosts, the effects of co-infection or immunological cross-protection, the presence of other insects competing for the same food sources or breeding sites as vectors (Davis *et al.*, 1998), and parasites and predators of vectors themselves, could have important effects (Harvell *et al.*, 2002). Climate change may affect the abundance or distribution of hosts or the competitors/predators/parasites of vectors and influence patterns of disease in ways that

cannot be predicted from the direct effects of climate variability/change alone. Climate change-related disturbances of ecological relationships, driven perhaps by agricultural changes, deforestation, the construction of dams and loss of biodiversity, could give rise to new mixtures of different species, thereby exposing hosts to novel pathogens and vectors and causing the emergence of new diseases (WHO, 1996).

The standard for linking disease change to climate change has been set- there must be change in both at the same time, in the same place, and in the 'right' direction (Rogers and Randolph, 2003). Recent outbreaks of bluetongue in Europe have now been linked to recent climate warming in Europe (Purse *et al.*, 2005).

2.6 Participatory Rural Appraisal (PRA) Methods as data gathering tools

Participatory rural appraisal (PRA) was developed in the past three decades or so, primarily as a tool to facilitate needs assessments of projects. It was closely associated with the concept of community participation where the local people were to be involved in identifying important issues and problems, suggesting solutions, generating an action plan, and subsequently implementing and monitoring development activities based on the action plan (Lelo at al., 1995; Chambers, 1997). As a development tool, it was developed out of the realization that use of conventional technologies to foster development in rural less developed set-ups, where a majority of the poor reside, was yielding poor results for several decades (Chambers, 1997). In research, it was realized that conventional methods produce a lot of data at high costs that was often unused, were inflexible and complex (Catley, 1999; Mariner and Roger, 2000).

The concept was initially widely used by social scientists (Chambers, 1997). Development professionals in the field such as human health, agriculture, education, water supply and natural resource management, soon adopted it to foster general development (Leyland, 1991). In the recent past, there has been increased focus to develop field-specific or appropriate PRA approaches, both for development and research; for instance, application of PRA methods in livestock development and research has been documented by Leyland (1991), Catley (1999), and Mariner and Roger (2000).

A wide range of PRA tools are in use by development workers and researchers as described by Leyland (1991), Lelo *et al.* (1995), Catley (1999), and Mariner and Roger (2000). They are classified into secondary sources; direct observation; interviewing techniques such as semi-structured interviews; visualization techniques such as maps, venn diagrams, flow diagrams, timelines, seasonal calendars and transect walks; and scoring methods such as simple ranking, pair-wise ranking, proportional piling and matrix scoring.

Before undertaking any PRA study, gathering already existing information from reports and literature (secondary sources) is paramount. Interviewing techniques involve use of an open, semi-structured checklist to guide a discussion. They are part and parcel of other methods and involve asking follow-up question to gain insightful information. In the process of data collection, use of probing questions is important in assessing the consistency of information given. To ensure validity and reliability of information collected, information from a set of informants and/or methodologies is triangulated with the aim of observing patterns, indicating either uniformity or disagreement.

Maps mark and give a rough idea of the spatial distribution of important resources in an area such as grazing areas, water resources, mountains, and seasonal movements, whereas timelines and seasonal calendars give a picture of temporal distribution of important resources in a location or illustrate variation in time of a given item of interest. Ranking and scoring methods provide a priority pattern of relative or importance of different items by attributing a specific score to each item.

Researchers and academicians have been more concerned about inappropriateness of publishing qualitative nature of information from PRA methods. However, ability of methods such as proportional piling, ranking and matrix scoring to produce numeral data that can be subjected to and summarized using simple statistical packages giving hope and relief to academicians and researchers (Catley, 1999).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Study area

The study was conducted in Enkaroni Location of Central Division of Kajiado District, Kenya, where pastoralism is the main livelihood activity (Figure 3.1). Semi-nomadic pastoralism is practiced on communally-owned land, which has been the traditional Maasai mode of life; however this lifestyle has undergone changes due to on-going land adjudication and sub-division of group ranches progressively leading to individual land tenure system.

The location was chosen due to its livestock population, nomadic pastoralism, climate changes and livestock disease outbreaks. Pastoralists from the location migrate frequently in search of water and pastures occasioned by climatic variations.

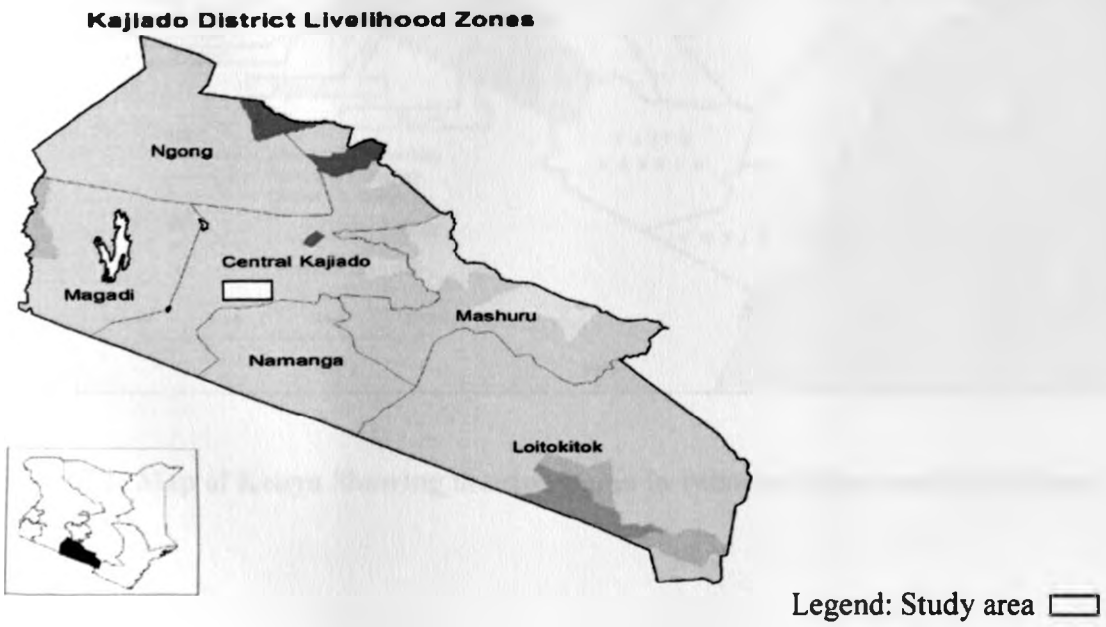

Figure 3.1 Map of Kenya showing Kajiado District and the location of the study area, 2008.

MAP OF KENYA INDICATING THE FIVE WEATHER STATIONS

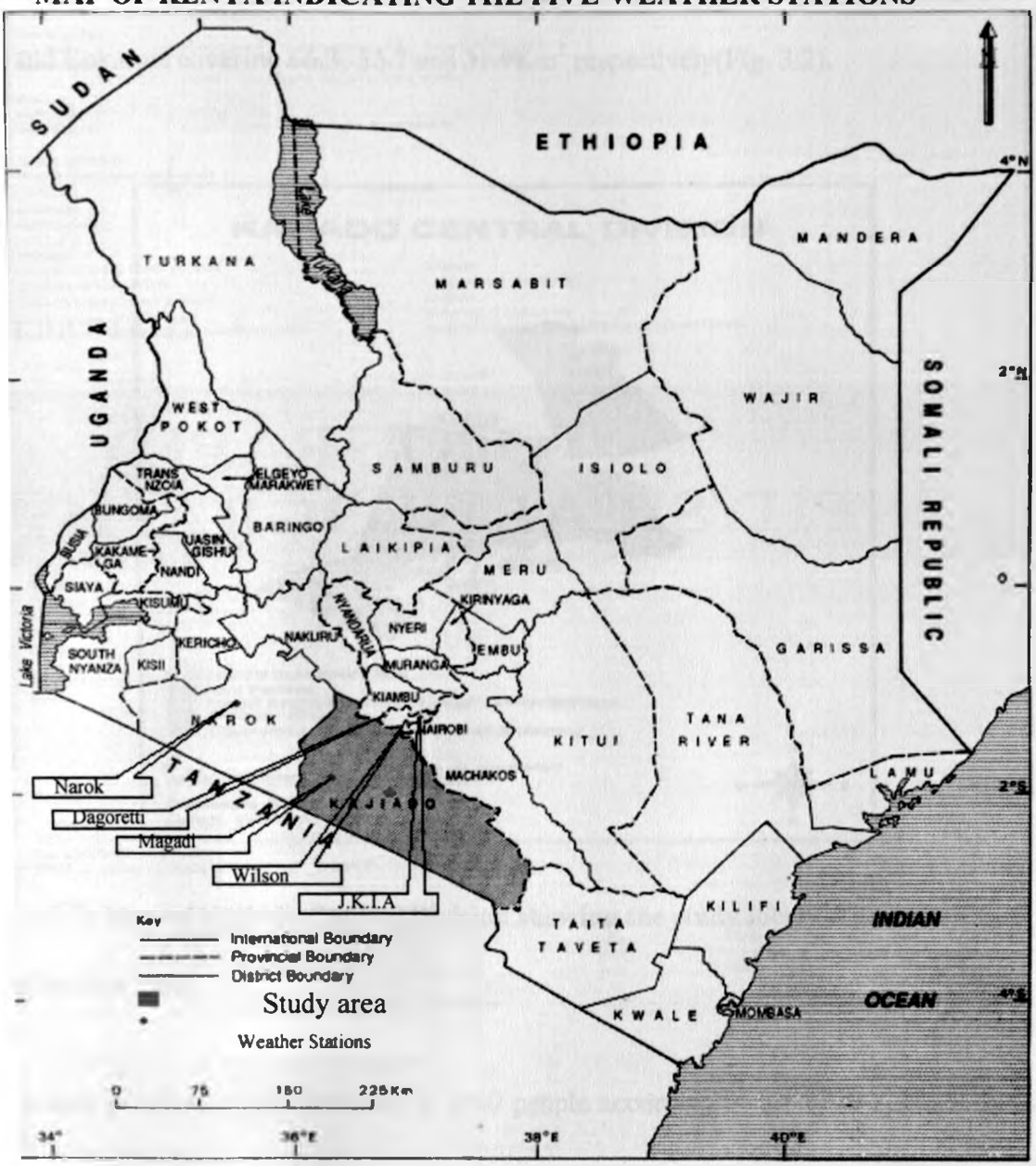

Figure 3.2: Map of Kenya Showing the study area in relation to the weather stations

The location covers an area of 153.9km^2 divided into three sub-locations namely, Nalepo, Isiait and Enkaroni covering 66.3, 55.7 and 31.9Km^2 respectively(Fig: 3.2).

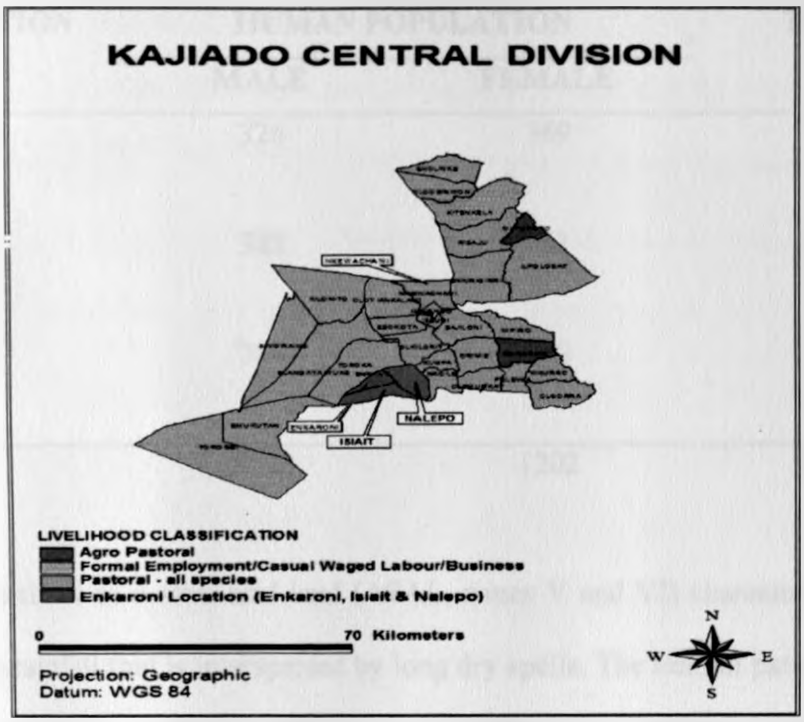

Figure 3.3: Map of Kajiado Central Division showing the study location and livelihood classification, 2008.

The human population was estimated at 2300 people according to the 1999 national census (Table 3.1) but is estimated to have risen to 3498 people by Central Bureau of Statistics, 2008 household listing (pre-census survey) carried out in August 2008. The population density is 22.7 persons per km^2 which is comparable with the district mean density of 23 persons per km^2 with annual growth rate of 4.51%. The average household size is 4.2 persons.

Table 3.1: The 1999 Human Population Census for Enkaroni Location. (Kajiado District Development Plan 2002-2008).

SUB-LOCATION	HUMAN POPULATION		TOTAL
	MALE	FEMALE	
ENKARONI	326	369	695
ISIAIT	388	461	849
NALEPO	384	372	756
TOTAL	1098	1202	**2300**

The area is classified as a semi arid land (ASAL, zones V and VI) characterized by erratic and inadequate rainfall that is interspersed by long dry spells. The rainfall pattern is bi-modal with an annual average of 300mm. The long rains fall between March and May while the short rains fall between October and December. The Inter-Tropical Convergence Zone (ITCZ) generally influences rainfall in the region, but local variations in topography also play a major role in its distribution (Brown and Cocheme, 1973).

Temperatures in the area also vary with both altitude and season. The highest temperatures of about 34°C are recorded around Lake Magadi which is to the west of the study area while the lowest minimum of 10°C is experienced at Loitokitok on the eastern part. The coolest period is between July and August while the hottest months are from November to April. (Kajiado District Development Plan, 2002-2008)

Topographically, Enkaroni location falls within the Central Hills of Kajiado which is to the South-Eastern edge of the Athi-Kapiti Plains, to the East of the Rift Valley and to the West of the Amboseli plains. It is an area of gently undulating plains with deep, reddish-brown clay loams and a variety of poorly drained vertisols. The Amboseli plains are an extension of the basement system in the Central Hills while the land falls away steeply to the east (Kajiado District Development Plan, 2002-2008). Numerous gneiss and limestone hills protrude from the slope rising to 2800 m. Soils are red, sandy and often shallow. The land is dissected and divided by water courses that drain into Kiboko River, a tributary of the Athi River.

The vegetation types in the central hills vary from deciduous bush lands to deciduous shrub land. The bushes consists mainly of the *Acacia melifera, Commiphora* and *Tarconanthus spp* shrubs while the trees are mainly *Acacia tortilis* and *Acacia xanthopholea*. The grasses in the area are mainly star grass and Maasai red oats.

The geological formation gives rise to minerals of economic importance such as gypsum. In addition, the area has other natural resources such as wildlife. However, there is encroachment in fragile areas such as water catchments, wetlands, conservation areas through quarrying and mining which have long term effects on grazing land. There is also increased loss of vegetation cover due to charcoal production which poses grave danger to the water catchment areas and exposes the fragile environment to rapid degradation.

The area does not have adequate surface water resources as there are few permanent natural sources of surface water for livestock and human consumption. The occurrence of the ground water in the area is mainly influenced by climate and topography. The other alternative source of water for domestic and livestock are sub-surface resources such as water pans,

dams and shallow wells and boreholes. Only 28% of households in Kajiado District have access to potable water supply and the average distance to the nearest source is 10 Km (Kajiado District Development Plan, 2002-2008).

The study area is poorly-connected to other locations through good road network, has very poor physical infrastructure that hinders effective transportation and communication. This has hindered organized livestock marketing and infrastructure. Only the main market is supplied with electricity, so that most energy needs of the population are met by exploitation of forests for firewood and charcoal.

The livestock population in Central Division is estimated at 69,456 cattle, 88859 goats, 83,628 sheep, 7,891donkeys, 852 camels, 16 pigs and 10,826 poultry (MoLD Central Division Veterinary Annual Report, 2008).

3.2 Data Collection

3.2.1 Community Mobilization

A multidisciplinary Stakeholders meeting was held in Kajiado District headquarters to explain the aim and objectives of the project while at the same time incorporating suggested improvements. The stakeholders included the University of Nairobi, Community based organizations (CBOs), Non-governmental organizations (NGOs), Provincial administrators, local leaders, churches, Ministries of Livestock Development, Water Development, Agriculture, farmers/pastoralists. Permission was sought from local leaders to conduct the research in the area.

Mobilization of the pastoralists to participate in the activities of the project was undertaken by the provincial administration in collaboration with community based organizations. The chief and his assistants held a *barasa* to introduce the researcher to community leaders in the location. The researcher explained to the community the purpose of the study and outlined the specific objectives that were to be persued. The leaders requested the community to cooperate with the researcher and give true information during interviews and the administration of questionnaires.

3.2.2 Primary Data

Data were collected through Participatory Rural Appraisal (PRA) and a semi-structured questionnaire. This took place between August 2008 and April 2009. The timings were such that in August and April most pastoralists were likely to be found within the location.

3.2.2.1 Participatory Rural Appraisal (PRA)

Pastoralists were invited through the local leaders to attend the PRA process that was conducted for four days at Enkaroni centre in a Church compound. Participants were divided into fourteen groups of 5-8 depending on the PRA tools being used. For each tool, participants went to separate points and discussed the task and presented the findings to the plenary where all participants made contributions.

Methods on participatory disease investigations by Catley and Mariner (2002), Catley, (2003) and Catley and Admassu (2003) were adopted. The methods were tested before use to assess their suitability, and appropriate adjustments made. To quantify the impact of different diseases and be able to compare different climate changes, proportional piling and matrix scoring were used.

Focused groups discussions were conducted to come up with a Daily activity calendar, seasonal calendar, matrix scoring, proportional piling, and comparison of the control measures of the various livestock diseases.

3.2.2.1.1 Livestock movement and Disease Mapping

Participants were asked to draw on the ground a map of the area, the areas to which they move their cattle in the dry and wet seasons, and any features they thought important including roads, rivers, villages and salting areas. They highlighted areas associated with disease, markets areas and stock routes, watering areas and areas most likely to mix with wildlife. One person was responsible for drawing the map with others commenting throughout. Another map showing livestock movement was also drawn in relation to pastures and water access. Participants were allowed to raise issues of interest and of importance to them.

A resource map was drawn and later transferred to an A4 piece of paper, scanned using HP scanner and saved as a Jpeg image. A Maasai homestead indicating the main features that included the cattle *Boma*, calf pens, sheep and goats' pen and sick bay was also drawn.

Participants were also asked to make a livelihood profile and an institutional analysis in which they indicated and weighed institutions operating in the location. The flow and access of resources such as pastures, water, charcoal, milk, meat, livestock and firewood were analysed as were the control and access of the resources at household level by different gender groups.

3.2.2.1.2 Disease rankings

Participants were asked to rank the five important diseases of livestock according to impact on their livelihood using pair-wise ranking. The major constraints to the community including livestock rearing within the area were also ranked. Problem analysis was used to prioritise problems, their causes and coping mechanisms and strategies being adopted by the pastoralists to deal with them.

3.2.2.1.3 Disease Incidence

A comparative approach of locally defined problem of animal diseases was adapted from Catley *et al.* (2002) and carried out at the PRA meetings. The five diseases named during priority scoring were used to estimate disease incidence taking into consideration difficulties in estimating disease incidence due to the reluctance of livestock owners to reveal the size of their herd (Cleaveland et al, 2001; Catley, 2003). Participants through proportional piling method were asked to divide 100 beans into 'sick livestock in the last year' and 'healthy livestock in the last year'. They were then asked to subdivide the pile of sick livestock to show the relative numbers of livestock suffering from each disease. Cattle were categorized into three categories: *ilasho* (calves up to about 1 year of age); *olarum* (calves between1-2 years old); and *ngishu* (adults more than 2 years old). Sheep and goats were categorized into *Ntare* (mature goats/ sheep) and *Ilkuo* (kids or lambs less than 6 months).

3.2.2.1.4 Seasonal Calender

The participants were asked to list various attributes such as rainfall, pastures, livestock diseases, pests, markets and food availability and relate them to the Maasai seasons. This exercise generated their seasonal calendar, diseases incidences according to seasons and

related causes. Additionally their daily activity calendar was also drawn showing the daily activities relating to their livelihood.

3.2.2.1.5 Trend lines

Trends of various attributes relating to livelihood within the Enkaroni location since 1970 were done. The trend lines included attributes such as population, food, water, livestock numbers, livestock diseases, rainfall/ drought, and pastures over the years. In addition, a historical profile indicating major historical events considered important was also done.

3.2.2.1.6 Matrix scoring

The five most-important diseases from the proportion piling exercise were placed along the x-axis and the various diseases symptoms and seasons on the y-axis, to form a matrix. During focus group discussions, the matrix was done on the ground using beans. Participants were then asked to relate each disease and symptom or seasons. A matrix on the control methods, effectiveness, costs, user friendliness and type of approach for each disease was considered and scored using a maximum score of ten beans. Benefits accruing from cattle which were considered important were also scored.

3.2.2.1.7 Key informant meetings

Key-informant meetings were arranged to gather more specific information on certain trends and issues. These involved the Divisional Veterinary Officer (DVO) for Central Division, the chief of the location and leaders from Enkaroni location. Interviews with organizations working in the district included Red Cross, Neighbors Initiative Alliance (NIA) and other Government officials' from Ministries of Agriculture, Water, and Social Services. They provided information on livestock diseases, climate (rainfall) data, food production and

availability, human populations, problems addressed in the location, water sources and location, livestock disease control infrastructure and markets that was used to triangulate information from the community.

3.2.2.1.8 Transect Walk

Transect walks were conducted in the location. The area was traversed from north eastern part to the south western part and from west to easterly parts. Observations on the condition of pastures, vegetation, water sources and availability, climate, land tenure, dips and other factors were made. During the transect walks semi structured interviews (SSI) were conducted to groups of pastoralists at water points along the transect line. The interviews aimed at finding out the problem pastoralists faced and their mechanisms for coping with them.

3.2.3 Households selection

The chief of the location compiled a list of households (stratified into sub-locations and *manyattas*) using a Central Bureau of statistics pre-census survey. A total of 674 households were listed. A household was the unit of study. However, in the Maasai cultural set up, people live in groups called *manyattas* that consists of 6-10 households of close relatives.

A systematic random sampling was used to select the households to be included in the survey. The first household was randomly selected between the first and fourth listed names and thereafter every fourth household was selected. A total of 177 households were selected. During a chief's baraza the area residents were informed of the planned survey and a guide selected. A maximum of three households per *manyatta* were selected. Semi-structured interviews were conducted on the selected households. In case the selected household

members were not available due to migration or any other reason, then any nearby household was selected for the interview.

3.2.4 Questionnaire survey

A questionnaire was developed and administered to capture information on seasonal trends (Maasai seasons and the normal seasons), climate changes or variability (rainfall, temperature patterns for the last 10years), and livestock losses caused by climatic variability and various livestock diseases.

The questionnaire consisted of both closed and open ended questions. A pretest of the questionnaire was done in a neighboring location called Torosei. This was to test the weaknesses of the questionnaire before being administered. Final modifications were then made and the questionnaire administered to the pastoralists via personal interviews with the assistance of enumerators who had been trained on aspects of data collection (Appendix I). The data collected included household structure, problems associated with drought and floods, the hazards pastoralism face, animal movements, animal diseases and management practices, livestock markets, water sources, coping mechanisms and environmental conservation strategies.

3.2.5 Secondary Data

An in-depth search and review of information and literature was conducted on climatic Variability/change trends, livestock diseases outbreak trends, livestock movement trends, demographic figures, livestock markets and water sources from 1997. The information search focused on the impact of climate variability and change leading to livestock disease outbreaks.

Long-term climate data (Temperature, humidity, rainfall and wind direction and pan evaporation) were obtained from the Kenya Meteorological Department headquarters based on three main meteorological stations managed by the Department at Wilson airport (Nairobi), Narok station and Dagoretti Corner (Nairobi). In addition data were collected from Magadi Company that manages a weather station under the supervision of the Meteorological department. Wilson airport, Narok station and the study area are in the same Agro-Ecological zone, Magadi is a drier zone and Dagoretti a wetter zone.

Livestock population figures were obtained from the Department of Livestock Production, the Department of Veterinary Services, and the Ministry of Livestock headquarters in Nairobi, Kenya. Records of incidences of livestock diseases in Central Division over a 10-year period were collected from the divisional veterinary office, while other crop production records were also sought from the Ministry of Agriculture. Other sources of data included the Ministry of Water, the Ministry of Environment, and NGOs within the locality.

3.3 Data Handling and Analysis

Data collected through PRA and by means of 177 Semi-Structured Questionnaires, climate data and livestock disease data obtained from the offices were organized, cleaned and entered into Microsoft Excel (Microsoft Version) and exported to SPSS programme for analysis. Descriptive statistics like means, frequencies, percentages, bar-charts, pie charts and graphs were used to present the results. Inferential statistics such as ANOVA, and t-tests were used in testing the study hypotheses. The significance differences were tested at 5% level of significance.

CHAPTER FOUR

4.0 RESULTS

4.1 Characteristics of the study area.

A Resource map of Enkaroni location indicated that there are three seasonal rivers in the area. There were several dams constructed in the area that had dried up as a result of drought (Fig 4.1).

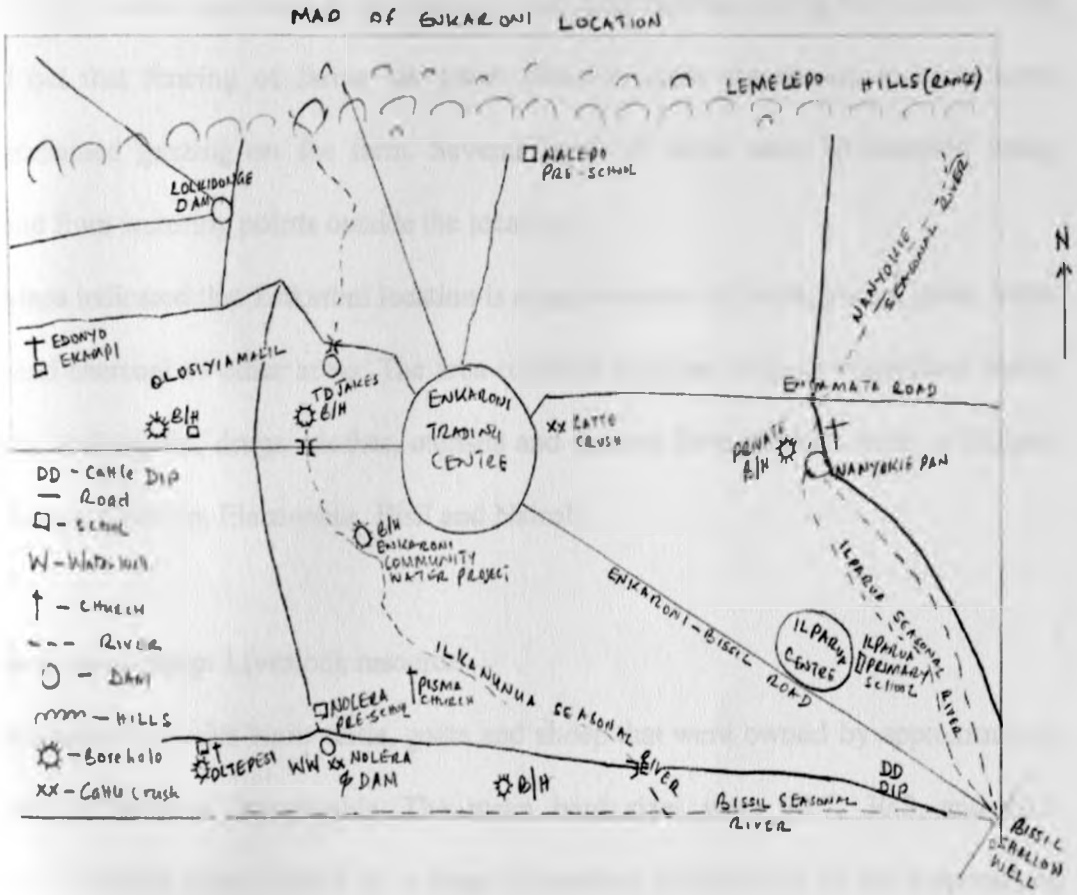

Figure 4.1: Resource map of Enkaroni Location, Kajiado District, 2008

There were no dry period grazing areas in the location. The area also had six bore holes and one shallow well that reportedly did not provide adequate water for human and livestock use. During the study the borehole next to Enkaroni market was under repair while the TD Jakes

one was in disuse due to unavailability of power for pumping. Consequently many families opted to ferry water on donkeys from boreholes and wells in the far-off Bissil area for calves, small stock and household use. There was a single cattle dip and one cattle crush in the location. The dip was not in use due to water shortage. No murramed road traversed the location except for earth roads. The land in most places had little tree or shrub cover with the scanty grass cover having dried leaving the ground bare. In those areas only few livestock, mainly sheep, goats and calves were seen around homesteads.

Most of the information provided in the resource map was verified during the transect walk that found out that fencing of farms had taken place in some places and in such farms livestock remained grazing on the farm. Several herds of cattle were encountered being driven to and from watering points outside the location.

Mobility Maps indicated that Enkaroni location is a major source of cattle, sheep, goats, hides and skins and charcoal to other areas. The area receives Supplies such as vegetables, maize flour, beans, cooking fat, drugs, clothes, utensils and cement from markets such as Kajiado town, Namanga, Kiserian, Elant-waus, Bisil and Nairobi.

4.2 Livestock ownership: Livestock resource

The major livestock species were cattle, goats and sheep that were owned by approximately 89% of the 177surveyed households. The mean herd sizes were 30.7, 30.3, and 30.1 respectively. Donkeys were owned by a large proportion 121(68.4%) of the respondents (Table 4.1). The types and numbers of livestock owned by interviewed respondents are shown in Table 4.1.

Table 4.1: Average Number of Livestock Owned by Respondents in Enkaroni location, Kajiado District, 2008

Number of Animals	Mean	Std. Dev	No of respondents
Cattle	30.68	34.33	158
Goats	30.27	32.75	158
Sheep	30.12	25.52	157
Camel	9.5	12.71	8
Poultry	07.12	04.34	17
Pigs	06.59	12.63	17
Donkeys	06.15	09.64	121
Rabbits	1.7	0.79	11

4.3 Reasons for keeping livestock:

The respondents ranked in order of importance the three most important reasons for keeping various species of livestock

4.3.1 Reasons for Keeping Cattle

Reasons for keeping the various types of livestock are shown in Table 4.2. The most important reasons why pastoralists in Kajiado District kept cattle are for live animal sale (67.1%) while the second most important reason for keeping cattle was as a source of meat for household consumption (69.6%). The third most important reason was given as prestige or sign of wealth (17.5%).

Pastoralists have resorted to keep livestock cattle rather than practice arable agriculture as observed during transect walks. The harsh climatic conditions in the area do not sustain any meaningful crop production. Frequent droughts experienced in the area cannot allow for crop

farming. The major livelihood in the area was found out to be pastoralism. The earnings realized as a result of sale of live cattle are used to purchase food, pay school fees and meet other household obligations.

4.3.2 Reasons for Keeping Sheep

The first most important reason as to why people of Kajiado kept sheep was for live animal sale. An estimated 68.8% of the respondents' kept sheep for this reason. The respondents' second most important reason for keeping sheep was for providing meat for the family (42.2%). The keeping of sheep for manure, prestige and wealth and for paying dowry was however rated lowly by the respondents as in Table 4.2.

4.3.3 Reasons for Keeping Goats

67.1% of the respondents keep goats first for sale of live animals with the second most important reason for keeping the goats being meat for human consumption at 60.4%. The third most important reason for keeping goats was given as prestige or wealth at 22.9% Table 4.2.

Table 4.2: Distribution of reasons for livestock ownership by species in Enkaroni location, Kajiado district, 2008

Reason for livestock ownership	*Species*	*Percent (%) responding:*		
		1st most important	2nd most important	3rd most important
For live sales	Cattle	67.1	23.9	26.3
	Sheep	68.8	23.3	2.5
	Goats	67.1	29.2	29.2
	Donkeys	6.6	34.8	80.0
	Camels	75.0	25.0	0
As source of meat/milk	Cattle	28.9	69.6	31.6
	Sheep	28.6	42.2	19.8
	Goats	28.0	60.4	41.7
	Donkeys			
	Camels	0	75.0	0
For manure	Cattle	0	4.3	8.8
	Sheep	0	0	4.9
	Goats	1.2	0	4.2
	Donkeys	0	26.1	20.0
Prestige / wealth status	Cattle	2.6	2.2	17.5
	Sheep	1.3	7.8	13.6
	Goats	2.4	8.3	22.9
	Donkeys	0	34.8	0
Bulls for service	Cattle	1.3	0	15.8
	Goats	1.2	2.1	2.1
Dowry payments	Sheep	1.3	1.1	7.4
Draught power	Donkeys	90.2	4.3	0

4.3.4 Reasons for Keeping Camels

Only a very small proportion of camels are kept in Kajiado. An estimated 75% of the respondents who keep camels, kept them for sale. The second most important reason for keeping camels was for meat for household consumption. However some respondents kept camels for milk for sale and for household consumption Table 4.2.

4.3.5 Reasons for Keeping Donkeys

Table 4.2 indicates that of those who own donkeys 90.2% kept them mainly for traction/transport while an average of 34% kept donkeys for sale while few believe they are for prestige or as a source of wealth. During the transect walks donkeys could be seen trekking carrying water from long distances. Women were the main keepers of the donkeys as they used them for ferrying water, firewood, and other family supplies.

The most important reason given was the live sale of animals at 67.1% and consumption of meat was ranked as the second most important reason for keeping livestock while 17.5% gave wealth/ prestige as the third most important reason. Live sales were important for all the species except in donkeys where traction (90.2%) was cited as the most important. Meat as a source of food for home consumption was reportedly the second most important reason for all species of animals except donkeys.

4.4 Trend lines:

4.4.1 Impact of Disease

Trends and changes of various parameters that were perceived to have changed between 1970 and 2007 in the location are shown in table 4.3. There were major decreases in the 37year period in the amount of rainfall received, pasture availability, livestock numbers per

household and food availability. There was a concomitant increase in the frequency of livestock diseases and drought occurrences. However, water availability increased during the period through the provision of more boreholes and wells but this was considered inadequate probably due to an increase in the human population (Table 4.3). Rainfall amounts were on the decrease and increasingly unpredictable. Drought frequencies were on the increase which probably caused decrease in pastures.

Table 4.3: Trends and changes of events in Enkaroni location, Kajiado district between 1970 and 2007

	1970-1980	1981-1990	1991-2000	2001-2007
Population	++	++++++	++++++++	+++++++++
Food availability	FFFFFFFFF	FFFFFFFF	FFFFFF	FFFF
Water availability	WW	WWW	WWWWW	WWWWWWWWW
Livestock numbers	LLLLLLLLLL	LLLLLLL	LLLLL	LLL
Livestock diseases	D	DDD	DDDDD	DDDDDDDDDD
Annual rainfall received	RRRRRRRRR	RRRRRRR	RRRR	RR
Drought occurrences	OO	OOOO	OOOOO	OOOOOOOOO
Pastures	PPPPPPPPP	PPPPPP	PPPP	PP

A historical profile of the location showed that the area experienced very devastating droughts accompanied by high livestock morbidity and mortality in the years 1974, 1981,

1990, 2000, 2004, and most recently in 2008. The droughts appeared to occur in cycles of 4 to 14 years. A characteristic feature of the drought was massive movement of the pastoralists and their livestock to far off areas such as Nairobi city, Mount Kenya and Tanzania, in search of water and pastures. Major livestock disease epidemics occurred during this period including foot and mouth disease (1970-80), East coast fever (1984) and blue tongue in sheep and goats in the year 2000(Table 4.4).

A number of development activities were initiated during the period under review. This included the construction of the *Esilanke* and *Enkaroni* dams in 1978 and 1984, respectively. Three boreholes (*TD Jakes*, *ole Tepesi*, *Oloosiyiamalil*) and a shallow well (*Noorela*) were dug in the year 2008. A group ranch was started between 1981-1990 which was subsequently subdivided and title deeds issued in 1992. Two primary schools were constructed in the location while Enkaroni market was recently (2008) supplied with electricity.

The social activities which occurred during the period include graduation of the *Iseuri* age group in 1970-1980 and that of the *Ilkitiop* age group 1981-1990 (Table 4.4).

Table 4.4: Historical events related by pastoralists of Enkaroni Location, Kajiado District

Year	Events
1970-1980	1st FMD vaccination
	Severe Drought, 1974
	High livestock deaths
	Graduation of *Iseuri* age group
	Esilanke dam constructed
	1977-1978 very good weather, ample pastures
1981-1990	Enkaroni Dam constructed
	Severe drought 1984
	Pastoralist migrated to Tanzania
	Death of livestock
	Graduation of *Ilkitoip* age group
	Severe ECF problems
	Enkaroni group ranch started
1991-2000	Severe drought 2000
	Migration to Tanzania
	Migration to Nairobi
	Endoingo pre-school started
	Ilparua Pre-school started
	Title deeds 1992
	Out break of sheep and goats blue tongue disease
2001-2008	Severe drought 2004
	Severe drought 2005/06
	Floods, Outbreak of bird flu in world
	T.D. Jakes drilled a borehole
	Ol tepesi bore hole drilled
	Shallow well at *Noolera*
	Oloosiyiamalil community borehole drilled
	Electricity line to *Enkaroni*
	2008/09 drought

4.5 Constraints to livelihoods

Analysis of the constraints to livelihoods in the location and their ranking revealed that water scarcity followed by food shortage, livestock diseases, human diseases and lastly low levels of education were considered major problems as indicated in Table 4.5. The Causes, coping mechanisms and strategies for each problem were given. Of major concern was water scarcity for both human and livestock use that was perceived to be caused by frequent droughts, destruction of water catchment areas, lack of permanent rivers or water sources and population pressure. Donkeys played a major role in easing the water problem by ferrying water from far off places. The prices of livestock during these drought periods were usually very low and the pastoralists had to dispose of them at throw away prices to cater for their food needs. Droughts were thus a severe cause of food insecurity and migration of livestock due to lack of pastures and water.

The occurrence of livestock diseases especially during movements in search of water and pastures was another problem identified by the pastoralists. The diseases caused great reduction in livestock productivity in addition to high mortalities. The pastoralists had sometimes to result to the use of herbal medicines in an attempt to cope with disease outbreaks.

Other problems identified included livestock-wildlife interactions that led to competition for pastures, predation of sheep and goats, and disease transmission. Charcoal burning was rampant with the resultant degradation and denudation of land and soil erosion. Roads and other infrastructure were poorly developed making access to markets difficult.

4.5.1 Problem analysis

Table 4.5 Problem analysis of pastoralists of Enkaroni Location, Kajiado District, 2008

Problem	*Causes*	*Coping mechanism*	*Strategies*
Water scarcity	• Prolonged drought • Destruction of water areas • Lack of permanent rivers/water sources • Population pressure of both human and animals • Forest destruction	Walk for long distances between 3-6 hours to fetch water Stay without water for two days Wake up very early as from 5 a.m. Keep many donkeys	Drilling of boreholes Protection of catchment areas Construction of earth dams Sharing of water between communities
Food shortage	Unreliable rainfall Prolonged drought Poor road network to markets Livestock deaths	Sale of goats at throw away prices Buy food Sleep hungry Migration in search of pasture, food and water Charcoal burning	Protect catchment areas Repair existing boreholes
Livestock diseases	Wildlife Floods Ticks Movements Flies Worms	Protect our livestock Move away from flooded areas	Fence grazing areas Spray animals using acaricides Deworm Use herbs
Human diseases	Contaminated waters Poor hygiene		
Low levels of education	Pastoral life style Culture	Keep children in boarding schools	Put up more schools Settle our people Demarcate land

4.6 Livestock diseases

4.6.1 Disease ranking

Diseases were ranked through pair-wise comparisons according to their economic impact and frequency of occurrence. The five cattle diseases in decreasing order of importance were East Coast Fever (ECF), Foot and Mouth disease (FMD), Lumpy Skin Disease (LSD), Blackquarter (BQ) and Anthrax (Table 4.6). This information was triangulated for all the species during the questionnaire administration to livestock owners.

Table 4.6: Pair-wise ranking of diseases of cattle Enkaroni Location, Kajiado District, 2008

	ECF	FMD	BQ	ANT	LSD	MCF	TRYP	ANA	CBPP	RIND	HEL	Score	Rank
ECF		ECF	ECF	ECF	ECF	ECF	ECF	ECF	ECF	ECF	ECF	10	1
FMD			FMD	FMD	FMD	FMD	FMD	FMD	FMD	FMD	FMD	9	2
BQ				BQ	LSD	BQ	BQ	BQ	BQ	BQ	BQ	7	4
ANT					LSD	ANT	ANT	ANT	ANT	ANT	ANT	6	5
LSD						LSD	LSD	LSD	LSD	LSD	LSD	8	3
MCF							MCF	ANA	MCF	MCF	MCF	4	7
TRYP								ANA	CBPP	TRYP	HEL	1	9
ANA									ANA	ANA	HEL	5	6
CBPP										CBPP	HEL	2	8
RIND											HEL	0	10

The rankings are based on the economic losses a disease causes to the pastoralist and frequency of occurrence.

KEY

ECF-East Coast fever	FMD-Foot and Mouth disease	LSD-Lumpy Skin Diseases	BQ-Black Quarter	ANT-Anthrax
CBPP – Contagious Bovine Pleura Pnemonia	MCF-Malignant Catarrhal Fever	TRYP-Trypanosomoses	ANA-Anaplasmosis	RIND-Rinderpest

4.6.2 Pair-wise ranking of livestock diseases of sheep/goat diseases

Similarly sheep and goat diseases were ranked as Contagious Caprine Pleuropneumonia (CCPP), Pox Virus, Enterotoxaemia, contagious ecthyma Orf virus, and foot rot (Table 4.7). The diseases were reportedly important in terms of losses in production as well as treatment cost.

Table 4.7: Pair-wise ranking of diseases of Sheep/ Goats Enkaroni Location, Kajiado District

	FMD	CCPP	BQ	ENT	HEL	POX	ORF	F/ROT	Score	Rank
FMD		CCPP	FMD	ENT	HEL	POX	ORF	ROT	1	7
CCPP			CCPP	CCPP	CCPP	CCPP	CCPP	CCPP	6	1
BQ				ENT	HEL	POX	ORF	ROT	0	8
ENT					ENT	POX	ENT	ROT	4	4
HEL						POX	ORF	ROT	2	6
POX							POX	ROT	5	3
ORF								ROT	3	5
ROT									6	1

Key:

ROT-Foot-rot	FMD-Foot and Mouth disease	POX-Sheep/goat pox	BQ-Black Quarter	ENT-Enterotoxaemia
CCPP– Contagious Caprine Pleura Pneumonia		HEL-Helminthiasis		ORF-Contagious ecthyma

4.6.3 Matrix scoring on disease indicator.

Matrix scoring on the five cattle diseases generated in the ranking exercises by their indicators is shown in table 4.8. Foot and mouth diseases was reportedly associated with lameness, a reduction in milk yield and salivation while ECF was associated with high mortality, enlarged lymph nodes, diarrhea, coughing and occurrence during the rainy season(Table 4.9). Anthrax was associated with high mortality and occurrence in the dry season. Lumpy Skin disease was scored highly on reduction in milk yield, appearance of skin swelling and lameness, while BQ was associated mostly with occurrence in the rainy season, reduced milk yield and presence of skin swellings.

Table 4.8: Matrix scoring for cattle diseases by their indicators in Enkaroni Location, Kajiado District, 2008

Indicator	*FMD*	*LSD*	*BQ*	*ECF*	*ANTHRAX*
Drought	4 (3-6)	-	-	6 (3-8)	5 (1-8)
Rainy	6 (5-8)	6 (4-8)	8 (6-9)	9 (6-10)	2 (1-4)
Coughing	3 (2-4)	1 (0-4)	3 (2-6)	8 (7-9)	-
Diarrhea	-	-	-	9 (7-10)	-
Causes deaths	2 (0-4)	5 (2-7)	6 (4-7)	9 (7-10)	7 (3-9)
Lameness	8 (5-10)	7 (3-9)	6 (3-8)	-	0 (0-3)
Reduced milk	7(5-10)	7(3-9)	7(0-10)	6 (3-8)	0 (0-3)
Loss of hair	0(0-5)	6 (3-8)	-	-	-
Enlarged l/nodes	-	5 (2-7)	1(0-4)	8(4-10)	0 (0-4)
Skin swellings	1 (0-7)	7(6-10)	7 (5-8)	2 (0-5)	-
salivations	8(7-10)	2(0-6)	-	8(6-9)	4(1-5)
Goes to shade	1(0-8)	4(0-10)	3(0-8)	9(8-10)	-

Key: The matrix score indicates the median score with numbers within parenthesis ( ) giving the range

The most important disease of sheep and goats was reportedly CCPP that was associated with coughing, high mortality and occurrence during the rainy season (Table 4.9). Sheep and goat pox occurred almost equally in both dry and wet seasons, while enterotoxaemia occurred more frequently during the wet season and were associated with diarrhea. Foot-rot reportedly occurred more in the wet season and was accompanied by lameness.

Table 4.9: Matrix scoring for sheep and Goat diseases by their indicators in Enkaroni Location, Kajiado District, 2008

	CCPP	SG POX	ENTEROTOXAEMIA	ORF	FOOT ROT
Drought	3(2-5)	3(1-8)	1(0-2)	1(0-2)	0(0-1)
Rainy	6(3-8)	4(3-8)	9(7-10)	6(4-8)	9(8-10)
Coughing	9(7-10)	0(0-4)	-	-	-
Diarrhea	5(3-7)	0(0-1)	6(5-7)	0(0-3)	0(0-1)
Causes death	7(5-10)	3(0-10)	1(0-3)	-	0(0-1)
Lameness	0(0-2)	0(0-3)	-	-	9(6-10)
Mouth swelling	-	3(2-8)	-	6(5-8)	0(0-3)
Skin lesions	0(0-4)	6(4-8)	0(0-2)	5(0-7)	1(0-4)
Tearing	5(0-8)	3(1-6)	1(0-2)	2(1-3)	0(0-1)
Salivation	3(0-4)	2(0-3)	5(3-6)	2(0-4)	0(0-1)
Loss of hair	4(0-8)	6(3-8)	1(0-3)	0(0-2)	0(0-4)

Key: The matrix score indicates the median score with numbers within parenthesis ( ) giving the range

4.6.4 Estimates of morbidity and mortality

The proportional pilings estimates of morbidity and mortality annual rates for the five cattle diseases ranked important from disease ranking is shown in Table 4.10.

Table 4.10 Proportional piling estimates of morbidity/mortality annual rates (%) of cattle diseases by age class in Enkaroni location, Kajiado district, 2008

Disease	*Annual % morbidity (mortality) by age class*			*Overall morbidity(mortality)*
	<1 year (Ilasho)	**1-2 years (Olaramu)**	**>2 years (Ngishu)**	
East coast Fever	21(12)	21(11)	26(10)	68(33)
Lumpy Skin Disease	10(3)	9(3)	14(4)	33(10)
Foot and Mouth Disease	15(3)	17(3)	20(2)	52(8)
Black-quarter	5(2)	7(3)	8(1)	20(6)
Anthrax	8(3)	8(2)	11(3)	27(8)

East coast fever had the highest (68%) morbidity rate of all the five diseases and appeared to affect the *Ngishu* age class more (26%) than the *Ilasho* (21%) and *Olaramu* (21%) age classes (Table 4.10). However, mortality was slightly more in the younger age classes. Foot and mouth disease had the second highest reported morbidity at 52% and affected slightly more of the *Olaramu* and the *Ngishu* (20%) than it did the *Ilasho* (15%). Mortality due to FMD appeared to be distributed equally among the three age classes (table 4.10). The overall morbidity rate of LSD was estimated at 33% and was slightly more in the older age class than in the younger ones. There appeared to be no differences in LSD mortalities across the age classes. An example of how proportional piling was conducted to estimate morbidity and mortality is shown in Figure 4.2 for ECF

Proportional piling for ECF*(oltikana)*

Terms: *Olaramu* is a Maasai word for a bovine whose age ranges 1-2 years. *Ilasho* refers to young stocks less than 1 year of age while *Ngishu* is a bovine over 2 years of age.

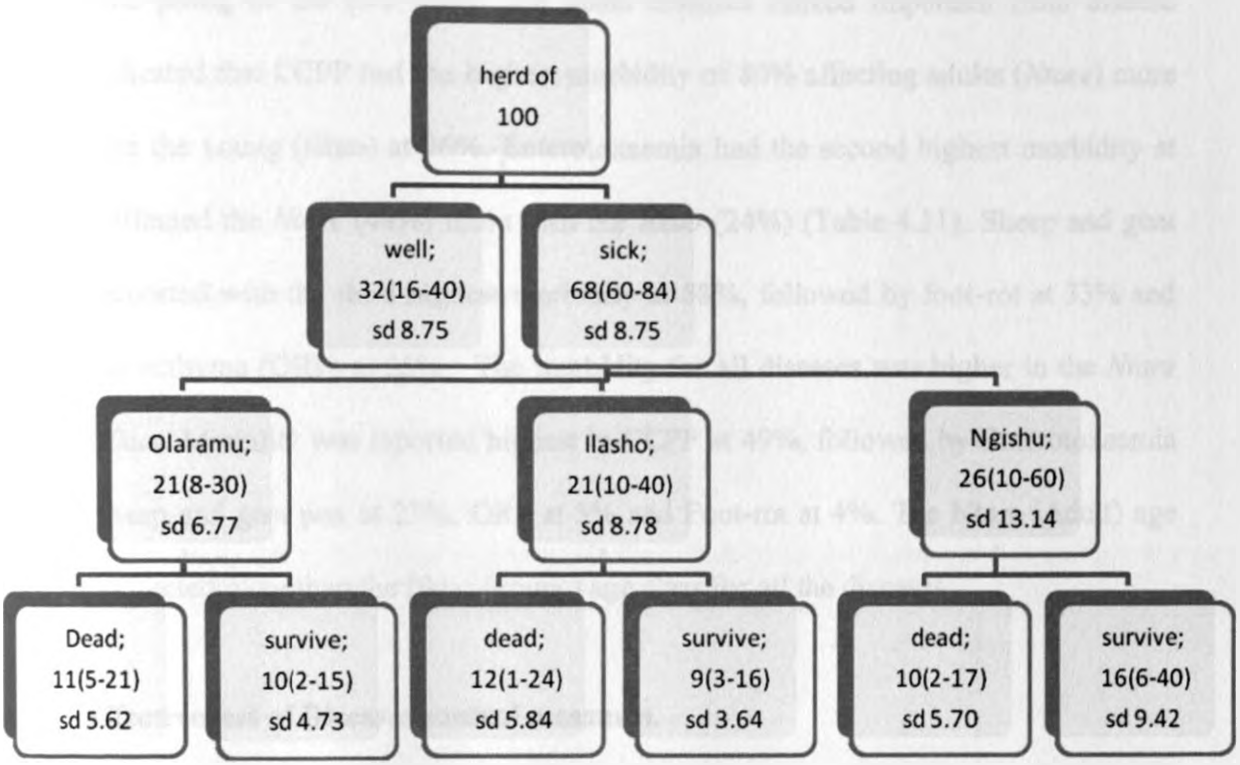

Figure 4.2: Proportional piling for ECF in Enkaroni Location, Kajiado District, 2008

Table 4.11 Proportional piling estimates of morbidity (mortality) annual rates (%) of sheep and goat diseases by age class in Enkaroni location, Kajiado district, 2008.

Disease	Annual % morbidity (mortality) by age class		Overall morbidity (mortality)
	<6 months (*Ilkuo*)	adults (*Ntare*)	
Contagious Caprine Pleuropneumonia (CCPP)	26(10)	54(39)	80(49)
Sheep and goat pox	20(7)	38(15)	58(23)
Enterotoxaemia	24(8)	44(24)	68(32)
Contagious ecthyma (ORF)	10(2)	15(3)	25(5)
Foot rot	11(1)	22(3)	33(4)

Proportional piling of the five sheep and goats diseases ranked important from disease ranking indicated that CCPP had the highest morbidity of 80% affecting adults (*Ntare*) more at 54% than the young (*ilkuo*) at 26%. Enterotoxaemia had the second highest morbidity at 68% and affected the *Ntare* (44%) more than the *Ilkuo* (24%) (Table 4.11). Sheep and goat pox was reported with the third highest morbidity at 58%, followed by foot-rot at 33% and Contagious ecthyma (ORF) at 25%. The morbidity for all diseases was higher in the *Ntare* than the *Ilkuo*. Mortality was reported highest in CCPP at 49%, followed by Enterotoxaemia at 32%, sheep and goat pox at 23%, ORF at 5% and Foot-rot at 4%. The Ntare (Adult) age class was affected more than the Ilkuo (young) age class for all the diseases

4.6.5 Effectiveness of Diseases control measures.

The perceptions by the pastoralists on the effectiveness of control measures of the five most important livestock diseases are given in tables 4.11 and 4.12 cattle and sheep/goats respectively. This information elicited the pastoral community knowledge, attitude and acceptability. The effectiveness for the control of ECF was considered equally for the three control methods of spraying, fencing and vaccination. However, vaccination was considered slightly expensive than spraying and fencing (Table 11). Individual approach was preferred for the control of ECF to group approach.

Isolation of sick animals and separation of livestock from wildlife were considered the most effective methods for the control of FMD. Treatment for FMD was perceived to be very expensive. The separation of livestock from wildlife required a group approach than an individual for effective control of the disease (Table 4.12). Of the two control methods for LSD vaccination of livestock was favored to spraying and a group approach was considered the best approach. Methods given for the control of BQ were Isolation, treatment and vaccination that were considered to be equally effective. Individual approach to BQ control

was the most favored. Of the three methods given for the control of Anthrax vaccination and quarantine were perceived to be more effective than treatment of sick animals. As for the other diseases an individual approach was favored over group approach to the control of Anthrax. The pastoralists considered the cost of the control methods to be high in all the method s except for isolation of sick animals and separation from wildlife.

Table 4.12: Perception of pastoralists on the Effectiveness of Cattle Diseases control measures in Enkaroni Location, Kajiado District, 2008

Disease	*Control methods*	*Effective-ness*	*Financial Cost*	*User friendly*	*Group approach*	*Individual approach*
ECF (oltikana)	Spraying	7(6-9)	7(5-9)	7(6-9)	4(2-5)	6(6-9)
	Fencing	6(4-9)	8(6-9)	6(5-8	4(1-6)	7(3-9)
	Vaccine	6(3-8)	9(7-10)	7(4-9)	4(1-8)	8(6-9)
FMD (Oloirobi)	vaccine	8(6-9)	7(5-9)	5(3-8)	8(6-9)	3(1-5)
	Isolation	6(3-7)	3(2-6)	5(1-8)	3(1-5)	5(2-7)
	Treatment	3(1-6)	8(5-10)	5(1-9)	3(1-6)	7(5-9)
	Separation from wildlife	6(3-7)	4(1-5)	3(1-5)	8(5-9)	3(1-5)
LSD (Erirri)	Spraying	6(3-7)	7(5-8)	3(1-6)	3(2-5)	4(2-7)
	Vaccine	8(6-9)	7(3-9)	2(1-5)	7(4-9)	3(2-7)
BQ (Empuruo)	vaccination	9(7-10)	7(5-8)	6(5-8)	6(2-8)	4(2-6)
	Isolate	7(5-8)	2(1-4)	7(2-9)	2(1-4)	8(6-10)
	Treatment	8(5-9)	8(6-10)	3(1-5)	2(1-4)	8(6-9)
Anthrax (Entemelua)	Vaccination	9(7-10)	9(8-10)	7(4-9)	2(1-6)	9(7-10)
	Treatment	6(5-7)	9(7-10)	6(4-8)	2(1-4)	8(6-9)
	Quarantine	8(6-9)	4(2-6)	6(5-8)	8(5-10)	6(3-8)

Numbers in brackets are ranges given by 14 groups

The methods given for the control of CCPP were vaccinations and quarantine whose effectiveness was considered to be equal. Vaccinations, quarantine restriction, spraying, deworming and cleanliness were all considered effective for the control of the various

diseases (Table 4.13). However the financial implications for the methods were perceived to be high with an exception of quarantine restrictions and hygienic standards in the pens. A rather surprising result was that a group approach to the control of most sheep/ goat diseases was favored to individual approach unlike was the case for the control of the cattle diseases (Table 4.13). Individual approach was preferred for Foot-rot and enterotoxaemia.

Table 4.13: Effectiveness of Sheep and Goat Diseases control measures in Enkaroni Location, Kajiado District

Disease	*Control methods*	*Effectiveness*	*Financial (cost)*	*User friendly*	*Group approach*	*Individual approach*
CCPP (Olkipei)	Vaccinations	8(7-9)	9(6-10)	8(5-10)	8(5-9)	2(1-5)
	Quarantine	7(5-9)	7(5-9)	8(6-10)	7(5-9)	3(1-6)
S/G pox (Eirri)	Spray	6(4-7)	8(5-9)	6(4-7)	7(4-9)	3(2-6)
	Quarantine	7(5-9)	2(1-5)	6(3-9)	8(6-10)	3(1-5)
Enterotoxaemia (Olbus)	Deworming	6(2-8)	7(5-9)	7(5-9)	4(2-5)	7(5-8)
	Vaccinations	7(5-8)	9(7-10)	7(5-9)	7(4-9)	4(2-8)
Foot rot (Elelei)	Clean pens	9(6-10)	3(1-6)	9(7-10)	2(1-3)	9(7-10)
	Treatment	8(6-9)	7(5-9)	7(5-8)	3(1-6)	8(6-9)

Numbers in brackets are ranges given by 14 groups

4.7 Livestock: Wildlife interface

The interaction of livestock and wildlife was also sought through the administration of questionnaires to 177 households. The frequency of contact between livestock and wildlife appeared to be minimal in the rainy months of April- May but appeared to reach a peak during the dry seasons of August through to November. Figure 4.3.

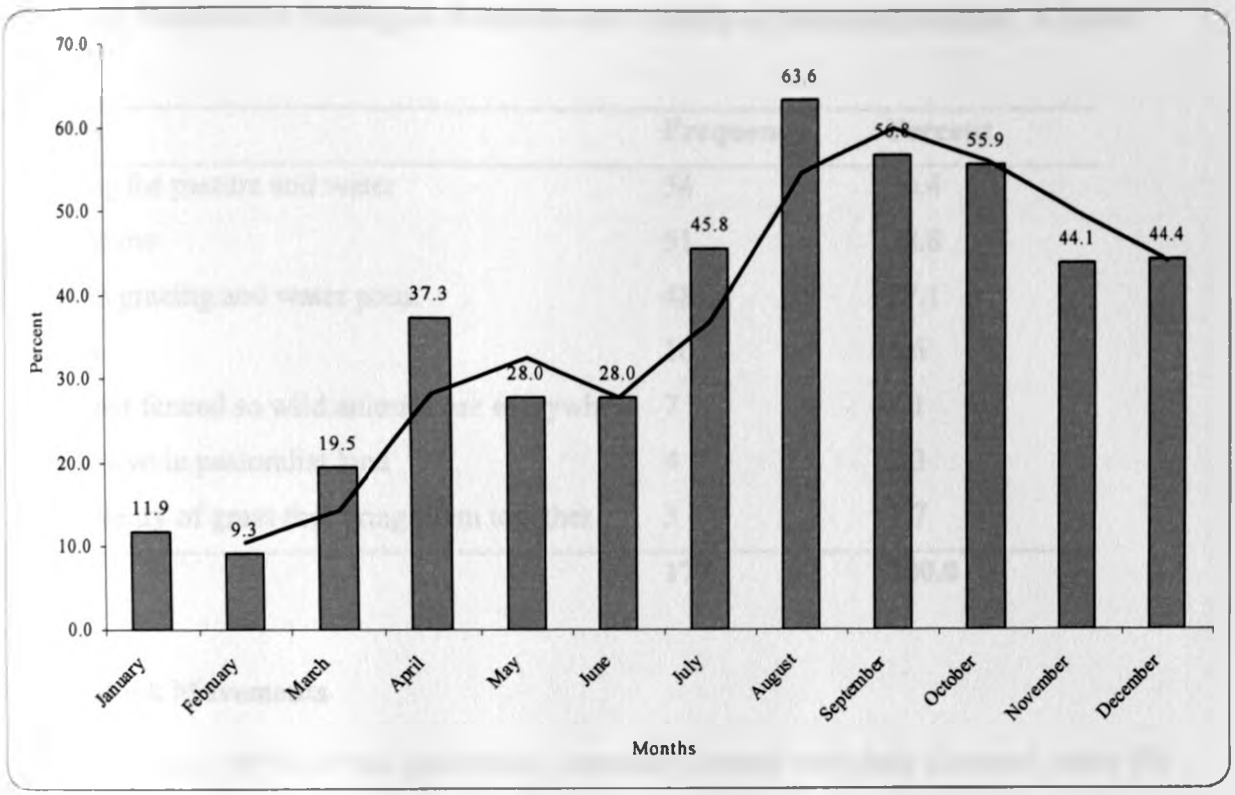

Figure 4.3: Monthly distribution of responses indicating livestock: wildlife interaction in Enkaroni location, Kajiado District

When pastoralists move their livestock in search of water and pasture there is a lot of mixing with wildlife. In periods of very severe drought the pastoralists move their livestock to dry season grazing areas which are in the national parks or out of the location to far places that includes Mt Kilimanjaro, Nairobi national park, Amboseli national park, Mt Kenya and Kiambu disrtict. According to the respondents, they encountered problems with the mixing which included spread of diseases, death of livestock, depletion of water and pasture and predation (Table 4.14).

Table 4.14: Reasons for mixing of livestock and wildlife in Enkaroni location, Kajiado District

Reasons	Frequency	Percent
Searching for pasture and water	54	30.4
Do not know	51	28.8
Common grazing and water point	48	27.1
Drought	10	5.6
Area is not fenced so wild animals are everywhere	7	4.1
Wildlife live in pastoralist land	4	2.3
Due to plenty of grass that bring them together	3	1.7
Total	**177**	**100.0**

4.8 Livestock Movements

The vast majority (97%) of the pastoralists reportedly moved with their livestock while 3% were sedentary. Reasons advanced for the movement included search for water and pasture in periods of drought (99.4%). Other minor reasons given were during disease outbreaks, security and cultural reasons. The mean distances covered during movement was an average of 11.6 kilometres with a range extending to over 100Km.

4.9 Disease occurrences

The proportion of the 177 herds sampled that experienced cases of cattle diseases from 1999-2008 are shown in Table 4.15. The diseases which affected the majority of the cattle herds were ECF (78.5%), FMD (77.4%), Anthrax (61.0%), and skin Diseases (28.8%). Sheep herds were mainly affected by FMD (69.5%), Enterotoxaemia (52.5%) and Theileriosis (43.5%) Table 4.16. Figure 4.4 shows that goats were affected mostly by CCPP (77.4%), and FMD (37.9).

Table 4.15: Occurrence of Cattle Diseases in 177 herds in Enkaroni Location, Kajiado District, 1999-2008

Disease	Proportion (%)herds affected
East Coast Fever	78.5
Foot and mouth	77.4
Anthrax	61.0
Skin diseases	28.8
Trypanosomoses	19.7
Black quarter	13.6
Lumpy Skin Disease	10.7
Mastitis	8.5
Anaplasmosis	0.6
CBPP	0.6

Table 4.16: Occurrence of Sheep Diseases in 177 herds in Enkaroni Location, Kajiado District, 1999-2008

Disease	Proportion (%)herds affected
Foot and mouth	69.5%
Enterotoxaemia	52.5%
Theileriosis	43.5%
Trypanosomoses	9.0%
Sheep pox	4.5%
Anthrax	4.5%
Diarrhoea	2.3%
CCPP	1.1%

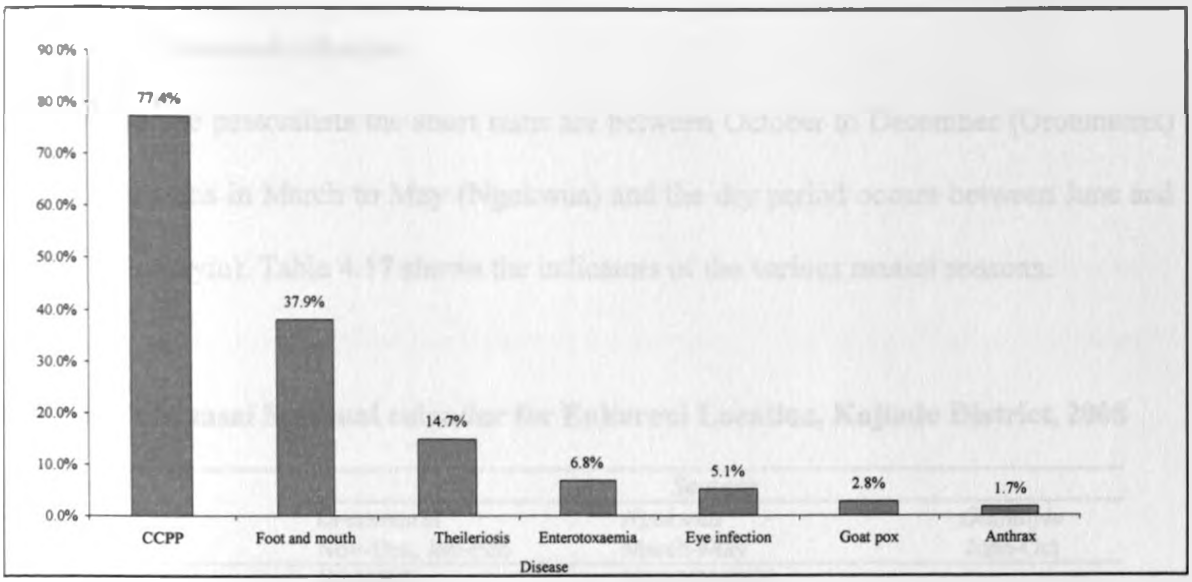

Figure 4.4 Percentage of herds which experienced goat diseases in Enkaroni Location, Kajiado District, 1999-2008

4.10 Livestock Losses

Of the 177 respondents interviewed 98.7 % reportedly lost livestock in 2008 due to drought, while 78.9 % lost their livestock due to diseases and 8.2% due to thefts. The other possible causes of livestock losses were reported by only 2% of the respondents. During transect walks carcasses of animals were observed as represented in the photograph in plate 4.1

Plate 4.1: Loses due to drought in Enkaroni location, Kajiado district, 2008

4.11. Maasai Seasonal calendar

According to the pastoralists the short rains are between October to December (Orotumuret) and the long rains in March to May (Ngokwua) and the dry period occurs between June and October (Olamayiu). Table 4.17 shows the indicators of the various maasai seasons.

Table 4.17: Maasai Seasonal calendar for Enkaroni Location, Kajiado District, 2008

Indicators	*Seasons*		
	Orotumuret Nov-Dec, Jan-Feb	*Ngokwua* March-May	*Olamayiu* June-Oct
Rainfall	XXXXX	XXXXXXXX	
Pastures	XXXXX	XXXXXXXX	XXX
Water availability	XXXXX	XXXXXXXX	XX
Livestock diseases			
ECF	XX	XXXXXXXX	XXXXX
Anthrax	XXXXXXX		XX
LSD	XXXXXXX		
Helminthiasis	XXXXXXX		
FMD	XXXXXX	XX	XXXXXXXX
MCF/wildlife	XXX		
Pests (ticks)	XXXX	XXXXXXX	XXXXX
Vaccinations(FMD)	XXXXX	XXX	XX
Food availability	XXXXX	XXXXXXX	
Livestock Market prices	XXXX	XXXXXXX	XX

According to the calendar ECF is associated with the *Ngokwua* season while Anthrax, LSD and Helminthiasis were strongly associated with *Orotumoret* season. FMD was more associated with *Olomayiu* season.

4.12 Mobility/Disease Mapping

4.12.1 Periods When Animal Diseases Occur Most

Kajiado district has two main seasons; the seasons are identified by the residents as wet season and dry season. The rainy season starts in March and end in June while the dry season starts in July and end in October when there is a short rains period from October to December when again the dry period starts in December ending in February.

4.12.2 Livestock diseases season of occurrence

Disease associations with seasons according to the pastoralists are listed in table 4.18. The diseases mostly associated with the wet season were LSD, Blackquarter, Anthrax and FMD. Trypanosomoses, CBPP, Anaplasmosis and ECF were associated with the dry seasons. However, FMD and ECF were at a lesser extent associated with both the wet and dry seasons. Rinderpest was last reported in 1996 as reported by the key informants and was associated with the wet season.

Table 4.18: perceived seasonal occurrence of Cattle diseases in Enkaroni location, Kajiado District, 2008

Diseases	Wet Season	Dry Season	Both Wet & Dry Season
LSD	63.2%	10.5%	26.3%
Black quarter	47.6%	33.3%	19.0%
Anthrax	46.4%	36.9%	16.7%
Foot and mouth	44.3%	23.6%	32.1%
ECF	25.0%	44.4%	30.6%
Trypanosomoses	35.3%	64.7%	-
Rinderpest	57.1%	14.3%	28.6%
Anaplasmosis	-	100.0%	-
CBPP	-	100.0%	-
Mastitis	40.0%	20.0%	40.0%

Note- the dash(-) indicate no response was given

Tables 4.19 and 4.20 shows the perceived seasonal occurrence of sheep and goat diseases respectively. The perceived occurrence of sheep diseases indicate that enterotoxaemia, diarrhoea, sheep pox and FMD occur more in the wet season (Table 4.21). FMD, goat pox and enterotoxaemia were 100% associated with the wet season while CCPP occurred in both the wet and the dry season (Table 4.22)

Table 4.19: Sheep diseases and season the diseases occur in Enkaroni location, Kajiado District, 2008

Diseases	Wet Season	Dry Season	Both Wet & Dry Season
Enterotoxaemia	76.6%	16.9%	6.5%
Diarrhoea	66.7%	33.3%	-
Sheep pox	100.0%	-	-
Foot and mouth	43.2%	21.1%	35.8%
CCPP	50.0%	50.0%	-
Theleriosis	35.7%	40.0%	24.3%
Trypanosomoses	33.3%	33.3%	33.3%
Anthrax	66.7%	33.3%	-

Note: the – indicates that no response was given.

Table 4.20: Goat diseases and season the diseases occur in Enkaroni location, Kajiado District, 2008

Diseases	Wet Season	Dry Season	Both Wet & Dry Season
CCPP	11.8%	38.2%	50.0%
FMD	100.0%	-	-
Goat pox	100.0%	-	-
Enterotoxaemia	100.0%	-	-
Eye infection	55.6%	22.2%	22.2%
Theileriosis	16.0%	32.0%	52.0%
Anthrax	-	66.7%	33.3%
Fleas	-	100.0%	-

4.13 Coping strategy

4.13.1 Management of Livestock Diseases

The disease management strategies reported by the 177 respondents are displayed in Tables 4.21. The most commonly used strategy was treatment of the animals by the pastoralists themselves (61.9%). Surprisingly only a small proportion (8.7%) reported they could consult a veterinarian. Consultation of herbalists was also a common practice (17.3%) Table 4.21. Similarly management of sheep and goat diseases were done by the pastoralists themselves through treatments and consultation of herbalists. It was observed during the transect walk and key informant interviews that there was only one animal health assistant covering the entire Central Division. The officer does not have means of transport to serve far away areas from the divisional headquarters.

Table 4.21: Disease management strategies for cattle diseases in Enkaroni location, Kajiado District, 2008

Disease	Disease management Strategy (%)			
	Self Treatment	**Vaccination**	**Treated by Vet**	**Treated by Herbalist**
ECF	75	25	-	-
FMD	81.2	-	-	18.8
LSD	-	84.2	-	15.8
Blackquarter	100	-	-	-
Trypanosomoses	66.7	-	33.3	-
Anthrax	100	-	-	-
CBPP	33.3	-	33.3	33.3
Mastitis	50	-	12.5	37.5
Average	**61.9**	**12.13**	**8.7**	**17.26**

Other coping mechanisms include livestock movement restriction, Migration from areas of high disease risk and herd health management practices.

4.14 Mitigation measures

4.14.1 Drought

The most significant response during drought was Migration (85.9 %) in search of water and pastures. Selling of livestock to reduce their numbers was reported by 35.9% of the respondents. The purchase of hay and slaughter of livestock was reported by 14.1% and 17.6% of the respondents respectively.

4.14.2 Water conservation Measures

Among the most common water conservation measures in Enkaroni locations are dams and bore holes which was reported by 90% and 89.4% of the respondents respectively. Other mitigation measures used to conserve water include water pans, subsurface dams, rock catchments, rivers and roof catchments (Table 4.22).

Table 4.22: Water conservancy measures in Enkaroni location, Kajiado District, 2008

Water conservation Measures	Count	Percent of Responses	Percent of Respondents
Dams	152	27.0	89.4
Water holes	38	6.7	22.4
Bore holes	153	27.1	90.0
Water pans	68	12.1	40.0
Rock catchments	26	4.6	15.3
Subsurface dams	29	5.1	17.1
Rivers	38	6.7	22.4
Roof catchments	60	10.6	35.3
Total responses	564	100.0	

4.14.3 Marketing (Livestock sales)

A high proportion (64%) of the respondents reportedly sold their livestock for money to meet food needs (99.4%), payment of school fees (96.3%) and to meet other family obligations (68.8%). The main livestock markets were Bissil, Kiserian and Mile 46 which neighbor the location.

4.15 Availability or shortage of Water and Pasture (Drought)

The years between 1998 to 2008 when drought and the accompanied water shortage were experienced in Enkaroni Location of Kajiado district were given as 2000, 2004, and 2005 by the 177 respondents interviewed (Table 4.23). The year that was reportedly very wet was 1998.

Table 4.23: Years of drought /water shortage and years of plenty of water/pastures in Enkaroni location, Kajiado District

Years of Drought& water shortage			Years of plenty of water & pastures	
Year	**Count**	**Percentage of responses**	**count**	**%age responses**
1998	57	6.2	20	32.3
1999	39	4.3	11	17.7
2000	136	14.8	3	4.8
2001	50	5.5	4	6.5
2002	83	9.1	8	12.9
2003	55	6.0	4	6.5
2004	153	16.7	2	3.2
2005	120	13.1	-	-
2006	78	8.5	6	9.7
2007	73	8.0	4	6.5
2008	35	3.8	-	-
Total responses	**916**	**100.0**	**62**	**100.0**

4.16 Association between Climate elements and livestock disease

4.16.1 Association between rainfall and occurrence of diseases

A correlation analysis of changes in rainfall (mm) and crude morbidity showed a significant ($p<0.05$) positive correlation ($r= 0.47$) between rainfall and reported cases of diseases between year 2001 and 2008 (Figure 4.5). There was an increase in disease reported immediately following heavy rains and a reduction following low rainfall.

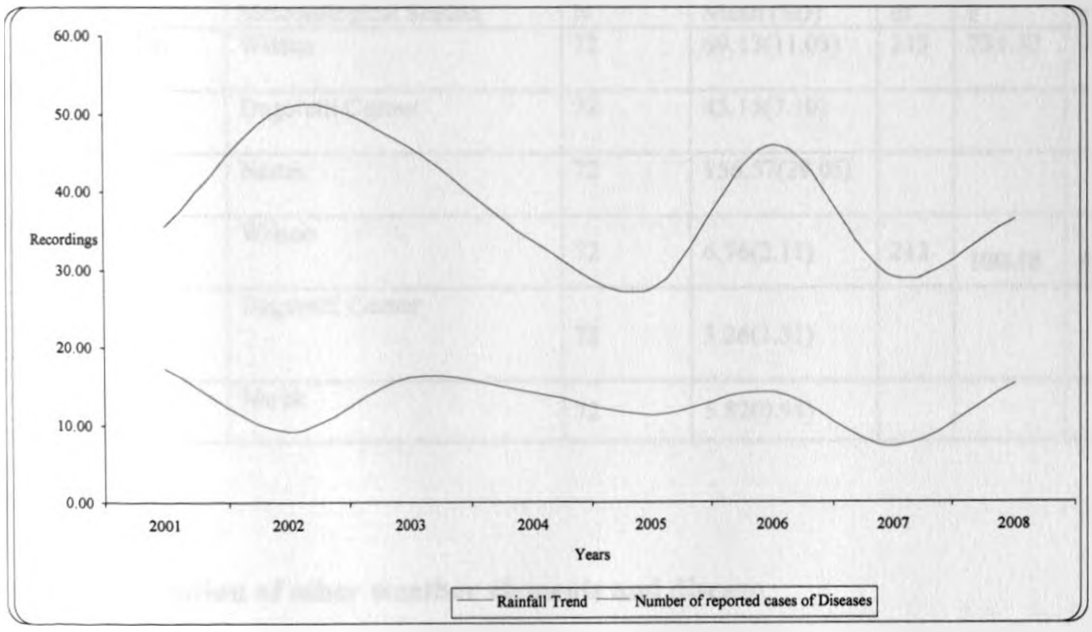

Figure 4.5: Relationship between Total Number of Reported Cases (00) and Rainfall Variability (mm)

4.16.2 Influence of wind direction and speed on diseases

Analysis of the wind data from Wilson , Dagoretti and Narok weather stations showed that wind speed was significantly ($p<0.05$) higher at Wilson (6.76 knots) compared to Narok (5.82 knots) and Dagoretti Corner (3.26 knots) for the period 2001-2008 (Table 4.24). However, changes in wind direction for the same period were highest in Narok (156.7 degrees) compared to Wilson (69.13 degrees) and Dagoretti stations (45.15). One way analysis of ANOVA between the crude morbidity data collected for the years 2001-2008 showed a

significant ($p<0.05$, $F= 731.32$) association between the direction of wind and disease occurrence. In addition wind speed was significantly ($p<0.05$, $F=100.18$) associated with disease occurrence

Table 4.24: Wind direction and speed Monthly Measurements in various weather stations around Kajiado District.

Elements	Meteorological Station	N	Mean (SD)	df	F	p-value
Wind direction	Wilson	72	69.13(11.03)	213	731.32	0.000
	Dagoretti Corner	72	45.15(7.10)			
	Narok	72	156.57(29.05)			
Wind speed	Wilson	72	6.76(2.11)	213	100.18	0.000
	Dagoretti Corner	72	3.26(1.31)			
	Narok	72	5.82(0.94)			

4.16.3 Association of other weather elements and disease

The relationship between individual disease cases and the various weather elements were also examined. Most of the diseases were strongly influenced by the weather elements examined in Table 4.25.

The table shows the relationship between number of cases of each individual disease and the various weather elements. For example Helminthiasis has significant and positive relationship with temperature ($r=0.486$, p0.05), humidity ($r=0.415$, $p<0.01$) and rainfall 0.579, $p>0.01$). Other diseases showed a negative correlation between weather elements and the disease, for example red water was negatively correlated with rainfall ($r = -.67$, $p< 0.05$) Since most of the diseases have shown significant relationship with most of the whether elements the study concludes that climatic variability had significant effect on the occurrence of livestock diseases in Kajiado District.

Table 4.25: Correlation Matrix between Weather Elements and Reported Cases for Individual Livestock Diseases between 2001 and 2008.

Diseases/ Conditions	Dry Bulb Temp.	Humidity	Rainfall	Wet Bulb Temp.
Helminthiasis	-.143	.415(*)	.579(**)	.486(*)
ECF	.529(**)	-.063	-.022	.126
Anaplasmosis	-.134	-.161	.628(**)	-.496(*)
Pneumonia	.021	-.405(*)	-.456(*)	-.507(*)
Milk fever	-.507(*)	-.117	-.190	-.039
Eye infection	.671(**)	-.657(**)	-.469(*)	-.332
Heartwater	.329	-.223	-.607(**)	.077
Mastitis	.602(**)	-.477(*)	-.087	-.235
Redwater	.286	-.631(**)	-.672(**)	-.517(**)
Enteritis	-.117	-.601(**)	-.024	-.629(**)
Bloat	-.198	.707(**)	.341	.343
Downer cow syndrome	.114	-.177	.525(**)	.357
FMD	.324	.448(*)	-.525(**)	.180

** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed).

4.17 Climate Change

Analysis of the weather elements was done to determine the trends of any climate change.

4.17.1 Comparison of weather elements between weather stations

Data on various weather elements according to the weather stations is shown in Appendix III. The average of annual weather conditions between 1997 and 2007 in the four stations of Wilson airport, JKIA, Dagoretti Corner and Narok. Dagoretti station recorded the highest average annual rainfall of 93.457 mm followed by Wilson Airport, Nairobi of 79.99mm and JKIA with 66.651mm. The lowest average annual rainfall was observed in Narok (63.557mm).

An ANOVA revealed that there were significant ($p<0.05$) differences in all the weather elements tested except relative humidity.

Further analysis was done to examine the stations where the differences in weather elements were significant ($p<0.05$) and the results are displayed in Appendix IV

The results indicate there was significant ($p<0.05$) difference in the rate of evaporation and amount of rainfall between Dagoretti and Narok stations. The maximum temperature varied significantly between Dagoretti and JKIA, Wilson Airport and Narok. There was also a significant ($p<0.05$) difference in minimum temperature between Dagoretti and Wilson airport. Significant ($p<0.05$) differences in minimum temperature were also observed between Narok and JKIA, Wilson airport, and Dagoretti.

4.17.2 Climate change/ Variability between 1967-1976 and 2001-2008

The mean dry and wet bulb temperatures (^{0}C), the mean monthly humidity and rainfall (mm) values for period 2 (2001-2008) were slightly higher than the average monthly recording for period 1 (Figures 4.6-4.9). There was no significant increase in dry bulb temperature recordings from 1967 to date (Figure 4.6). However, wet bulb temperature recordings for period 2(26.51^{0}C) were significantly ($p<0.05$) higher than for period 1 (mean 21.25^{0}C) (Figure4.8). There was no difference in the amount of rainfall between the two periods (Figure 4.9). There was a significant ($p<0.05$) increase in humidity from an average of 342.08 in period 1 to an average of 436.42 in period 2(Figure 4.8).

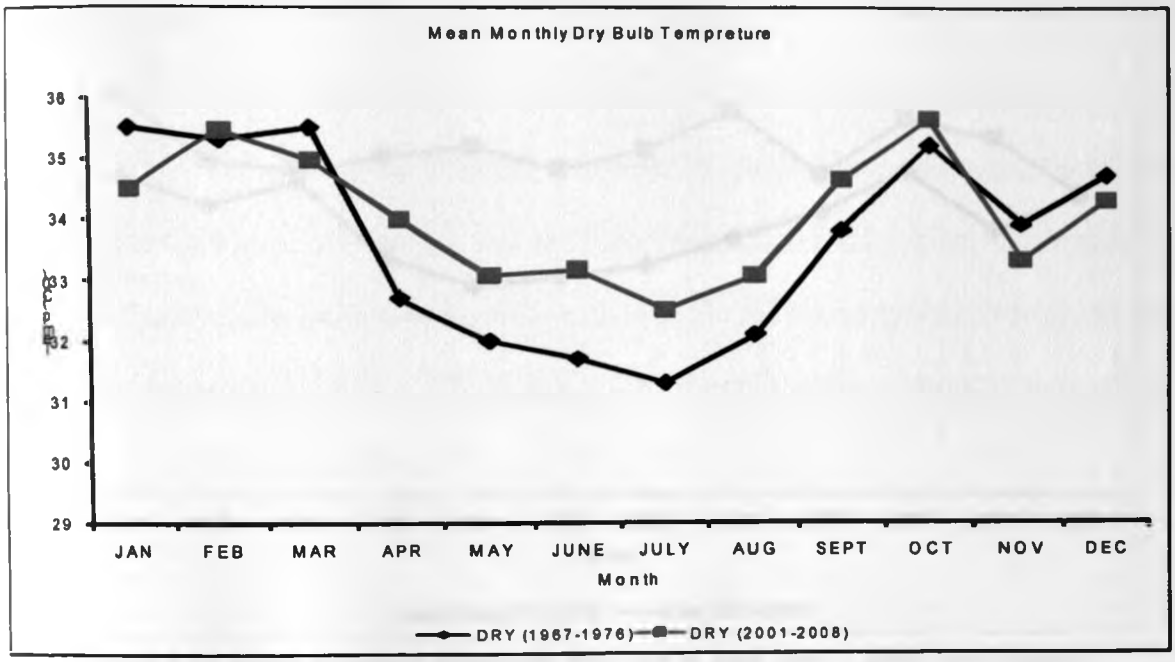

Figure 4.6: Mean monthly dry bulb temperature for Magadi weather station

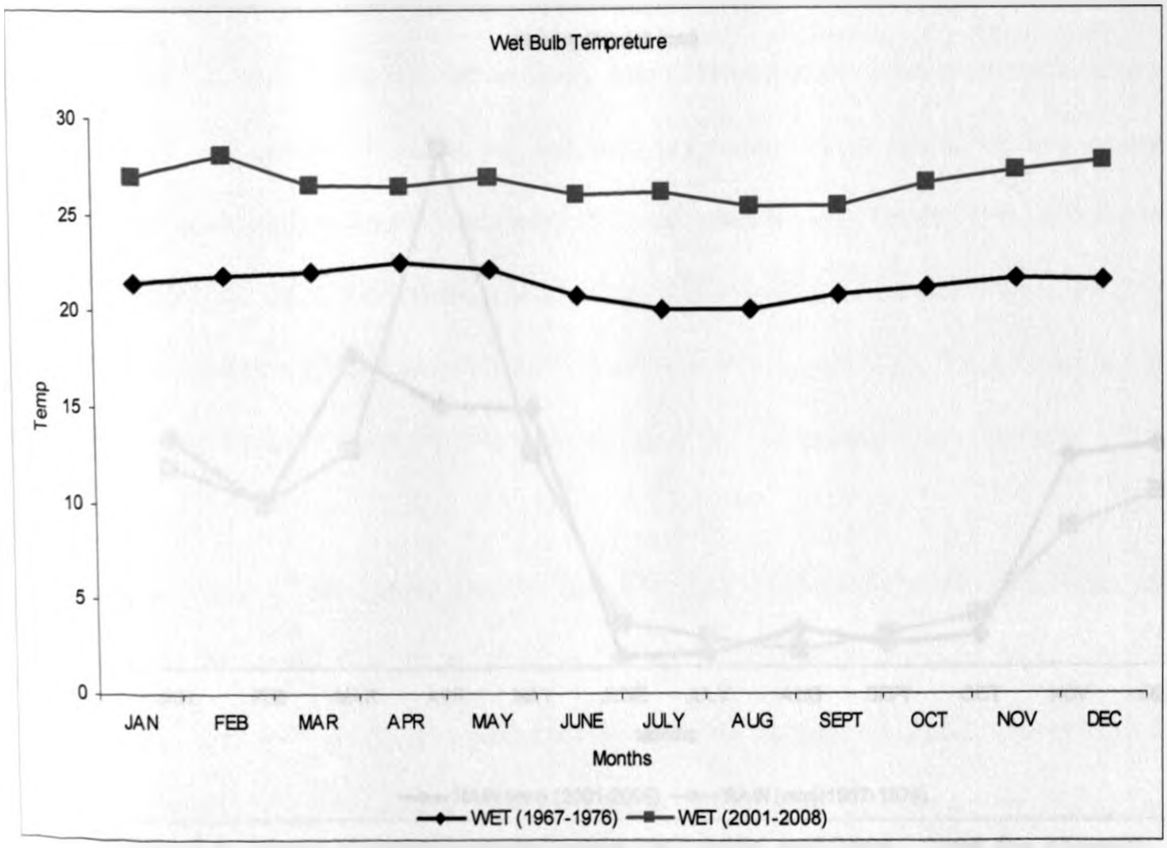

Figure 4.7: Mean monthly wet bulb temperature for Magadi weather station.

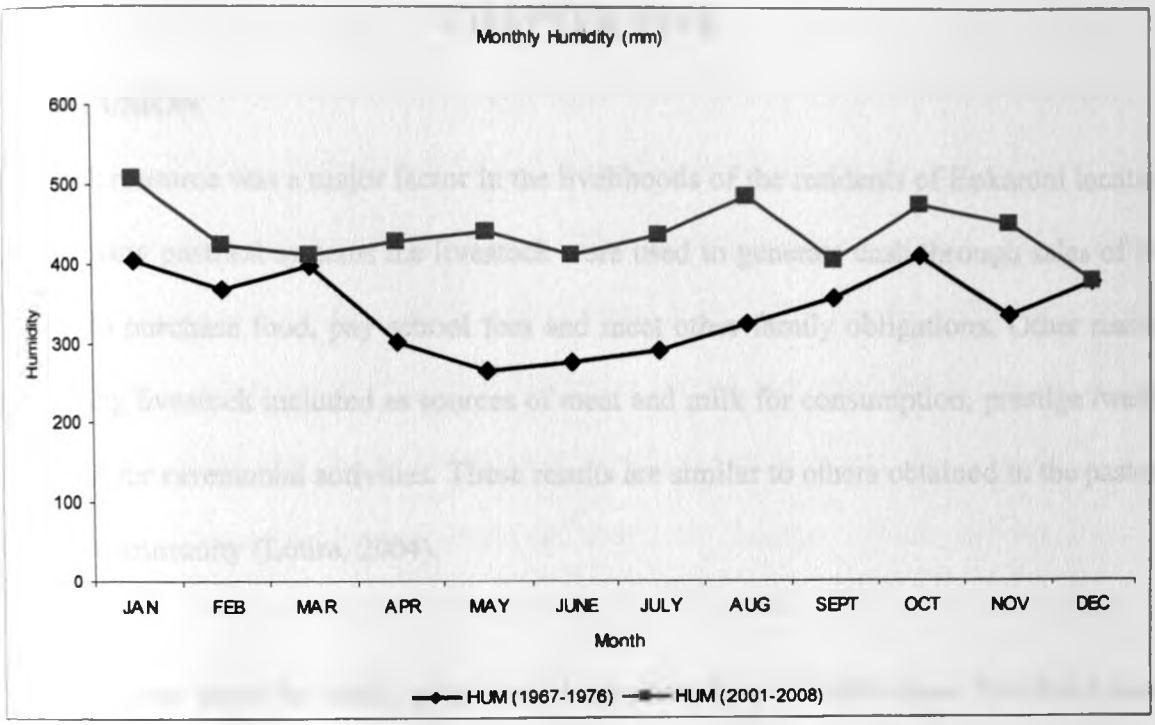

Figure 4.8: Mean monthly humidity 1967-1976 and 2001 - 2008 for Magadi weather station

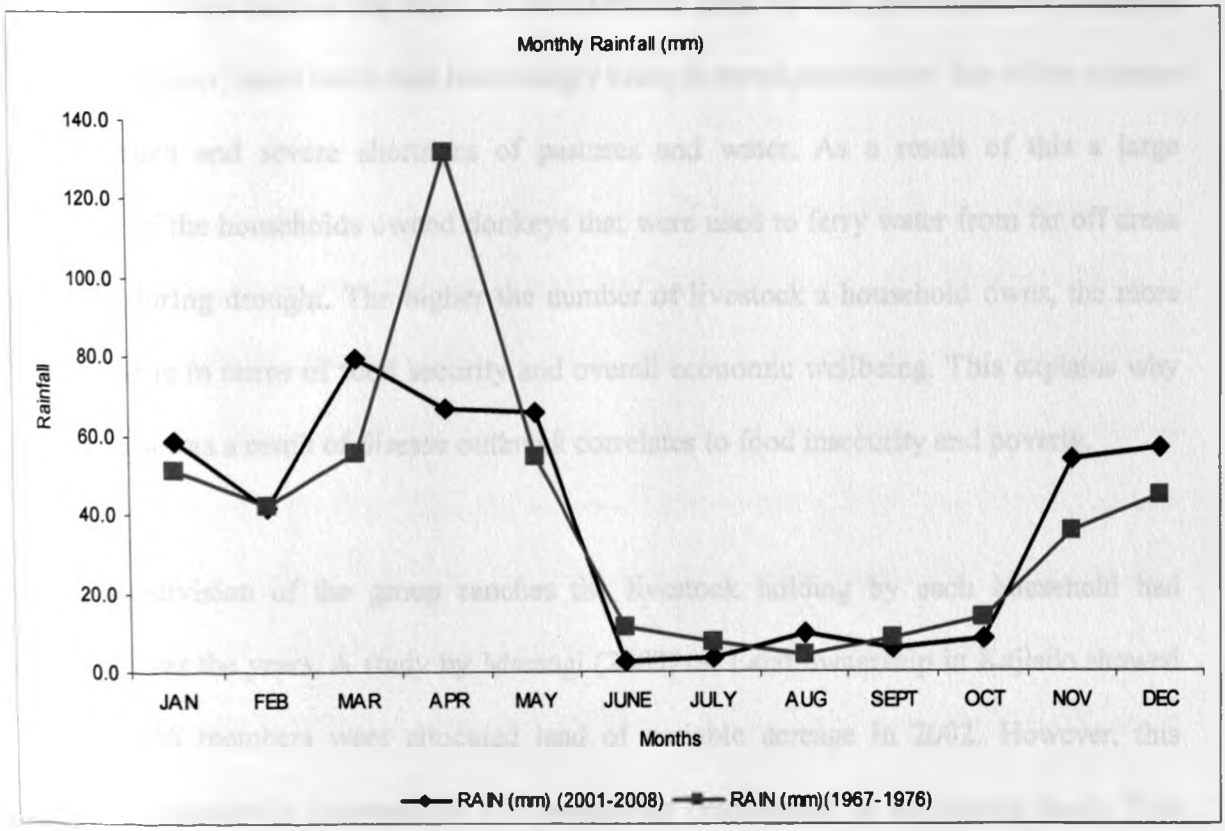

Figure 4.9: Mean Monthly precipitation 1967-1976 and 2001 - 2008 for Magadi weather station

CHAPTER FIVE

5.0 DISCUSION

Livestock resource was a major factor in the livelihoods of the residents of Enkaroni location. Like in many pastoral systems the livestock were used to generate cash through sales of live animals to purchase food, pay school fees and meet other family obligations. Other reasons for keeping livestock included as sources of meat and milk for consumption, prestige /wealth status and for ceremonial activities. These results are similar to others obtained in the pastoral Turkana community (Lotira, 2004).

The high mean score for cattle, goats and sheep show how valuable these livelihood assets are for the Maasai community. They are the major sources of food, income, security and bride price. Cattle formed the bulk of the livestock kept by the pastoralists of Enkaroni Location however, small stock was increasingly being favored presumably due to the extreme land pressures and severe shortages of pastures and water. As a result of this a large proportion of the households owned donkeys that were used to ferry water from far off areas especially during drought. The higher the number of livestock a household owns, the more assured one is in terms of food security and overall economic wellbeing. This explains why livestock loses as a result of disease outbreak correlates to food insecurity and poverty.

Due to subdivision of the group ranches the livestock holding by each household had decreased over the years. A study by Mwangi (2003) on Land ownership in Kajiado showed that only 356 members were allocated land of variable acreage in 2002. However, this number has apparently increased to 674 households enumerated in the current study. This was an indication that the Human population of Enkaroni Location has been increasing in the recent times. This apparent increase could be attributed to provision of water sources reported

by the pastoralists in the current study. The increase in human population and the concurrent subdivision of the group ranches may have had adverse effects on the environment including overstocking, reduced livestock mobility, charcoal burning and denudation of land. A number of studies have documented similar adverse effects caused by parcellation of land in pastoral settings (Niamir-Fuller, 1995, 1998, 1999; Mehta *et al*, 1999; Bruce and Mearns, 2002). Indeed some of these effects were observed during the transect walk. While pastoral systems are resilient because they enable people to cope with the unpredictable environment they are also dependent on maintaining a delicate and constantly changing balance between livestock and people. If there are too many animals the family herd will not find sufficient pasture, and there is a danger of overgrazing if livestock mobility is constrained, e.g. by the subdivision of group ranches as occurred in Enkaroni. Reduced mobility will likely magnify vulnerability to drought and may jeopardize the viability of the livestock enterprise upon which pastoral livelihoods are dependent (Van der Brink et al., 1995).

Mwangi (2003) discuses the reasons for land adjudication undertaken in Enkaroni group ranch. These reasons were corroborated by the information from the key informants. Some of the reasons included the promise of better delivery of services and infrastructural development by the government, e.g. construction of dams, sinking of bore holes and provision of dipping facilities and regular vaccination against prevalent animal diseases (Davis, 1970). In addition they were promised that they could acquire title deed that they could use to secure loans from banks such as the Agricultural Finance Corporation (AFC). The Key Informants indicated that most of the promises were not fulfilled leading to resentment.

Climatic change/ Variability cycles have become unpredictable and have played a major role in the occurrence of droughts experienced in the area and the resultant reduction in livestock numbers. Due to prolonged drought water and pastures in the area become scarce forcing the residents to migrate with their livestock. During these times there is increase contact between livestock and wildlife resulting in disease transmissions. In addition the risk of disease transmission increases when animals congregate especially at the few available water points. Various past droughts have been reducing cattle numbers and therefore the average household ownership has reduced over the years

The study revealed that there were drastic reductions in the number of livestock kept by individual pastoralists' households. The major causes of livestock losses were drought, diseases, predation by wild animals and livestock thefts. The drought related losses expose the vulnerability of the residents as they lack effective coping mechanisms to mitigation against drought. Another factor that adversely affected livestock were diseases especially the tick borne diseases that were reported to have high incidence during the dry periods. Lack of water for spraying livestock for the control of the tick vectors may have played a significant role. Furthermore the disease situation may have been exacerbated by the observed poor delivery of veterinary services as well as the reportedly high cost of veterinary drugs. Indeed the pastoralists at times had to result to the use of herbal remedies to treat their livestock. It was indicated that veterinarians usually take long to respond or never respond to disease outbreaks especially those which require vaccinations. Furthermore their perceived knowledge on most of the diseases may have led to self administration of treatments rather than consult the few veterinary personnel in the area. Similar observations have been reported in other pastoral production systems in Kenya (Lotira, 2004; Mochabo et al, 2005).

East Coast Fever (ECF) was reported as the most important cattle disease in Enkaroni Location and occurred most frequently in dry seasons. This observation was not surprising as there were no functional dips. The other method of tick control was the use of sprays but these may not have been effective due to improper use. In addition it was noted that tick control was not done on a regular basis. Other diseases perceived to be of economic importance included Foot and mouth disease (FMD), Anthrax, Lumpy skin disease (LSD) and Blackquarter (BQ). These findings are consistent with the results of Claire Bedelian et al. (2006) in a study conducted in the Maasai ecosystem stretching from Kitengela in Kajiado District to Ngorongoro in Tanzania.

Contagious Caprine Pleuropneumonia (CCPP) was ranked the most important disease affecting goats followed by FMD, Tick borne diseases and enterotoxaemia.
The disease is transmitted through contact between infected and susceptible animals and was attributed to cold weather when animals tend to congregate. The disease reportedly occurred in both the wet and the dry seasons. The probable reason for occurrence in the dry season may be the potential congregation of animals from different herds at watering points.

The control of diseases such as CCPP, FMD, LSD, Anthrax, BQ and Enterotoxaemia through vaccination has not been practiced widely reportedly due to cost implications. This strategy of disease control was reportedly very effective. However, the poverty levels of pastoralists dictate that they sell one animal in order to meet the vaccination costs. It was observed that there were several Non- governmental organizations with programmes for disease control in the area. Their presence may have discouraged the pastoralists from taking initiatives for the control of diseases. The pastoralists were not aware of which goats' diseases could be

prevented through vaccination. This may have explained the high morbidity and mortality reported for small stock diseases occurring in the area.

Livestock movement control and quarantine were not popular methods for disease control as they were considered punitive. However the pastoralists felt that the methods are effective as they indicated that they normally migrate whenever disease outbreaks occurred. Moreover animals perceived to be suffering from FMD were always watered after other animals. This indicated that they were aware of the mode of transmission.

Migration was practiced by a large proportion of the surveyed pastoralists in response to drought as well as disease outbreaks. Only a small proportion indicated that they never move and was thus considered sedentary. This latter group had other sources of livelihood that included crop production, quarrying and charcoal burning. A small proportion of pastoralists moved with the whole family as livestock were their only source of livelihood. During migrations men and young boys moved with the animals while children and women stayed back in the manyattas with recently calved cows and small stock. This ensured that they met their milk requirements especially to the children. The distance moved ranged from 11Km to over 100Km from their homes and lasts until the rains returned. Similar migration pattern was observed among the pastoral community of Turkana District (Lotira, 2004)

According to the pastoralists of Kajiado District there have been marked climate changes in the area which have led to changes in their way of live impacting negatively on their livelihoods. This information was collaborated by the climate data collected in five weather stations in the neighborhood of Kajiado. There were marked associations between disease occurrence and climate change/variability pertaining to humidity, wind speed and direction as

well as temperature. Some diseases were positively associated with certain climate elements (e.g. Helminthiasis with rainfall), while others were negatively associated with other climate elements (e.g. redwater with rainfall). The pastoralists felt that there was less rainfall over the last past years although the climatic data showed non- significant variations in the amount received during the same period (2001-2008).

The observed association between wind speed and direction is biologically plausible. Many diseases are known to be airborne such as FMD, while in LSD the vector are assisted to move faster and over great distances by wind (Blood and Henderson, 2004). In addition many infections especially the arthropod vectors and helmint parasites are known to occur under wet conditions and therefore influenced by climate change.

CHAPTER SIX

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions:

From the results obtained from the study, it can be concluded that;

1. The pastoralists of Enkaroni Location recognized livestock diseases as a constraint in their livelihood. They indicated that veterinary services are not adequate and timely in the control of these diseases and as a result they treat livestock themselves.
2. The pastoralists' main livelihood was livestock that they sell to raise cash for food, school fees and other family obligations. Climatic change/ variability led to loss of livestock due to inadequate pasture and water. This led to food insecurity to the pastoralists.
3. The pastoralists identified drought as a major problem in the area that leads to loss of livestock due to malnutrition and thus loss of livelihoods. Droughts cause inadequacy of pastures for livestock and water for human and livestock use.
4. Tick borne diseases are a major constraint in the area. Climate variations influence the tick vectors and limit the control of the vectors due to shortage of water.
5. There has been a significant change in climate in Kajiado over the last 10years (1997-2007). The significant variations in all weather elements observed over the last ten years is an indication of climate change in Kajiado District.
6. Climate change in Kajiado District is positively and significantly related to occurrence of livestock diseases. This may have led to significant increase in occurrence of livestock diseases in Kajiado District. Significant variations in certain weather elements may have modified the ecosystems of the diseases causing an increase in pathogens and vectors populations.

6.2 Recommendations

The following are recommendations arising from this study:

1. An early warning system should be developed to predict climate changes in Kajiado and generate information that pastoralists can use to manage possible occurrences of livestock diseases.
2. Targeted and strategic disease management interventions should be developed to moderate the multiplication of disease-causing pathogens and their vectors as a result of climate variability.
3. Extension education should be undertaken to enlighten the pastoralists on the importance of strategic disease control, stocking density of animals and environmental conservation in order to mitigate against climate variability.
4. Water should be provided by constructing more boreholes and water pans in the pastoral areas as it is the most important commodity for the sustenance of their livelihood for humans and livestock during drought.
5. The government should create a national pasture/hay reserve for provision to pastoralists during severe droughts.

CHAPTER 7

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APPENDIX I

QUESTIONNAIRE FOR SURVEY

LIVESTOCK HEALTH AND WATER MANAGEMENT UNDER CLIMATE VARIABILITYAND CHANGE: DISASTER MANAGEMENT IN KAJIADO DISTRICT

Semi-Structured Baseline Survey Tool

QUESTIONNAIRE NO..... CODE NUMBER..... (Leave blank)
ENUMERATOR NAME.....NAME OF RESPONDENT.....
DESIGNATION.....

A) **Demographic Information**

1) Division_____ Location_____ S/Loc_____

2) Gender of respondent

1 Male [ ] 2 female [ ]

3) Age of respondent

Age	Tick here
1 (15-25)	
2 (25-35)	
3 (35-45)	
4 (45-55)	
5 (55-65)	
6 (65-75)	
7 (75-85)	

4) ***Level of education of Respondent***

Education Level	Tick here
1 No formal Education	
2 Primary	
3 Secondary	
4 Tertiary	
5 University	

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LIVESTOCK HEALTH AND WATER MANAGEMENT UNDER CLIMATE VARIABILITYAND CHANGE: DISASTER MANAGEMENT IN KAJIADO DISTRICT

Semi-Structured Baseline Survey Tool

QUESTIONNAIRE NO..... CODE NUMBER..... (Leave blank)
ENUMERATOR NAME.....NAME OF RESPONDENT.....
DESIGNATION.....

A) **Demographic Information**

1) Division_____ Location_____ S/Loc_____

2) Gender of respondent

1 Male [ ] 2 female [ ]__

3) Age of respondent

Age	Tick here
1 (15-25)	
2 (25-35)	
3 (35-45)	
4 (45-55)	
5 (55-65)	
6 (65-75)	
7 (75-85)	

4) Level of education of Respondent

Education Level	Tick here
1 No formal Education	
2 Primary	
3 Secondary	
4 Tertiary	
5 University	

5) **Household Composition by age, occupation and relationship**

Age	Male	Female	Occupation	Relationship with respondent
0 - 5				
5 - 10				
10 - 15				
15 - 20				
20 - 25				
25 - 30				
30 - 35				
35 – 40				
40 - 45				
45 - 50				
50 - 55				
55 - 60				
60-				

6) How many family members are in the following levels of education?

No. in	Female	Male
Pre-school		
Primary		
Secondary		
Tertiary		
University		

B) Livestock health

7) Which of the following livestock do you rear, what is their number and what are the three most important reasons for keeping them?

Type of livestock	Total number	1st most Important reason for keeping	2nd most Important reason for keeping	3rd most Important reason for keeping
Cattle				
Sheep				
Camel				
Goats				
Donkeys				
Rabbits				
Pigs				
Poultry				
Others				

Reasons for keeping the animals:

1 = live animal for sale
2 = Meat for HH consumption
3 = Milk for sale
4 = Milk for HH consumption
5 = Bulls for service
6 = Traction
7 = Manure
8 = Prestige
9 = to pay dowry
10 = Eggs for sale
11 = Eggs for home consumption
other 1 (specify) _____
Other 2 (specify) _____

8) Did you lose livestock last year? 1 Yes [ ] 2 No [ ]

9) What were the major causes? 1 disease [ ] 2 drought [ ]
3 theft [ ] 4 other [ ] specify

10) How do your restock your livestock whenever you want to increase the numbers? Purchase from
1. Market [ ] 2. Neighbors [ ] 3. Other [ ], specify

Disease constraints

11) What are the most common diseases/conditions in the area for the livestock? Rank them with respect to economic importance. In which periods do they occur and how many times have they occurred in the last 10 years?

Livestock	Disease	Rank	Periods	Number of Outbreaks
Cattle				
Sheep				
Goat				
Poultry				
Pigs				

Camel				
Rabbits				

Recent Disease outbreak and control measures

12) How do these diseases come about?

Cattle		
Disease	**Cause of the disease**	**What helps in their spread?**
Disease		
1		
2		
3		
4		
5		
6		
7		
Camel		
Disease	**Cause of the disease**	**What helps in their spread?**
1		
2		
3		
4		
5		
Disease	**Cause of the disease**	**What helps in their spread?**
1		
2		
3		
4		
5		

Goat		
Disease	**Cause of the disease**	**What helps in their spread?**
1		
2		
3		
4		
5		
Pigs		
Disease	**Cause of the disease**	**What helps in their spread?**
1		
2		
3		
4		
5		
Poultry		
Disease	**Cause of the disease**	**What helps in their spread?**
1		
2		
3		
4		
5		
6		

13) How do you manage disease outbreaks in your herd?
1=Treat yourself, 2=use a local herbalist 3=veterinary officer 4=other (specify)

Livestock	Disease	Management
Cattle		
Sheep		

Goat		
Poultry		
Pigs		
Camel		
Rabbits		

14) For the diseases listed above do you notice any climatic change before their occurrence? How is the disease related to the weather?

Disease	**Year**	**Climatic change (drought, floods, etc)**	**How disease is related to weather**

15) How do determine that an animal is suffering from the diseases listed above? 1 take a sample for confirmation [ ]
2 look at the symptoms [ ] 3 other specify [ ].....

16) What preventive measures are taken to reduce? 1 vaccination [ ]
2 quarantine [ ], 3 livestock movement [ ] 4=treatment [ ]
5 no action [ ]

Livestock	Disease	Control	Implementer	Enforcer
Cattle				
Sheep				
Goat				
Poultry				

Pigs				
Camel				
Rabbits				

17) What are the reasons for not reporting some of the diseases?

18) How much do you spend averagely per year in the control or treatment of diseases in your herd?

a) Control.:
b) Treatment

Livestock losses due to Diseases outbreaks

19) Which loses do you suffer from livestock diseases

Species	Abortions	Milk production loses	Deaths	Loss of Marketing	Treatment costs	Loss of livestock condition
Cattle						
Sheep						
Goats						
Camels						

20) How many of your livestock, young and adult, died as a result of the three most important diseases last year?

Livestock		**Herd number**		**Number of Deaths**	
Cattle	**Disease**	**Young**	**Old**	**Young**	**Old**
Sheep					

Goat					
Poultry					
Pigs					
Camel					
Rabbits					

21) Are there times when you move livestock? Yes [ ] no [ ]

22) If yes when?

23) Why do you move? 1 culture [ ] 2 drought [ ] 3 security [ ]
4 other [ ] specify

24) How far do you graze your under normal condition?

25) Who owns the pastures?

26) What makes you move livestock from your normal pasturing areas to other areas? (i.e. in search of feed, in search of water, cultural practice/ group decisions or other reasons indicate)

27) Who moves with the livestock?

28) Do you move in groups or alone? ----------

29) For how long do you stay in the new area? new pasturing areas

30) How often do you water your livestock

31) Which season/ months of the year do you have plenty of water/ rains

32) When/ which months do you suffer from shortage of water and pastures

33) For the last ten years how many times have you experience drought?

34) Which years have you experienced drought during the last 10 years

35) Which years have you experienced floods during the last 10years

36) What other climatic changes affects your livestock health

37) How do you mitigate in such conditions

38) How often do your livestock mix with wildlife?

39) Which months are they most likely to mix

40) What are the reasons for the mixing?

41) Are there problems associated with mixing livestock and wildlife?
Yes [ ] No [ ]

42) If yes which?

C) WATER HARVESTING

43) What soil types do you recognize in your local language?

44) Which soil type(s) is/are best for crop production, pasture production?

Soil Type	Crop Production	Pasture Production

45) Do you have problems with soil erosion yes [ ] . no [ ]

46) If yes what are the causes?

47) What crops do you grow for food if any?
1. ,2. , 3 ,4.
5. ,6. , 7. ,8.

48) Where did you get the seeds?
1. Ministry of Agriculture [ ] 2. NGO [ ] 3. KARI [ ] 4 Church [ ] 5. Stockist [ ] 6 other [ ].

Climate Data

49) How many rainfall seasons do you have? 1 one [ ] 2 two [ ]

50) In which months do they/does it fall

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

.....
.....

51) Which of the seasons is more reliable in terms of rainfall received?

.....
.....

52) What are the indicators that the rainy season is about to start?
Use of stars and moon position in the sky [ ]
Wind speed and direction [ ]
Temperature [ ]
Others specify [ ]

53) In every 10 years how often do you get drought?
.....
.....

54) Which year and months did you experience drought or floods?

Year	Months	Drought	Floods	Normal

55) On average how long are the droughts.
.....
.....

56) What do you do to cope with the impact of drought?
.....
.....
.....

57) What do you do with your livestock when drought strikes?
.....
.....
.....
.....

58) What do you do about your food shortage when droughts come?
.....
.....
.....
.....

59) What losses you have incurred from droughts?

1 Animal losses [ ].2 Pasture losses [ ] 3 Crop losses [ ]
4. Human deaths [ ] 5. Other, specify [ ]

60) Have you ever experience conflicts as a result of drought?
1. Yes [ ] 2. No [ ]

61) If yes which ones?
1. Human-wildlife [ ] 2. Human-human [ ] 3. Livestock–Wildlife [ ]

62) What are your sources of water? Indicate whether they are permanent or temporary and the years in the past ten that you did have water throughout for each source.

Source	**Permanent**	**Temporary**	**Years Available Throughout**

63) What are the water conservation measures in your area?
1 Dams [ ] 2 Water holes [ ] 3 Boreholes [ ] 4 water pans [ ]
5 Rock catchments [ ] 6 subsurface dams [ ] 7 Rivers [ ]
8 roof catchments [ ] 9 others specify [ ]

64) What soil and water conservation structures do you have on pasture land and cropped land?

Conservation Structure	Pasture Land		Cropped Land	
	Soil	Water	Soil	Water
Terraces				
Cutoff drains				
Grass strips				
Ridges				

65) What constraints do you face in water harvesting structures:
1 Technical advice. [ ] 2 Land ownership. [ ] 3 Maintenance [ ]
4 Lack of ownership. [ ] 5 Site problems [ ]
6 Cost of constructing water conservation structures [ ]

66) Who are the stakeholders in construction of the above Conservation structures? 1. 2. 3. 4.

67) What do you propose in solving the above problems?
1. 2.

3. 4.

68) How do you preserve your pasture?

69) How do you preserve your crop yields?

70) How does weather affect your pasture yields?

71) How does weather affect marketing of your livestock?

72) How does weather affect marketing of your crop yields?

73) Does weather have any effects to the prices of food commodities and livestock? 1. [yes] 2 [no]

.....

74) What vegetation types do you have on your farm?
1 Pasture species [ ] 2 Fodder species [ ]
3 Medicinal plants (for both livestock and human) [ ]

75) Are there any efforts to conserve the fodder and pasture species? 1. [yes] 2. [no]

76) If yes which ones?

77) Is there any organization that is helping in conservation of pasture and fodder? 1. [yes] 2. [no]

78) If yes which ones? 1.....2.....3.....
4.....5.....6.....

D) Food security

79) What is the current land tenure system?
1. Free hold [ ] 2. Communal [ ], 3. Group ranches [ ]
4. Public [ ]

80) What is your land size? (acres) [ ]

81) What are main land use types in your farm/area 1. Pasture [ ]
2. Crop [ ] 3. Forest [ ] 4. quarry [ ]

82) How much land per each activity?

Activity	*Acreage*
Pasture	
Crop	
Forest	
Quarry	
Other	

Division of Labour

Gender role in livestock production central division of Kajiado district		
Parameter/decision making	Gender	Yes=1 No=2 Sometimes=3 Both=4
Who decides which animal to keep?	Men	
	Women	
	Both men and women	
Who sells produce	Men	
	Children	
	Women	
Who decides on expenditure	Men	
	Women	
	Both men and women	
Who decides on Ploughing and crop sowing	Men	
	Children	
	Women	
Who harvests	Men	
	Children	
	Women	
	All family	

Cooking and fetching of water	Men	
	Children	
	Women	
Child care	Children	
	Women	
	Both children and women	
	Men	
Herd management	Men	
	Women	
	Children	
Animal feed preservation	Men	
	Children	
	Women	
Milking	Children	
	Women	
	Men	
Consultation for sick animal	Men	
	Children	
	Woman	
Selling produce	Men	
	Children	
	Woman	
Animal ownership	Male	
	Women	
	Children	
Animal holding trend	Increasing	
	Decreasing	
(What is the off take trend)	No change	
Decision making for sale of produce	Men	
	Women	
	Children	
Right and access to information, school,	Man	
	Women	

capital and Land ownership	Both	
Access to trainings on livestock husbandry practices	Men	
	Women	
	Children	
Role of livestock in the livelihood (Rank 1, 2, 3,n)	Source of food	
	Source of cash	
	Source of manure	
	Social status	
	Draught power	
	Source of manure	
	Employment	

Costs of Livestock Production

83) Do you buy any feed or grass/fodder for your animals?
1 Yes [ ] 2 No [ ]

84) If yes, list the types, amount of feeds and the costs per season.
Type of feeds amount bought/year cost per unit

Feed Type	Amount	Cost/unit	Total Cost

85) Do you buy water? 1 Yes [ ] 2 No [ ]

86) If Yes from how far---------km and at how much? Ksh-----per/20liters

87) How much milk do you get from your cows per day? ------cups/liters

88) Do you sell milk? 1. [Yes] 2. [no]

89) Where and how much?

Customer	Amount/day	Cost/liter	Total Amount
Neighbor			
Market			
Society			
Middlemen			

90) What are the main foods Consumed by the household?

1. ----------, 2. ----------,

3.----------, 4. ----------.

91) Which months do you run short of food? ----------

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92) What are the sources of support when there is food scarcity?
1.----------, 2. ----------, 3. ----------

93) What are the activities that threaten food supply and water supply for human and livestock uses?

Cultural Aspects

94) What are the important cultural norms about water management and husbandry of livestock?
1----------2----------3----------4.....

95) How do these cultural norms affect livelihoods of the pastoral households?
1----------2----------3----------4----------

96) What can you say about trends in availability of pasture and in livestock numbers in this locality?
1----------2----------3----------4----------

Marketing

97) What are the indicators of wealth for you?
1.....2.....3.....4.....

98) Do you sell your livestock for any purpose?
1 Yes [ ] 2 No [ ]

99) To which markets? Rank them

Market	Rank

100) Why do you sell your livestock?
1. Raise money for food [ ] 2 School fees [ ]
3 Drought/feed shortage 4 other [ ] specify

101) How often do you take your livestock to the market?

102) Are animals graded during the auctions? 1 Yes [ ] 2 No [ ]

103) Are the animals examined/inspected for signs of the disease before being moved from the market? 1 Yes [ ] 2 no [ ]

104) Are there designated livestock routes near the grazing areas?
1 Yes [ ] 2 No [ ]

105) Describe the routes briefly. i.e. the points it goes through.

106) How do you ensure separation of your livestock from other passing livestock?

107) **Live animal sales**

Species	When do you like selling your animal (Month) Jan, Feb., March…	Marketing system 1. Bargain 2. Auction 3. Live weight	Preferred marketing system 1. Bargain 2. Auction 3. weight basis	Problems in that market Cartels -1 Low prces-2 High taxes-3 Insecurity-4 Market system-5 Distance -6
Cattle				
Goat				
Sheep				
Camel				
Other; specify				

108) What is the price pegged on?

Criteria	rank the weights on a scale of 1 to 5
Body condition	
Supply in the market	

Age	
Size	
Sex	
Time of the year	

109) Livestock product sales

Product	Estimated output per year/family	Price per kg or unit	Gross output
Milk			
Hides			
Skin			
Eggs			
Manure			

110) What are your other 3 major sources of income, other than livestock and livestock products?

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111) Sources of income

Rank from the leading source to least source, on annual basis

Source of income	Rank (1, 2, 3…n)	Is it a coping strategy or a livelihood? 1. Livelihood 2. Coping mechanism
Pastoralism (keeping livestock)		
Employment		
Growing crops		
Trading in livestock		
Butchery		
Middleman ship		
Broker		
Hides and skins trader		
Working in the slaughter slab		

D) Resources (to be obtained from respective district/divisional offices)

- Area under forest
- Area under grazing land
- Area under cultivation
- Area under game reserve

- Livestock population figures
- Water facilities and their distribution
- Institutions working in the region/division
- Population of the division
- Number of dips in the division
- Number and distribution of crushes
- Number of markets and distribution
- Administrative map
- Rainfall figures
- Crops grown and acreages covered
- Number and distribution of slaughter slabs
- Seasonal calendar for the division

APPENDIX II

Table 4.25: Correlation Matrix between Weather Elements and Reported Cases for Individual Livestock Diseases between 2001 and 2008.

Diseases/ Conditions	Dry Bulb Temp.	Humidity	Rainfall	Wet Bulb Temp.
Helminthiasis	-.143	.415(*)	.579(**)	.486(*)
Disbudding	-.016	-.436(*)	-.311	-.517(**)
ECF	.529(**)	-.063	-.022	.126
Anaplasmosis	-.134	-.161	.628(**)	-.496(*)
Pneumonia	.021	-.405(*)	-.456(*)	-.507(*)
Milk fever	-.507(*)	-.117	-.190	-.039
Castration	-.352	.225	.303	.016
Eye infection	.671(**)	-.657(**)	-.469(*)	-.332
Heartwater	.329	-.223	-.607(**)	.077
Mastitis	.602(**)	-.477(*)	-.087	-.235
Redwater	.286	-.631(**)	-.672(**)	-.517(**)
Enteritis	-.117	-.601(**)	-.024	-.629(**)
Retained after birth	.345	-.374	-.365	-.644(**)
Abortion	.093	-.025	-.516(**)	-.310
Endometritis (RAB)_	-.443(*)	.427(*)	-.069	-.146
Wounds	-.465(*)	-.488(*)	-.073	-.536(**)
Dehorning	.681(**)	-.087	-.106	-.473(*)
Dystocia	-.276	-.150	.543(**)	-.403
Bloat	-.198	.707(**)	.341	.343
Abscess	.299	-.511(*)	-.716(**)	-.819(**)
Downer cow syndrome	.114	-.177	.525(**)	.357
Uterine after birth	-.246	-.362	.532(**)	-.568(**)
Uterine prolapse	-.246	-.362	.532(**)	-.568(**)
Pregnancy diagnosis	-.807(**)	-.245	.103	-.188
Prepucial prolapse	-.128	-.112	.727(**)	-.014
FMD	.324	.448(*)	-.525(**)	.180

** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed).

APPENDIX III

Table 4.26: Annual averages of weather elements in the four weather stations around Kajiado District, 1997-2007.

Weather Elements	Weather Stations	Mean	Std. Dev
Evaporation; Pan1; Daily Total	DAGORETTI CORNER MET. STATION	128.471	20.3842
	J.K.I.A. MET. STATION	151.419	27.5822
	NAROK MET. STATION	148.535	13.7157
Precipitation; Daily Total	DAGORETTI CORNER MET. STATION	93.457	26.2641
	J.K.I.A. MET. STATION	66.651	27.5219
	NAIROBI WILSON AIRPORT	79.990	24.9551
	NAROK MET. STATION	63.557	18.7030
Relative Humidity At 06Z	DAGORETTI CORNER MET. STATION	80.325	2.9786
	J.K.I.A. MET. STATION	79.324	2.8044
	NAIROBI WILSON AIRPORT	78.412	2.2265
	NAROK MET. STATION	76.890	2.7767
Relative Humidity At 12Z	DAGORETTI CORNER MET. STATION	49.643	4.4012
	J.K.I.A. MET. STATION	48.093	3.2175
	NAIROBI WILSON AIRPORT	46.426	2.6954
	NAROK MET. STATION	48.206	3.5550
Temperature; Daily Maximum	DAGORETTI CORNER MET. STATION	24.143	.7994
	J.K.I.A. MET. STATION	25.638	.3821
	NAIROBI WILSON AIRPORT	25.277	.2563
	NAROK MET. STATION	24.806	.4113
Temperature; Daily Minimum	DAGORETTI CORNER MET. STATION	13.580	.3776
	J.K.I.A. MET. STATION	13.882	.4209
	NAIROBI WILSON AIRPORT	14.288	.5021
	NAROK MET. STATION	10.276	.3277