"EFFECTS OF FIRE ON GRASSLAND ECOSYSTEM"A CASE OF MASHURU RANGELANDS IN MAASAI LAND, MASHURU DIVISION, KAJIADO DISTRICT, KENYA.

BY

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DECLARATION

I **Nkonge Evans Kinoti (BEM/5668/41/DF)** hereby declare that this research project is my original work and has never been submitted in any academic institution for examination.

Signature..... **Date**.....3/09/07.....

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(Supervisor)

DEDICATION

This book is dedicated to the late CHARITY NKIROTE whose love, support and interest in what I was doing enabled me endure and still remains a source of inspiration in my heart. You're my life long source of strength.

ACKNOWLEDGEMENT

Duty of writing this project was so enormous but it success was through efforts from various individuals who participated in different ways enabling me to achieve my goal.
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MAY GOD REWARD YOU ABUNDANTLY

TABLE OF CONTENTS

Declaration ii

Dedication iii

Acknowledgement iv

Table of Contents v

List of Tables x

List of Photos xi

List of Maps xii

List of Acronyms xiii

Abstract xiv

CHAPTER ONE: INTRODUCTION

1.0 Definitions 1

1.1 Importance of grasslands 2

1.2 Need for protection for protection of grassland ecosystems in Kenya 3

1.3 Laws and policies on rangeland management and conservation in Kenya 4

1.4 Background of study 5

1.5 Statement of the problem 5

1.6 Significance of the study 6

1.7 Research objectives 7

1.8 Research questions 7

CHAPTER TWO: LITRATURE REVIEW

2.0 Introduction 8

2.1 Rangelands 8

2.2 Impact of burning Grassland zones on environment. 8

2.3 Impacts of fire on biodiversity 10

2.4 Ways in which fire affects the vegetation and land's productivity 15

2.5 Minimizing fire effects on vegetation's 17

2.6 Control Nomadism 19

2.7 Restorations of burnt rangelands 20

CHAPTER THREE: METHODOLOGY

3.1 Geographical background of study area 22

3.1.1 Location 22

3.1.2 Climate 22

3.1.3 Demographic and Populations profile 22

3.1.4 Relief and Topography 23

3.1.5 Vegetations 23

3.1.6 Soils 23

3.1.7 Social Economic Activities 23

3.2 Methods 24

3.2.1 Research design 24

3.3 Study population 24

3.4 Sample size 24

3.5 Sampling framework 25

3.5.1 Sampling design 25

3.5.2 Sampling technique 25

3.6 Data collection instruments 25

3.6.1Questionnaires 25

3.6.2 Oral Interviewing 26

3.6.3 Direct Observation 26

3.6.4 Photography 26

3.6.5 Library search 27

3.6.6 Data analysis and presentation 27

3.7 Limitations 27

CHAPTER FOUR: PRESENTATION, DISCUSIONS AND RESEARCH FINDINGS

4.1 Common activities practiced in Mashuru division 29

4.1.1 Nomadic pastoralism 29

4.1.1.1 Burning of rangelands 30

4.1.1.2 Watering of animals 30

4.1.1.3 Treatment of Livestock's 31

4.1.1.5 Breeding of livestock's 32

4.1.2 Cultivation 32

4.1.2.1 Clearing of land for cultivation 32

4.1.3 Marketing of Animals and their products 34

4.2 Reasons for burning rangelands in Mashuru division 34

4.2.1 To Encourage fresh re-growth 35

4.2.2 Control Pests and Diseases 35

4.2.3 Control common weeds 35

4.2.4 Scare wild animals 36

4.2.5 Clearing land for crop Cultivation 36

4.3 Effect of burning grasslands ecosystem on the environment 37

4.3.1 Ecological effects 37

4.3.1.1 Natural Ecological Succession: 37

4.3.1.2 Change in Soil structure 37

4.3.1.3 Presence of Termites and Army Worm 38

4.3.1.4 Change in Plant Species Composition 39

4.3.1.5 Micro climate 39

4.3.1.6 Vegetation/ pasture level 40

4.3.1.7 Animal productiveness 40

4.3.1.8 Water sources 41

4.3.2 Economic effects 41

4.3.2.1 Loss of income 41

4.3.3 Social factors 42

4.3.3.1 Migration 42

4.3.3.2 Conflicts 43

CHAPTER FIVE:SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary 44

5.2 Conclusions 45

5.3 Recommendations 45

Reference 48

Appendices 50

Appendix 1 50

List of Tables

Table 1: Showing Representation of sample size from different respondents.....24

Table2: Periods and Season when burning of grass takes place 30

Table 3: Production of various key crops in Mashuru division.....33

Table 4: Reasons for burning rangeland zones in Mashuru division 34

List of Photos

Photo 1: Cattle grazing in Mashuru rangelands 12

Photo 2: Various animals found in rangelands. 15

Photo 3: Rangelands of Mashuru division.....29

Photo 4: Burnt rangeland patches in Mashuru division.....43

List of Maps

Map 1: Map of Kenya showing location of Mashuru.....21

List of Acronyms

CBO	-	Community Based Organization
DECO	-	District Environment Conservation Officer
D.M	-	Dry Matter
G.I.S	-	Geographical Information Systems
GLASOD	-	Global Assessment of Dry Lands
Ha	-	Hectares
I.U.C.N	-	International Union for Conservation of Nature
KIU	-	Kampala International University
L.C	-	The Local Council
NEMA	-	National Environmental Management Authority
NEMA	-	National Environmental Management Agency
NGOs	-	Non-Governmental Organizations
OCC	-	Ol-Kejuado County Council
SCCC	-	Species of Common Conservation Concern
UNEP	-	United Nations Environmental Program

ABSTRACT

A study on effects of burning in rangeland on the environment was carried out in Mashuru Division, Kajiado District. Chapter one defines what is rangeland ecosystem, importance of rangeland ecosystem, need for protecting rangelands, laws and policies on range management and conservation in Kenya. Research questions and objectives were also realized. Objectives of study included; main activities carried out in Mashuru division, reasons for burning grass in Mashuru division, effects of burning grass on the environment and ways, suggestions and measures to minimize burning of grass in Mashuru division.

Chapter two involved collection of literature from various institutions, libraries and inherent sources, this provided relevant regarding this study, by collection of information from other parts of the world having relevant case studies on effects of burning rangelands on the environment.. In chapter three, a general research design was used in carrying out the study, method of data collection included questionnaires, interviews, photographing and direct observations from different parts within Mashuru division.

In chapter four; research findings revealed that, main activities practiced in Mashuru were Nomadic Pastoralism, cultivation of crops and marketing of animals and there products were among the major activities practiced. Accompanying practices included; burning of vegetation (grass), watering, treatment, grazing and breeding of livestock's were practices carried out by pastoralist in Mashuru division. While cultivators were involved in practices such as; cultivation of crops and clearing of land for cultivation. Reasons prompting people to burn grass in Mashuru was to; encourage fresh re-growth, control weeds, among other reasons. Consequences and effects of burning grass in Mashuru lead to ecological, economic and social effects through changes in natural ecological succession, soil structure, micro climate, pasture levels, loss of income, conflicts and migration of people to other regions.

From above, chapter five summarized and concluded the way forward through suggested recommendations to control degradation of rangelands in Mashuru. Recommendations included range management and protection, community enhancement, controlled burning of rangelands, distocking of animals, provision of extension services, monitoring, provision of incentives, enacting by-laws to govern use of rangelands in Mashuru division and providing ways for future research studies on ways of improving and maintain rangelands ecosystem in Mashuru division and beyond Mashuru division.

CHAPTER ONE: INTRODUCTION

1.0 Definitions

Grasslands zones are biomes dominated by herbaceous species of grass abundant as the highest proportion of plants species in these regions. Grassland zones may be natural or artificial. Vegetation refers to the sum of total plants, in broadest sense at a given location. Distinguished by flora and defined by relative abundance of various species. Ideally, distribution of species in respect to habitat in a given region.

This concept refers to the form of the plants, species that are present and dominant in a given area. Such as forests, grasslands or scrubs relate to types of vegetation. The term flora, in contrast, considers an area's plant life as a collection of particular species. An ecosystem is a functional ecological unit in which biological, physical and chemical components of the environment interact. The term focuses its attention on the complex interplay between plants and animals with a biotic factor within their habitats. Ecosystem management is the science of directing human activities to sustain resources the desired diversity and productivity of terrestrial and aquatic ecosystem in the area. The essence of ecosystem management lies in its systematic approach in multi scale spatial temporal views. Rangeland is uncultivated land that will support graze and browsing animals. Rangelands are primarily grid and semi-grid and semi grid lands. They are predominantly grassy while others are found in zones of woody vegetation.

Biodiversity is the contraction of "biological diversity", term for variety or diversity within the biological world. In its widest sense, biodiversity is virtually synonymous with "Life on Earth". It is the variety of taxa in an ecological system ranging from the past of community's ecosystem, region and the biosphere. There is a great concern that human activities have resulted to reduction of biodiversity. This is through effects of fires, use of chemicals and other activities such as agricultural practices, which contribute to loss of biodiversity.

"Species" is classified as a measure of abundance in an ecological diversity in a given area or region. Normally determined by numbers and population size. Each species present (species equitability).

Conservation refers to sustainable use of natural resources, such as grasslands, water, plants, animals, and minerals. In economic terms, the natural resources of any area constitute its basic capital, and wasteful use of such resources constitutes to economic loss. From aesthetic and moral point of view, conservation includes maintenance, conservation and management of all significant biomes. In certain cases, conservation may imply to protection of the natural environment from various human activities.

1.1 Importance of grasslands

Grassland zones are important environmental units, which act and protect the environment in various ways such like reducing the water velocity thus controlling soil erosion. The usefulness of grasslands is usually underestimated and ignored where many individuals perceive them idle lands. It is important for us understand the crucial role played by grasslands ecosystems. These are direct and indirect benefits thus they act as important elements of environmental management.

Grasslands of eastern Africa are very diverse, with a range of dominant species dependent on rainfall, soil type and management or grazing system. Eastern Africa is renowned as a center of genetic diversity of tropical grasses and the centre of greatest diversity of cultivated grass species (Boon man, 1993). Over 90 percent of the major cultivated forage grasses have their centre of origin in sub-Saharan Africa and are indigenous to the extensive grasslands of eastern Africa. There are an estimated 1 000 species of grass indigenous to the region, with more than 600 species found in Kenya alone. Wide distribution and adaptability of many of these species across a range of environments and management systems indicates the presence of considerable genetic diversity within the region. This diversity is exploited to select superior ecotypes for use in other parts of the world. *Brachiaria* species, originating from eastern Africa, are the most widely used-planted forage grass.

1.2 Need for protection for protection of grassland ecosystems in Kenya

The need for further fieldwork studies was evident; this is to clarify on various issues raised. Such solutions will provide great importance towards the future of Mashuru division. Modern scientific insights are needed to ensure that present changes will favor implementation of sustainable ecosystem management strategies for the benefit of Mashuru population and the entire ecosystem. Majority of individuals depends on various resources originating from grasslands for there survival.

Grassland regions are the most threatened ecosystems in Kenya. Many conservation initiatives have been carried out to protect this ecosystem at national and binomial levels. There is need for protect grassland zones due to the abundant biodiversity and productive potential they posses, where grass acts as pastures for livestock's and has other distinctive values to the environment.

In Kenya, extensive grasslands are mostly in arid and semi -arid zones. These areas are subject to droughts and a high degree of pastoral risk. Potential vegetation is largely desert and semi-desert, bush and woodland and pure grassland dominated by herbaceous layer of the other formations important for wildlife and livestock; 75 percent of eastern Africa is dominated by grasslands, often with a varying amount of woody vegetation.

Livestock and game for millennia have grazed grasslands. Eastern Africa is a centre of genetic diversity for grasses. Six to eleven main grassland zones have been described. Grasslands are either under government control are open access or are common property resources

1.3 Laws and policies on rangeland management and conservation in Kenya

Environmental policies formulated by the ministry of lands and environment aims at minimizing good conditions of pastures, good water availability and quality, fertile productive soils as well as animals of good health condition, high production capacity and fertility levels in the herd. All these are addressed in order to prevent degradation of rangeland environment in the area. These strategies include controlled bush burning, directing runoff water to rangeland pasture area and increasing number of water points.

The national environment management authority under the district state of environmental report state that, rangelands environments are meant to maintain good conditions of pastures, good water availability and quality, fertile productive soils as well as animals of good health condition, high production capacity and fertility level in the herd. All these are addressed to, in order to prevent degradation of rangeland environment in Kenya. These strategies include, bush burning, locating water points, directing run off water to rangeland pasture areas among other factors.

Burning of grass is a major cause of concern to the environment. Uncontrolled burning result to high pollution levels it is also levels the land bare and vulnerable to be eroded by water and wind where the land lacks cover. Environmental law calls for controlled levels of pollution through minimizing intended activities that cause pollution. Such laws and policies are not clearly elaborated within the by laws of Mashuru county council. Furthermore, majority of individuals within the district was not aware of existence of such bylaws. This is one of the reasons for slow management of grasslands within this region.

Laws and Policies have constrained the movement of pastoralists and promoted sedentarization making them opt to burning grasslands. Previously pastoralist avoided risks by moving to others areas particularly during the dry periods. In S.E. Kajiado District, Kenya, land use conflict reflects the ongoing competition over access to scarce land and water resources between herders, farmers and wildlife - competition that has intensified strongly over the last decade, after the district became open to outside migrants.

Degradation of rangeland's environment in Mashuru division has been majorly attributes to pastoral activities which are characterized by overstocking, communal grazing, bush burning, inadequate information about the cattle grazing act (1995) as stated in the constitution of Kenya. Where continuous grazing methods, poor disease vector control methods, poor soil and vegetation conservation/management methods among others.

1.4 Background of study

Maasai land in southern Kenya and northern Tanzania has been subject to considerable vegetation changes since the beginning of the twentieth century. Over the past century, the area has passed through successive stages of transformation as the result of the interaction between four distinct, and probably cyclical, processes of change: change in vegetation; climate; tsetse and tick infection; and pastoral occupation and management. At the end of the nineteenth century, Maasai pastoralists had access to extensive grasslands (Waller, 1990). By 1910, wildlife numbers rose, Maasai herdsmen mostly use fire in these areas with the aim of improving pastures quality, clear bush lands which harbors tsetse fly or for establishment of farming units.

1.5 Statement of the problem

Communities' livings in Mashuru division, an extensive arid and semi-arid region predominantly occupied by pastoralist communities of Maasai origin rely on livestock's and their products for survival. Livestock production is the main farming system in these regions whereby nomadic pastoralism exists.

Nomads move from one place to anther in search of pasture and water for their animals. To enhance pasture regeneration, pastoralists use fire as a tool to control accumulation of old herbage, thereby stimulating re-growth of new grass of high quality nutrients.
There is gradual increase of pastoralists and in these regions and livestock's herds per person. Various reason which prompt different people in Mashuru to burn rangelands. Most livestock keepers usually burn grasslands in order to allow for fresh re growth of grass to livestock. During the last five years vegetation in Mashuru has declined as well as disappearance of various wild animals, which used to inhabit rangelands.

Grass levels have also reduced greatly and most people have been forced to move for long distances in search of pasture and water for their animals. In Koelel location in Mashuru division, individual communities usually burn grass during the dry season anticipating re-growth on the onset of a wet season. In dry when the land is bare dust from these rangelands usually fills all over in the sky. Heavy winds blow dust to houses making food, cloths and the entire region to be covered with dust. On the onset of wet season particularly in March to May the region receives heavy rainfall. In most cases this rainfall finds the land bare.

Unprotected soils are usually carried away by water due to absence of vegetative cover to stop this movement. Some regions have started experiencing instances of floods. In the rainy season the rates of floods levels has increased particularly in the flat areas all over Mashuru region. This has destroyed grass and other living organisms found in rangeland environment. Many herbivorous, insectivorous, omnivorous, and carnivorous birds, which inhabit the grasslands, characterize Mashuru division; antelopes and gazelles, which graze on grassland regions, have continuously been declining due to lack food.

1.6 Significance of the study

By introducing effects of fire in Mashuru rangelands, this information will be availed to the local authorities and other experts at the local level and the national level, upon which, decision making can be based in addressing the problems faced in the area. The research will provide clear guidelines to communities living in Mashuru on importance of abundance species found in grasslands and the need to protect such biodiversity. As public participation in this study will be highly encouraged this will ease implementation process.

Communities will gain information regarding grasslands and the need to protect and manage such areas. This will make them understand why it's necessary to keep few animals and avoid overstocking. This is one method of way maintain the region's productive potential and acts as form of maintain regular supply of grass through out the seasons.

This research will also be useful to policy makers in the ministry of environment, agriculture, livestock and economic development. Whereby, research-finding recommendations may be used as way of reducing poverty as stipulated in the Poverty Eradication Action Plan (PEAP). Lastly, the research study is an examination paper to be assessed by department of environment as the researcher's partial fulfillment for the requirement of the award of Bachelor of Science in Environmental Management.

1.7 Research objectives

The research intended to achieve the following objectives:

1. To examine the activities of nomadic pastoralists in Mashuru rangelands those require burning grass.
2. To find out the effects of burning grasslands on the environment.
3. To suggest measures that can control effects of burning grasslands.

1.8 Research questions

1. What are the nomadic activities of pastoralists in Mashuru division?
2. Why do Maasai burn grasslands?
3. What are the impacts of burning grasslands on the people?
4. What are the impacts of burning grasslands on the environment?
5. What are the measures to contain and minimize effects of fire on Mashuru rangelands?
6. What alternatives should be used instead of burning grasslands?

CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction

Throughout world, many hectares of land covering grasslands have continuously been subjected to fire annually. Effects of fire on the environment resulted to alteration of resources between different regions of the world, what was once palatable grass has changed to other form of grass resulting to its alteration.

2.1 Rangelands

The environment is the basic determinant of the nature and productivity of rangelands ecosystems. Physical environmental factors like climate topography and soil determine the potential of rangelands to support certain types and levels of land use. Within the limit set by this potential, the influence of pyric (fire) and biological environmental factors (grazing, tree cutting and cultivation) leads to different types of vegetation and levels of productivity. Therefore understanding of how various environmental factors affect rangelands is crucial to successful range management.

Rangelands of sub-Saharan Africa have undergone dramatic changes in terms of development policy and land degradation during the past three decades Behnket et, al (1993). Many organizations such as the World Bank and United Nations have invested a lot of dollars into range and livestock projects in the oral zones of sub-Saharan Africa for three reasons; to improve livestock production after droughts in these areas, improve economies of grassland areas and increase veterinary services, settling nomads, and improving systems of grazing based on strengthening the pastoral economy and reverse land degradation linked to overgrazing problems of the Sahelian rangelands.

2.2 Impact of burning Grassland zones on environment.

Fire has been man's most powerful tool in shaping subtropical and temperate ecosystems since time immemorial (i.e. Bird, 1995). "Grasslands fires, intentional or un-intentional, have wrought startling disasters". As a result, they have swept over enormous areas. Humans have exclusively altered the global environment changing the global biochemical cycles transforming land and enhancing the mobility of the biota.

Extinction has resulted to widespread changes in global distribution of organism. Loss of

biodiversity has altered ecosystem process resilience to environmental changes. The end of the twentieth century has witnessed unprecedented changes, such as extinction of different plants and animal species. All this is attributed to loss of biodiversity in different regions of the world. Biodiversity refers to variety of life and all its processes where both animals and plants are expressed as ecosystems, species and genetic diversity levels. Loss of biodiversity has generated international concern and many debates, it relates to the disappearance of species and ecosystem affecting the general environment.

Human carelessness or deliberate arson is one of the major causes of fire in grassland regions; there are fewer cases, which can be attributed to lightning. Weather conditions influence the susceptibility of an area to fire; factors as temperature, humidity, and rainfall determine the rate and the extent which inflammable materials dries, therefore combustibility of the vegetation. Wind movement tends to accelerate drying and increase the severity of fires by speeding up combustion.

The first settlers in Africa burnt the savannah grassland in-order to clear land for agricultural purposes. By clearing such huge chunks, of land a number of important elements found in grasslands disappeared. During this period, there was little knowledge concerning the usefulness of grasslands. Burning is perceived as a component of change. A given side can be right or wrong, but if one side defends, only an extreme interpretation it can go wrong. All these will depends on the local situations. Realities are not white or black but frequently grey. Nature should be considered in a differentiated manner. The results of a fire can be very devastating the negative balance predominates, if there is continuous burning of grass, which is uncontrolled, negative outcomes, are likely to occur. The early civilizations developed near temperate grasslands, shows that humans had interest on these kinds of ecosystem of quite long period.

Grasslands regions were inhabited by animals, which were hunted and provided food to communities living around them. A domesticated animal such as livestock has obtained their food from grazing in these areas. In California, burning of vegetation is attributed to undesirable climatic changes particularly in dry season. This accelerates temperature changes resulting to a decrease in rainfall patterns.

These affects landscape heterogeneity where spatial distribution of burnt and unburned areas may be affected, having an influence on re-establishment of new plants species in the already burnt sites. The major type of vegetation, which ultimately develops under a given set of climatic conditions, determines the climax vegetation type, Because rainfall tends to be relatively low, soluble nutrients remain in the soil and productive grass promote development of organically rich topsoil, thus soil tends to be inherently fertile.

As a result, most temperate grasslands have either transformed to grain crops or used to support domestic grazers, particularly cattle goats and sheep. In the process, large native grazers and other predators have been virtually eliminated. Natural grasslands have been extensively destroyed by various human activities such as burning of grass for different purposes; this has resulted to modification of grasslands resulting to introduction of alien species

2.3 Impacts of fire on biodiversity

Convention of biodiversity under the auspice of UNEP adopted in (1992) aimed to conserve and protect biodiversity through sustainable use of resources by fair equitable sharing o benefits. One of the major problems facing biodiversity is large scale uncontrolled fires, which have increased world wide for, last 1 decade. Estimates suggest that fires have adversely affected over 20 million hectares of vegetation worldwide.

Various reasons have prompted different communities to burn grassland ecosystems. Most livestock keepers usually burn grassland in order to allow for fresh re-growth of grass to there livestock's. As a result, this has greatly affected grassland regions where bare land has accelerated the rate of soil erosion; there has been disappearance of various plants and animal species. Leading to loss biodiversity where different plants and animal species are facing extinction. By destroying, they're natural habitats in which many animals and plants depend on for their survival.

Grazing affects species diversity and richness (Oba, and Stenseth, 2001). Traditional management systems by pastoralists recognized the need for controlled access to conserve the biodiversity and allow grasslands to recover. They were more effective to sustainable resource use and maintenance of grassland condition

(Pratt and Gwynne, 1977). However; the traditional systems are under threat from increased livestock populations' and decreased grazing lands, resulting in increased grazing pressure. This is already being recognized by Boran pastoralists in Ethiopia, who perceive that the conditions of rangelands poor as compared to 30 to 40 years ago (Angassa and Beyene, 2003) and consider the rangelands degraded and their livestock production declining.

Grass and other forage plants, which form the dominant type of vegetation, dominate grassland zones. Occasional fires and intense grazing of animals are the main factors preventing generation of grasslands. Grasslands form an ecological zone lying between deserts and temperate woodlands that include a wide variety of plant communities. Grasslands are composed of sod-forming grasses and perennial grasses and herbs.

Grasslands zones have been cultivated and used generate livestock's pasture and used for different purposes. Overexploitation of grasslands tends to denude soils nutrients leading to desertification. Diversity of vascular plants can be quite high in grassland areas (from 50 to 200 species depending on the latitude), but usually two or three species form upwards of 60 per cent of the biomes above ground level.

Destruction of grassland ecosystem have resulted changes in the environment whereby temperature changes, have been experienced where massive grassland regions have been cleared. These is mostly experienced where various elements from these zone are burnt up when they mix up with other elements in the atmosphere causing effects of global warming on the environment. Which is a serious problem today? In addition, the smoke produced through burning grasslands causes a great danger to human health, such poor visibility and breathing problems.

Photo 1: Heavily grazed grassland in the highlands near Blue, Ethiopia

Source: C.J. WILSON Ethiopia

Instance of land reclamation in Patagonia took similar course like in other parts of the world. In Australia (Pysne 1991). Extensive burning of grasslands by Pastoralist was an economic and ecological engine of European settlements. The early pioneers looked for pasturelands and used the power of fire to clear grasslands. It aimed to transform marginal grassland to other form particularly for cultivation. It was believed that fire could reduce weeds, control pests and slow down the re-invasion of scrubs. This resulted to destruction and reduction of grassland zones

Burning in pure and den stands of *Austrocedrus chilensis* resulted to extreme behavioral changes resulting to high rate of spread, prolific crown fire that spotted high accumulation of fuels into the atmosphere. Grass and shrubs are enough to create fires with lethal effects to the environment, which produce harmful chemicals in the atmosphere. Regeneration of different kinds of grass species can take more than 20 years to be re-established. Burning of grasslands causes enormous damage all over the world. In West-Sichuan. Areas inflicted comprised were estimated to be 755,000 ha (which is 6.3% grassland) with an annual average of 60 cases fires instances, severe effects have been experienced in this regions whereby huge chunks of land lie dormant because they can not withstand any growth.

Grassland is mostly inhabited by livestock keepers who rely grass as a souse of food to there animals. Overstocking of animals leads to exhaustion of grass. As a result burning

Grassland is mostly inhabited by livestock keepers who rely grass as a souse of food to there animals. Overstocking of animals leads to exhaustion of grass. As a result burning of grass takes place, with expected intention of re generation of nutritive grass on the onset of a wet season. Tibet. Tafel (1914: 254) concluded from his observations: that "Any pastoralist's whether Tibetan or any there nomad is an ardent enemy of grassland regions". Ward (1947: 73) recognized grassland regions are usually cleared to pave way for other activities normally agriculture and other forms of commercial purposes.

Burning of vegetation lead to destruction of conifer-rhododendron making them to be scarce in these areas. In this case, Burning extended slowly, nevertheless with a catastrophic effect whereby vegetation disappeared in the end, where long periods of regeneration have taken along time and are still taking place. Mesic sites a sharp transition between the intact grasslands First fires can be seen as favorable when bio-diversity is criterion for the review and minimal impacts can be observed. The initial homogeneity disturbed by fire; where grassland zones were transformed into mosaic structures. Loss of biodiversity in particularly disappearance of habitats which covered immense areas have drastically been reduced in Australia to fragments where vegetation has been degraded or destroyed into fragmented. Causing migration of birds and other form of animal species.

Destruction of plant roots experienced was because of soil surface inhibiting water for absorption of young plant growth and soil aeration being subjected erosion. When grasslands zones are cleared through burning, the land is, bare this causes high water runoff, caring away the topsoil and other nutrients in the soil. Succession stage is a very crucial period and plays an important role by spreading of fire. Therefore, it should be discussed more details. Shrubs are usually dominant; whereby areas dominated by Ciprés have been drastically reduced by fire; only a fraction of former grasslands exists at present. In transition to the steppe xeric conditions. The Lenga region has also been strongly decimated to drier sites, (e.g. Pre-Cordillera), from the stripe remained medium-sized islands.

However, grazing of livestock's is still practiced but with minimal gains. Approaches to replace these species with exotic ones such as (*Pinus ponderosa*) were considered. On the xeric sites, combination of animals and fire in grasslands is a fatal. The regeneration does not get on, but in the meantime, fires destroy native grasslands. Recent studies have shown that primeval grass would contribute more to a region productiveness through the modern technology grasslands can be developed for tourism, research or even as recreation centers. This will be a reasonable action to achieve financial advantage of grasslands, which will be self-sustained particularly to communities living around and will be a long-term effort as compared to burning which aims for short-term gains

The pastoral explosion not only destabilized indigenous biota but also modifies them making there reconstruction impossible. A long-term effect of fire on a landscape varies according to sequences of fire events, rather than to a single fire event. Sequences of fire events are known as 'fire regimes'. In these view a single instance fire may result to minimal destruction of vegetation but the sum of frequent uncontrolled fires is most disastrous. This disaster is not only ecologically distrustful but also results to economic strains. In southern Australia, millions of hectares of native grassland have disappeared irretrievably in the last century.

Fire regimes are determined by three factors: intensity (how severe fires is), frequency (how an often fire occurs) and season (the time of the year, fires occur). The frequency of fire affects growth cycle of plants. Plant communities vary in response to periods between fires as well as present species. Species, such as Mountain Ash (*Eucalyptus regnans*), may not survive if fires are too frequent, as plants are unable to reach maturity and produce sufficient seed before the next fire episode. In this case, Mountain Ash is replaced by other different species adapted cases of frequent fires, such as Messmate (*Eucalyptus oblique*). Infrequent fires may displace plants that require fire to assist with their regeneration, such as most heath species.

Photo 2: Large non-ruminant herbivores - zebra herd - Athi plains Kenya

Source: R.S. REID Kenya

2.4 Ways in which fire affects the vegetation and land's productivity

One of the most controversial and debated aspects of research about pastoral systems is the existence and extent of burning grasslands, overgrazing, and desertification leading to land degradation in pastoral lands, particularly in Africa. GLASOD, (1990) maintains that much of the earth's land surface is degraded and that overstocking and use of fire are the principal global cause of desertification (Mabbutt, 1984). However, other analyses show that livestock numbers only exceed likely carrying capacities of arid and semi -arid rangelands in about 3-19 percent of Africa (Ellis *et al.*, 1999) while burning result to re-growth of short grass but in the short run.

Annual variations in amount, distribution of rainfall, grazing effects, fires and human activities, have resulted to wide spread variation in grassland productivity (Walker, 1993). Rangeland ecosystems are very resilient, and can only recover well when there is sufficient rainfall and controlled use of the resources. Burning land results to profound effects on the soil's nutrient dynamic composition and dry matter (DM). Studies conducted in Athi river District in Kenya to investigate effects of range vegetations from burning, indicated that there were instances of chemical changes immediately after burning in the soils studied.

A study conducted in two adjacent sites; in one region, herbage subjected to a backfire while the other region it slashed up to ground level and classified as zone A and B respectively. Before planting, legumes and other soil samples collected using soil auger at a depth of 0-15 analysis were conducted for pH (H2O), organic carbon (C), nitrogen (N), phosphorus (P), potassium (K) and calcium (Ca).

The results indicated soil pH from zone b that was slashed to ground level as (5.25) significantly higher than in burnt site (5.06). Similarly, organic C was significantly higher in zone b as (1.34 %) than zone A, which was (1.29 %). However, the soil's N, P, K and Ca levels increased after burning with N and P achieving a significant increase while the increase in K and Ca was not so significant. Specifically soils with N content were significantly higher in zone A as (0.16 %) than in zone B (0.15 %). Similarly, the soils with P were significantly higher in zone A than zone B. Potassium levels in burned site (1.25 %) was higher though not that significant than in unburned site (1.20 %). Calcium levels were also higher in burned (5.34 %) than in unburned site (5.12 %).

Increased nutrient availability in the burned site may be attributed to treatments, which manifested to 54 % more DM yields than in unburned site. In addition, Glycine grown as monoculture yielded more DM in burned site (6.87 t ha-1) than in unburned site (4.81 t ha-1). Introduction of legumes as mixtures into natural pasture, showed their pattern to be similar. The results showed that fire could act as a mineralizing agent of nutrients mobilized in foliage to enhance nutrients and generation of plants and other forms of vegetation in the short-run.

At the same, time other nutrients are likely lost through volatilization, runoff and leaching to deeper soil layers. In addition, the results imply that soil chemical changes caused by burning vegetation affects the growth of Glycine in different ways, these should be further investigated. Bushfires may result to biological, chemical and physical effects into the soil. Occurrence or extent of these effects in soils depends on the fire's intensity and temperature present in the soil. Mostly, only the top few centimeters of soil are normally affected because they are subjected to the high temperature levels.

Fires of low intensity usually cause biological effects such as sterilization (or death of living tissue) within the soil. Higher soil temperatures (greater than 100°C) may alter soil chemical structure, by changing amounts and availability of nutrient levels such as nitrogen, phosphorus and ammonia. After burning of grass the already left 'ash-bed effect', increase the fertility of the soil. However, these nutrients are relatively soluble, and may be rapidly washed by rainwater. Fire cause changes in soil permeability (ability to absorb moisture) and alter soil structure. The removal of grasslands by burning exposes the soil to wind and water, which are agents of erosion. These makes soil susceptible to erosion, whereby, heavy rainfall amounts pounds on bare land without any form of vegetation to hold water. This causes massive erosion, mudslides whereby such regions are prone to floods.

In Baringo district rift valley province in Kenya, continuous effects of burning grasslands have resulted to desertification. In addition, changes in natural vegetation lead to introduction of other form of vegetation types which livestock's and other animals fed on but with time a number of animals developed certain changes such as loss of teeth, eye sight and in some instance others have died. Implications in human health are also a problem whereby smoky environments from grasslands have affected the lives of infants and old members of the community who are vulnerable to diseases.

2.5 Minimizing fire effects on vegetation's

Most pastoral areas, livestock are used as a social "safety net", an exchange cementing to mutual obligations to help each other in times of need. As well as a significance symbol of wealth and prestige, and owners are reluctant to sell. Sheep and goats are usually sold to raise cash for household needs. Although marketing of livestock products (milk, meat, hides) in pastoral systems, maybe relatively new phenomenon on pastoral peoples should be encouraged to do so particularly those who live near markets and roads should sell their products to earn some incentives. In addition these would reduces cases of overstocking which would be one way of averting all other problems, which advocate for burning of grasslands.

One of the most important elements in controlling impacts of fire is through understanding their effects on the environment. Land-based system is a way of detecting instances of fires. Impacts of human-caused fires on the environment may be characterized into different forms: ground fires, which burn the humus layer of the vegetation floor but do not burn appreciably above the surface; surface fires, which burn vegetation undergrowth and surface litter; and crown fires, which advance through the tops of trees or shrubs. In some cases, this can occur simultaneously.

Once established, ground fires are very difficult to extinguish. When humus layer is not very deep, ground fire may be extinguished using water or sand. In most cases, digging trenches around the site normally controls an instance of ground fires. In some cases, ground fire temperatures increase resulting into surface fires below the soil surface. Undersurface fires usually burn soil particles and other microorganisms through high temperatures. Surface fire can be controlled using by clearing the surrounding areas with low vegetation and litter, or digging emergency furrows in confined areas. Crown fires are difficult to extinguish. However, they can be controlled by allowing a specific area to burn out, halted by streams, or else backfire method may be applied to limit fire from spreading to a wide area. Backfiring involves a consistent and carefully controlled method of burning strips of grasslands, forests and other vegetation that have been subjected to fire.

In this case backfiring takes place on the leeward side of the blazing inferno, when fire gets to the site it finds no room for spreading any further. Fire management programs are extensive in many countries due to technological advancements, which include prevention, control and management by establishment of fire-fighting personnel who are well trained. More research in managing cases of fires particularly in vegetation's should be done. Grasslands are considered one of the most threatened environments in North America. Many conservation initiatives have been carried out to protect this ecosystem at a national level, especially within and between Canada and the United States. Mexico's potential importance, however, cannot be overstated; this country hosts the largest black tailed prairie dog colony remaining in North America. Since 2000, the three federal Wildlife Services of North America have agreed to work together to protect 17 species of wild birds and mammals considered as (SCCC).

Given that the majority of these species are associated with grasslands, the CEC organized workshops, with the assistance of the three governments, to establish the foundations of a conservation strategy for these species. This has enabled residents around grassland areas by giving them basic education concerning grasslands and the need to protect and conserve grasslands. This has enabled them to control and manage any arising case of fire outcomes. It has also raised awareness among individuals in the three regions. However, in the case of Mashuru division, an instance of grassland fires is deliberately ignited by individuals within the district unlike in North America where fire arises due to arson and natural causes.

An introduction conservation and management initiative by many states aims to protect grasslands national and binominal level. Whereby, various animal and species are located in grasslands. A shared vision should emphasize on the need to protect grassland, through conservation and management. To achieve such a vision, it requires an enhanced understanding of emerging trends and development of grasslands throughout Kenya by identifying areas to conservation manage and protect.

2.6 Control Nomadism

Nomadism involves the irregular yet cyclic movement of pastoralist and their herds (1993) these migrations contrary to widely held misconception routes and follow frequently repeated travel pattern Udo (1993). Nomads often establish settlement at selected locations in their travel routes, giving them the opportunity to cultivate some grains that are essential to their diets Udo, (1995). To control nomadic activities Mauritania government through its plan for modernization of rangelands into and livestock improvement projects have boosted pastoral related services. Where communal grazing has been regulated and most pastoralists have started keeping livestock's as well as the paddocks have been set up to try and maintain grass levels in this region.

Numerous observers have stressed the uniqueness of the social and political structure of pre colonial Moorish society in which the apparent rigidity of status and hierarchical positions both confirmed and cut across the political control of a territorial space within ill defined boundaries.

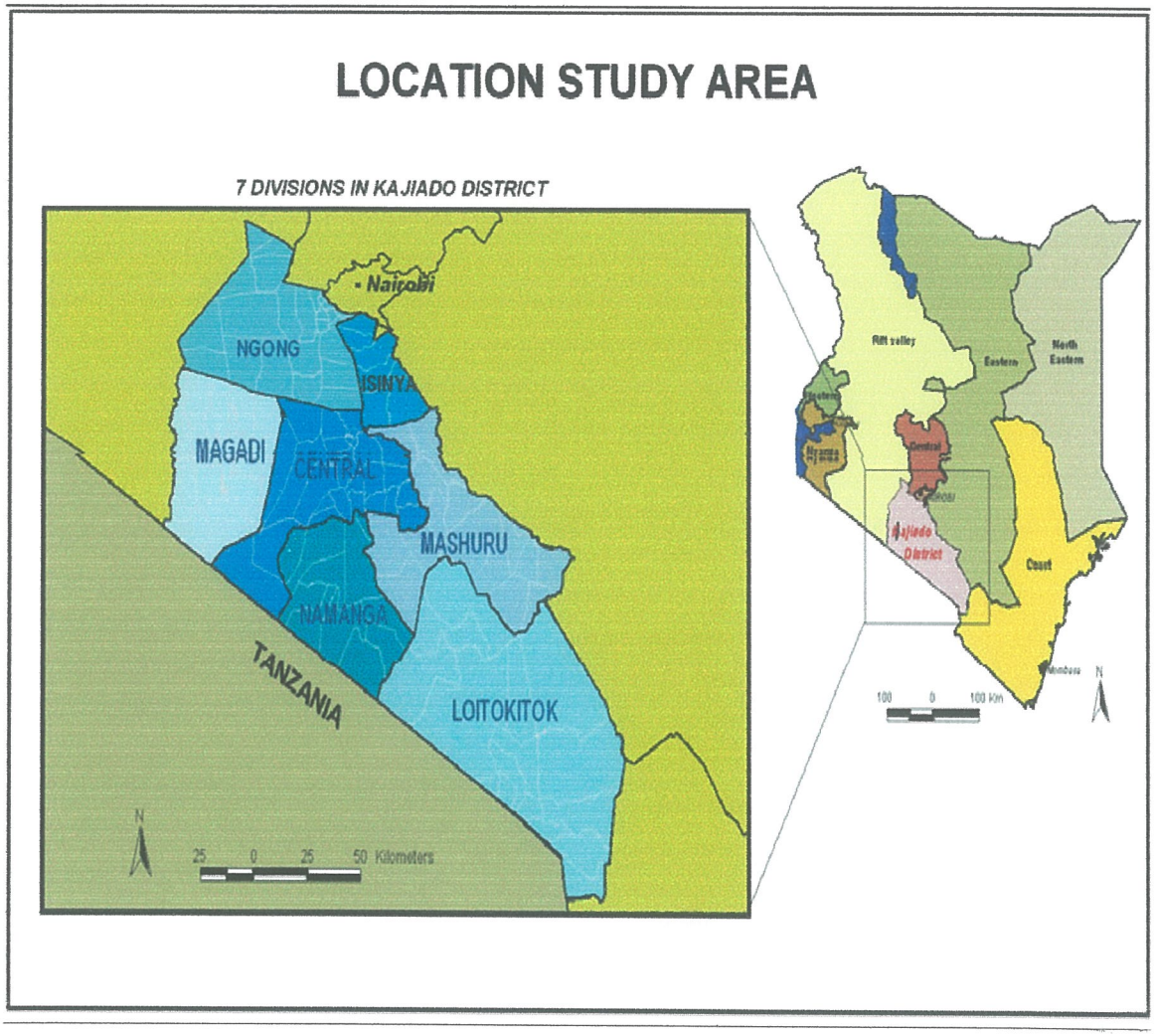
What was the nature of this hierarchy and political control, how has the evolution described above of the economic context, and particularly the extension of commodity relations affected this organization. What does the change of institutional judicial and ideological framework of nomadization that has occurred since colonization mean the future of pastoralism?

2.7 Restorations of burnt rangelands

Control burning involves restoration of already burnt lands, which are normally faced by direct blowing of wind. Through restoration of rangelands, pasture weeds that are not grass species on range are reduced thus improving pasture composition in rangeland environment.

Strategies formulated for minimizing burning of rangelands environment in many parts of Africa where rangelands environment burnt have started to be restored. In northeastern province in Kenya, burnt rangelands areas have been transformed by planting of new grass species particularly xerophytes species that withstand harsh living conditions found in arid and semi arid region.

Map 1: Map of Kenya Showing Location of Mashuru



CHAPTER THREE: METHODOLOGY

3.1 Geographical background of study area

3.1.1 Location

Mashuru is located on geographical coordinates of (WGS84) at Latitude: -2 03' 00" and Longitude: 37 07' 00". Kajiado district is one of the 18 Districts found in rift valley province in Kenya. The district covers an area of approximately 21,902.9 km² and is divided into 7 divisions namely; Ngong, Magadi, Isinya, Central, Namanga, Loitokito and Mashuru division. Mashuru division is one of the 7 within Kajiado district and it's located in the southern part of Rift valley province. It borders Machakos district to the north, Makueni district to the east, Isinya to the west and Loitokito district to the south. The division covers an area of approximately 1066.3 km² and is divided in 8 locations. With a distance of around 150km^2 away from the capital Nairobi, along the Nairobi – Arusha highway.

3.1.2 Climate

Mashuru division lies in the semi arid and arid zones. Only 8% of the division land is classified as having some potential for rain fed cropping. Most of this is in the Athi-Kapiti plans, close to Isinya division, mean annual rainfall ranges from 300-800mm. Rainfall is bimodal, with short rains from October to December and long rains from March to May. Distribution of rainfall between the two seasons changes gradually from east to east across Mashuru division. In eastern Mashuru, more rain falls during the long rains. The region the region receives average annual temperatures of 22^{0}C with minimum temperatures of 22^{0}C and maximum temperature levels ranging from 30-32^0.

3.1.3 Demographic and Populations profile

Mashuru division has a population of approximately 14,928. 50% of the total being at the age of 2 to 14 years with annual growth rate estimate at approximately 2% (1999 population census). The division is fairly populated built on low medium housing dominating the region. Indigenous community is mostly comprised of Maasai but there is an increasing influx of people from other tribal groups from other parts of the country migrating to this area.

3.1.4 Relief and Topography

Mashuru division is located on a flat terrain and forms an elevated basin of the Eastern African rift valley lying at an average altitude of about 1432m above sea level. The landscape consists of plains plus some volcanic hills and valleys. It a dry region with few continually flowing rivers.

3.1.5 Vegetations

Vegetation is fairy uniform in accordance to the ecosystem. Vegetation differs from grassland savannah found elsewhere in Kenya. The cover is open with patches of bare ground easily visible between plants. Perennial grass is usually less than three feet high with narrow basal leaves, which are usually folded. This enables them adapt to drier climatic conditions, which prevail in this region. In addition, numerous annual grazers are found in these areas.

Vegetation growth is influenced by climate and settlements. Savanna grassland is the most dominant type vegetation found in this region. This is classified into two main groups of dominant species of hyperthermia and *Themeda* both with grass cover of 400cm high tree and scrubs are generally scarce.

3.1.6 Soils

Soils are product of action of climate and living things on parent rock material under the influence of relief and drainage over along period of time. Mashuru soils are entirely Ferrallistic. They are mainly sandy loams and clay with fine granular structures. Productivity of ferrallistic soils depends on availability of rainfall.

3.1.7 Social Economic Activities

Management of livestock is the most common economic activity in Mashuru .The area is devoted to grazing, according to veterinary department reports; Mashuru division has 68,021 herds of cattle representing 35% of the 180,400 total herds of cattle in the district.(Source: livestock census in the district 2005). It's mostly attributed to the culture of the people who are pastoralists (Maasai tribe) as well as the major biome in this area being a rangeland zone, which favors livestock keeping.

3.2 Methods

This chapter highlights how data was collected, analyzed for the purpose of the study. It mainly focuses on general design of this study in relation to sample design, sample size, tools of data collection, data analysis and limitations faced in the course of this study.

3.2.1 Research design

A descriptive research design was used; these provide ways of describing many situation, opinions and perceptions of respondents in these region.

3.3 Study population

The study represented all stakeholders within Mashuru who included; divisional environmental officer, community, the areas chief and his sub chief, Koelel location sub clan heads, youth leaders and cattle keepers within Mashuru division.

3.4 Sample size

Due to nature of study and time frame, a total of 25 individuals were interviewed in different homesteads within Mashuru division. The research investigated on 1 the divisional environmental officer, the chief, sub chief, 3 clan heads, 4 youth leaders and 15 cattle keepers from the community on household basis.

Table 1: Showing Representation of sample size from different respondents

Respondents	**Male**
Chief	1
Sub- Chief	1
Divisional Environmental officer	1
Youth leaders	4
Clan heads	3
Cattle keepers	15
Total	**25**

Source: OCC, Ol Kejuado County Council

3.5 Sampling framework

3.5.1 Sampling design

Simple random sampling involved giving numbers to every subject of study; in selected locations and sites used in this study. This technique was important in that it was easy to collect samples from various people within Mashuru division. The technique also helped to gather important information from various respondents in Mashuru division.

3.5.2 Sampling technique

This involved giving every individual within Mashuru division an equal chance for participation. Assessments were made from various techniques frequently employed in the uptake of new technologies to overcome certain obstacles within the study. This was preferred because it gave out a representative data that covered a large area. Purposeful sampling of key informants involved the divisional environmental officer who had substantial knowledge in regard to the area of study. Koelel location was also selected due to the fact that most of burning of rangelands is mostly practiced in this region than anywhere else within Mashuru.

3.6 Data collection instruments

Mode of colleting data involved combination of tools, whereby primary and secondary sources of data collection were used. The researcher was directly involved in data collection particularly in the field, through observations, administering questionnaires to the divisional environmental officer and interviewing cattle keepers and clan heads within Mashuru.

3.6.1Questionnaires

A designed questionnaire was administered to the areas divisional environmental officer. Only one individual was selected partly because most respondents in Mashuru division were had poor educational background and were not in a position to read or write questionnaires. Divisional environmental officer was selected because he had professional knowledge regarding the areas environmental status and past and emerging issues regarding rangelands zones of Mashuru for the last five years thus enabling easier interpretation in the questionnaire.

3.6.2 Oral Interviewing

Interviewing process involved all people where it was a face-to-face instance with respondents. Selection of different individuals per every 500 meters within various locations visited. Majority of people in Mashuru division have only basic education whereby most of them cannot exclusively fill in questionnaires. Thus, the idea of interviewing was one of the best alternatives used in obtaining information from these individuals. Through interviewing, the researcher was able to probe respondents in giving in-depth information. Interview schedules helped to capture oral response particularly from those unable to fill in questionnaires. Mostly old people within Mashuru community who had poor educational background yet they had cumulative indigenous knowledge regarding rangelands in this in this region. Where language barrier was a problem interpreters were used. This was mostly helpful for the purpose of clarity.

3.6.3 Direct Observation

This method was specifically used to view the situation on the ground level. Observation involved visiting various areas within Mashuru division. Such information was added this research and helped in enhancing accuracy of these study through direct interaction with the environment. For example, areas where burning of grass were evidenced, common economic activities in these area, levels of grasslands, and numbers of herds among other factors. These helped the researcher to acquire additional information which was not availed from other methods.

3.6.4 Photography

Photographing helped in backing up study findings by providing rich detailed information about the physical appearance of the study area. By showing relevant pictures of rangelands of Mashuru, areas affected by burning, common economic activities practiced and animals grazing in rangelands in Mashuru division.

3.6.5 Library search

This method involved use of other related literature to provide information about effects of burning grasslands on the environment and its remedial measures at the world and national level. This included the National Environmental Management Authority (NEMA), Jomo Kenyatta, Macmillan press and British Council libraries. As well as information from various magazines, journals, textbooks, daily newspapers and the Internet source.

3.6.6 Data analysis and presentation

Data analysis involved qualitative and quantitative methods. Quantitative method involved variables such common activities practiced in the area, the level and extent of rangeland degradation and effects of burning on the environment. Qualitative method involved issue such as perception and altitudes of pastoralist communities and problems faced by pastoralists. Frequencies and percentages of various variables were generated through tables, pie charts and graphs given in chapter 4 as outcome of this analysis. Providing a clear way for data interpretation.

3.7 Limitations

Since Mashuru division is mainly composed of Maasai communities who are deeply entrenched to there cultural values and practices, certain limitations were evident in preparation of this research. At first, the researcher faced considerable resistance from the local communities particularly pastoralists who graze there livestock's on rangelands and thought they were being investigated. I managed to overcome this obstacle through assistance from the areas chairman in collaboration with the local leaders. As a result people understood my intentions and I was able to continue with may research. Although my research went on smoothly in some instances, individuals failed to give detailed information whereby they withhold details where else some never completed questionnaires and others refused to be interviewed. In some instances, those who agreed to be interviewed asked for small gifts in return. In addition,

Mashuru division is composed of both literate and illiterate individual's instances of language barrier were evident. People will poor educational background could not manage to fill in questionnaires and to add salt on an injury some didn't understand English or the national language Swahili thus it was difficult to communicate o them. Although later this problem was solved with the help of my friend Zurich, who hails from this region acted as my interpreter.

Other minor problems experienced were poor infrastructure, some roads could not be easily accessed, lack of transportation was also common when available it was too expensive and required the researcher to dig dipper into his pocket. In some cases, the researcher was forced to walk for long distance; this envisaged to tiresome evenings, later this was solved with the help of a bicycle from friends around. In most cases, pastoral communities tend to be resistant to any form of change. Whereby, they view such instances to be clashing with there cultural values. Thus for any change to be effectively implemented in such areas, endurance, awareness campaigns and sensitization programs be undertaken often.

CHAPTER FOUR: PRESENTATION, DISCUSION AND RESEARCH FINDINGS

4.1 Common activities practiced in Mashuru division

4.1.1 Nomadic pastoralism

In Mashuru division, pastoralist activities mainly include keeping of cattle, sheep and goats. The main economic activity in this region is grazing animals on large areas of grassland. Grazing of cattle in Mashuru is carried out on communal basis where different individuals take their animals in the rangelands to join other animals on the grazing fields. Mashuru rangelands belong to the entire community and every one has an equal opportunity to graze his animal in this land as long as he belongs to that community of Maasai origin. Many households from this community have more than 200- 300 herds of cattle. An individual with many herds of cattle is considered wealthy among the community members.

Photo 3: Rangelands of Mashuru division

Maasai livestock grazing in *Themeda* grassland, southwestern Kenya.

Nomadic pastoralism in Mashuru involves the following practices

4.1.1.1 Burning of rangelands

Burning of grass is mostly practiced towards the end of the dry season. Respondents said that they burn grass to encourage fresh growth and control common weeds such as *Lantana camara.* There is high anticipation of re-growth to grass for livestock particularly during the onset of a wet season. In most instances grass re-growth normally occurs when there is sufficient rainfall.

Table2: Periods and Season when burning of grass takes place

Period of the year	Season	Frequency	Percentage
January – March	Onset of wet season	28	70
April – July	wet season	7	17.5
August – October	Onset of dry period	2	5
November - December	dry period	3	7.5

Source: Data Survey 2007

4.1.1.2 Watering of animals

In Mashuru, majority of water point's areas are communally owned, where the main purpose is watering animals and other domestic purposes such as cooking and drinking. Watering points are usually full particularly in the wet seasons when there is plenty of water from the rain. Pastoralist drive there animals to common watering points at different time intervals within the day the main reason to this is to allow each individual in the community to have an equal chance to water his livestock to avoid any form of conflict. Particularly mixing of animals mostly those not branded.

In some water points, animals drink water directly from the wells, although this is a great health hazard because the same water is used for domestic purpose. This issue has continued unattended. In other watering points, water is drawn from the well in special troughs which are mainly made of clay and mud are filled with water using jerry cans and animals take water form this trough. This method is appropriate in that water from the wells is not contaminated and it acts as a way of maintain water quality and averting water borne diseases such as Bilharzias and Typhoid.

When the dry season hits the region for long periods particularly in the month of November, pastoralists are forced to migrate to other regions in search of water. As a result they walk for long distances out side Mashuru and even beyond Kajiado district for this reason. Water is normally retained in these wells to feed livestock's during the dry season when there is scarcity of water in many seasonal streams in Mashuru.

4.1.1.3 Treatment of Livestock's

Insects and ticks serve as vectors in transmission of disease causing pathogens to livestock's. Although animals are grazed communally treatment of animals is usually done individually. Spraying of animals is the most common treatment exercise in this region. Pastoralist spray there livestock's mostly after the end of 1 week using spraying pumps, by spraying ticks are controlled from animals. The most common Acaricide used is Triatick which is commonly supplied in this region.

Traditional methods used by pastoralist for treating animals involve use of natural herbs and scrubs the most common herb used is the 'Neem' bark and ' Muarubaine' known in the local language where its water is sprayed to livestock's to protect their skin from infectious disease and pests. Vaccination of animals is also done but this exercise is normally conducted by the divisional veterinary officer who visits Mashuru division after every two months vaccinating animals. The most common type of disease which animals are vaccinated against is foot and mouth and anthrax which are both infectious diseases.

4.1.1.4. Grazing of animals

In Mashuru division grazing of animals is carried in communal basis where individuals particularly young 'Moran's. These are young men from Maasai community who have been initiated into adulthood and there main responsibility is to graze livestock on behalf of other members of the community in the grazing fields. Mashuru rangelands belong to every member of the community where each member has a chance to graze his animals.

Grazing of cows is usually undertaken in flat gentle plains where ***Themeda*** grass species is usually dominant covering wide areas. Ships and goats are grazed on hilly and sloppy plain where shrubs and grass are found. Animals are usually driven into grazing land from around 9.00am in the morning up to 1.00pm where they are taken to different watering points and continue grazing again up to 6.00pm in the evening when they are driven back to different households.

4.1.1.5 Breeding of livestock's

In Mashuru division and entire Kajiado district, breeding of livestock is not managed. The most common practice used is natural breeding where male bulls mount female cows and mate. At least every household have there own bull which perform this exercise particularly in the grazing land. The bull with high libido mostly dominates this exercise among others in the herd.

Artificial insemination exercise of breeding cattle's is not common in Mashuru and other district in Kajiado district. Most people in Mashuru division being Maasai considers this exercise not helpful where they say it interferes with the natural way and they reject this breeding method to there livestock's.

4.1.2 Cultivation

Cultivation involves tilling of land, cutting down of bushes to open up farmlands, creating channels to direct run-off water to farming units. Farmers in Mashuru start cultivating their land during the start of rainy season. Crop rotation is confining or growing of crops in a particular unit in one season or period of time, before shifting to another piece of land in the next season this is aimed to enable land regenerate discouraging emergence of pests and weeds.

4.1.2.1 Clearing of land for cultivation

Farmers usually clear there land for cultivation particularly during the start of rainy season where bush are cleared in different ways to create space for planting food crops. Farmers usually use two main methods in clearing of lands in Mashuru division. Burning of rangeland which is aimed at clearing shrubs and other vegetation in the field it also aims at killing animals in grassland and scare others away such as snakes and rats.

Another method which is used in clearing vegetation in rangelands by farmers involve cutting down of vegetation trees which might hinder effective planting exercise. Farmers cut down vegetation and tall plants in rangeland to reduce and control weeds not to compete with there crops during germination period and allow smooth planting exercise to be conducted.

4.1.2.2 Cultivation of Crops

Commonly used tools for crop cultivation in most farmlands in Mashuru are 'Pangas' and hoes grasslands are set on fire to clear presence of grass, shrubs and other vegetation to pave way for introduction of crops. Subsistence farming is the common farming practice in Mashuru division. Staple food crops produced included; grain cereals such as maize, sorghum, millet and legumes like pigeon peas, cow - pea, green grams and beans. Other assortments of crops such as cassava and vegetables also cultivated. Water harvesting from the rain and seasonal rivers is used in most farms in Mashuru. Crop farming is a recent phenomenon in the region and it has been introduced by people have been constantly migrating to the region over the last ten years. Farming land units usually cover 5- 10 hectares. Majority of this people who practice farming also keeps livestock's

Table 3: Production of various key crops in Mashuru division

Crop	**Acres**	**Yield**
		in bags
Maize	5.6	21.3
Sorghum	1.6	2.4
Millet	3.1	3.8
Pigeon Pea	4.9	4.8
Cow peas	3.9	3.6
Horticulture	1.8	1.8

4.1.3 Marketing of Animals and their products

In Mashuru division an open market operates every Tuesdays where trading activities takes place. Buyers and sellers converge in Mashuru trading center to sell and purchase various animal products. Many buyers from outside Mashuru usually visit the market to order for various products in the market. Cattle meat is sold at around 120 Kenya shillings per kilogram while goat and sheep meat is sold from 160-180 Kenya shillings per kilogram. Some traders cook meat and sell milk to those who visitors in the market. Establishment of a small hides and skin industry and a milk processing plant in kajiado district have help livestock keepers to sell there products, enabling them to increase their income. Where pastoralist have been able to obtain relative high prices form there livestock's.

Animal products such as meat and milk have also been sold to nearby dairy collecting centers in Kajiado district. Hides and skin products are sold to hides and skin factory in Kajiado through brokers who purchase hides and skin in Mashuru market and transport it to Kajiado town. In a good season when dry climatic conditions have not hit the region, livestock particularly cows at market age and of good size cost around 12,000- 18, 000 Kenya shillings. Milk is sold from 25- 30 Kenya shillings per liter while hides go from 50- 100 Kenya shillings per kilo.

4.2 Reasons for burning rangelands in Mashuru division

The researcher asked respondents about periods and seasons when rangeland are mostly subjected to burning and from table two above it was noted that; Most people usually set their land on fire on the on set of a wet season; while a few during the wet season. While only a few percentage do so on the onset of dry season and during the dry periods.

Table 4: Reasons for burning rangeland zones in Mashuru division

Reasons	Frequency	Percentage %
To encourage fresh re-growth	30	75
Clearing land for crop Cultivation	6	15
Control common weeds	2	5
Scare wild animals	1	2.5

Source: Data Survey 2007

4.2.1 To Encourage fresh re-growth

Pastoralists in Mashuru usually set their land on fire mostly during the start of a wet season for the purpose of improving pasture levels for their livestock's. During this season vegetation normally grows faster due to plenty of water availability from the rain. When successive rain are experienced there is production of nutritive grass of species such as *Themeda Triandra*, *Cynodon Species* and *Brachiaria* commonly known as 'Webwe' in the local language.

4.2.2 Control Pests and Diseases

Pests are something that annoys or distracts from, some resource that we value or interferes with a pursuit that we value. Increased growth of tuff grass species has lead to formation of bush lands. Bush lands attract tse tse flies which cause diseases such as Nagana to livestock's and sleeping sickness to humans. Bush lands are also inhabited by insects and ticks which serve as vectors in transmitting a number of disease-causing pathogens and parasites. Malaria is usually a deadly disease whereby it kills lives each year from plasmodium protozoan spreads to humans from mosquito inhabited in bush land areas in this region. Ticks are also found in grasslands areas and it's a threat to livestock's where they suck animal's blood leading to reduction of animals through disease or death.

As a way of reducing and controlling invasion of pests and other diseases in Mashuru, pastoralists usually burn bush lands dominated by tuff grass species as a way of controlling pests and diseases which might be present in this area. They also burn such areas with the aim of reclaiming these zones into grazing fields.

4.2.3 Control common weeds

Pastoralists in this region value their livestock very much. Grazing lands are normally affected by common weeds such as *Vernomia Companea* and *Lanatana Camara* where herbs and shrubs are mostly dominant in this region. Such weeds usually hinder successful generation of grass due to competition for available nutrients in the soils and water. As a result there is loss of nutritive grass due to the effects of weeds in the rangelands.

4.2.4 Scare wild animals

Rangelands are usually providing habitat to a number of wild animals such as gazelles, antelopes, zebra, and lions among others. Mashuru division being located near Maasai Mara game reserve, wild animals usually encroach Mashuru grazing fields particularly during the dry season, wild animals such as zebras, gazelles cheetahs and lions can be spotted in some areas in Mashuru grazing fields. Animals such as cheetahs and lions which pose good hunting skills which are favored by camouflage status usually hunt and kill livestock's in this region. Creating a big threat to humans and there animals in the region, as a result pastoralists in this area are forced to burn up certain areas in Mashuru rangelands to try and create a buffer zone between wild and domesticated animals.

Policies towards wildlife conservation natural resource policy have initially, confinement of wildlife and pastoralists in Mashuru causing Competition for grazing and water resources in the remaining accessible parcels of productive land. In these gazing zones there have been issues of competition for grass and water mostly from grazers such as gazelles, antelopes and zebra with domesticated animals. This competition has resulted to reduced grass and water scarcity in Mashuru this is due to the fact that all these animals rely on some grass and because of dry conditions grass levels are not increasing but reducing at a higher rate resulting to scarcity. Subsequently, the creation of exclusive game conservation areas further denied the Maasai access to key resources. Indeed during the past century the Maasai and their cattle have been confined to increasingly small areas of increasingly over-exploited land, resulting in intense competition and often conflict, between Maasai and wildlife and recently those associated tourism industry.

4.2.5 Clearing land for crop Cultivation

Clearing of land is also carried out by some few farmers who inhibit Mashuru region. Grass is cleared by farmers who aim at converting such lands into faring units to grow crops. Native grass prairie which is more productive grass species has been cleared to create space for crop production by opening up land for cultivation of crops. Pastoralism is the most dominant practice in this region, farming is not wide spread. Farmers in Mashuru burn grasslands at the start of rainy season in preparation for planting of various.

Whereby land is tilled, bush lands are cut down to create farming units for growing of crops such as maize, sorghum, and millet which normally do well in this region.

4.3 Effect of burning grasslands ecosystem on the environment

Effects of burning rangelands were analyzed viewed from different perspective whereby the researcher asked respondents whether burning of grass had affected the environment and their experiences in Mashuru over the last ten years.

4.3.1 Ecological effects

4.3.1.1 Natural Ecological Succession:

Over the last ten years in Mashuru, there has been gradual change in vegetation biomass through observations stubble heights and bare patches have increased. The size of grass has reduced and bare patches of land in Mashuru rangelands have increased. Natural ecological succession is evident in that over the last ten years, native grass praire such as *Themeda* grass species which is highly productive has become extinct in most areas in Mashuru yet it was the dominant grass species in the region fe years ago. Through interviews from various individuals in the region, I realized that vegetation in Mashuru has taken various transformations to the present one.

Rangelands in Mashuru have faced transformations form grasslands and later changed to shrub lands and bush lands while in other areas, grasslands have attracted presence o herbs, forming growth of tuff grass species which cannot be taken up by livestock's. Formation of tuff grass species has resulted to increased growth of bush lands which are inhabited by various pests and diseases.

4.3.1.2 Change in Soil structure

Soils are a product of action of climate and living things on present rock material under the influence of relief and drainage over along period of time. As a result of nomadic Pastoralism activities continued burning of grass has render soils in Mashuru to be degraded this is evident due to the presence of termites which signifies degraded soils. Soils level and fertility rates have also declined considerably for the last ten years losing a lot of available nutrients in the process.

Soil erosion occurs normally when the land is left bare without any vegetation. Pastoralist in Mashuru normally burn grass anticipating for fresh re-growth.

After burning the grass the land is left bare and when this situation stays for along period of time especially when there is heavy down pour, the rain drops normally finds the land bare forming sheet erosion at the same time the rain water carries away all the top soil from the original location to anther location down slope. When the land is left bare particularly during the dry season, heavy winds blow the top soils making the skies in Mashuru in Mashuru to be filled with dust which is an environmental health hazard particularly to people ling around these areas. Increased rates of soil erosion have also lead to reduced levels of grass in this region. Overgrazing of animals has resulted to competition fo r available pasture in Mashuru. Respondents said that there were increased cases of soil erosion particularly in gentle sloping areas in hilly zones of Mashuru where formation of gullies was starting to be evidenced.

4.3.1.3 Presence of Termites and Army Worm

Invasion of army worms occurred in unspecified periods and resulted to heavy loss of grass and other vegetation, leaving grasslands bare with no vegetation and pasture for livestock in Mashuru. Continuous burning of rangelands in Mashuru has resulted into accumulation of dry matter from grass and other vegetation types which are usually burnt regularly; this has lead to growth of scanty vegetation. Presence of dry matter has attracted termites in most in most parts where grass is regularly burnt in Mashuru division. Termites have found good living conditions where they take the dry matter and mix it with dry with the soil. Other organisms present in the soil such as worms have disappeared in this region due to lack of nutrients for survival.

Presence of termites in Mashuru rangelands signifies that soils in this region have been degraded through continuous burning of land and other practices such as overgrazing and overstocking which is a common exercise in this region. Termites usually harden the soil restricting growth and spread of grass over the area this is evident in Mashuru where a number of bare patches can be seen in many areas where formation of anthills can be observed in many areas within Mashuru division.

4.3.1.4 Change in Plant Species Composition

The degree of grazing animals strongly affects the structure, composition, quality and productivity of rangeland vegetation. This phenomenon is likely to occur where a concentration of large herds of livestock in relatively smaller areas may lead to overgrazing, trampling and hindrance to vegetation regeneration the respondents of these study were aware that there had been a change in species composition over time due to intensities of rangeland use in their area. Another cause of change in composition of plant species had been due to the *El Nino* rains that occurred in 1997/98. Respondents Interviewed noted that these extraordinary heavy rains caused the increased growth of some grasses e.g. *Pennisetum mezianum* and also an invasion by strange grasses such as *Rottboelia exaltata* especially in the areas that were heavily affected by erosion. The respondents observed that some presently occurring species were not present 10 years ago while others were there but they had increased and others had decreased

4.3.1.5 Micro climate

Continuous burning of rangelands in Mashuru over the last ten years has changed the climatic conditions of this region. Vegetation levels have reduced the areas productivity drastically over the years. Such changes were as a result of activities such as result of burning and overgrazing in this region. Mashuru being a dry region, temperature levels range between 25-28°c and recently temperatures have increased up to 35°c. This has been attributed due to burning particularly in the dry season; the atmosphere of Mashuru is usually covered with smoke. Also strong winds find the land bare after vegetation has been burnt up causing wind erosion which carries away the top soils making the entire region in Mashuru to be filled with dust. Heavy rain droplets find the land bare and washing all the top sol through erosion creating sheet and gully erosion in sloppy areas within Mashuru.

Changes in temperature levels in many parts o Mashuru have resulted to reduced rainfall amounts in this region over the last ten years, rainfall amounts in Mashuru ranged between 1000- 1500mm per annum but this amounts have reduced drastically the regions receives rainfall amounts of 500- 900mm per annum according to sources from Kajiado district metrological department.

4.3.1.6 Vegetation/ pasture level

In this region there is increasing abundance of pasture weeds where invasion of *Solanum* species have been observed over the last years in most zones where burning of grass is practiced. Such weeds have become dormant where they are poisons to livestock and they act as a threat to there survival. Also the level of vegetation has greatly reduced where heights and bare patches have continued to emerge. Forage amount has declined according to most people whom I interviewed said the level of vegetation cannot be compared to that of 1990. There was an increase in number of bear patches of land is mostly attributed to burning of grassland zones.

The current levels of grass in Mashuru division are reducing as comp aired to previous years. Where grasslands covered wide extensive areas within this division. Respondents were asked regarding pasture levels. On what changes have occurred in grass structures, amount and distribution for the last few years in the region. The value of pasture was determined by the size of animals and their produce such as milk and meat within the area. Was an indication of reduces pastures in this region. Decline in pasture level and value is as a result of burning grass species of *Themeda,* which are dominant in this region.

Community's Perception of Range Condition Trend towards vegetation level provided information based on range condition trends. The trend indicated that vegetation resources have decreased over the last 10 years whereas the other trend is that the vegetation has increased. They said that the ever-increasing population in Mashuru caused increased pressure on rangelands. Migrations of people from other parts of the country to Mashuru also lead to reduction of grass among other reasons such as the on going structural development in Mashuru division.

4.3.1.7 Animal productiveness

The researcher used different indicators to assess the level of animal productivity in this region. Basing on weight gain, most animals in this region had lost weight considerably due to high temperatures and distances they covered in search of pasture and water. Poor nutritive pasture could not help livestock's to be as productive as one would expect. Due to weight loss milk and meat products were also becoming scarce in the region.

Cattle populations have fluctuated considerably during this century, primarily in response to drought and disease. For example cattle numbers fell from a peak of over 700,000 in 1982 to a low of 311,000 in 1984 following the drought. Drought during 1994 again decimated livestock herds in many areas of Mashuru division. No official figures are available but Maasai pastoralists are thought to have lost up to 70 percent of their herds in many areas.

4.3.1.8 Water sources

As it's a major practice most pastoralist move from one place to anther in search for water to there animals. Due to increased human population in Mashuru there has been an increased amount of livestock's this has resulted to high competition for water sources where many water wells have dried forcing pastoralist to move for long distances in search for water to there animals.

Water quality levels have also declined in Mashuru this was evident where the researcher observed change in watercolor and smell. The reason to these causes can be attributed to reasons such as erosion where run off water carries away cow dung From rivers and streams which changes the water color. Turbidity influences water color during the dry season where water reduces in ponds becoming muddy and turbid. During the wet season, run off that passes through bare ground surface in the range due to overgrazing and bush burning, comes with a lot of soil material to the low lying areas some enters water ponds and wells affecting water turbidity and color.

4.3.2 Economic effects

4.3.2.1 Loss of income

Continuous burning of rangelands has resulted to land degradation in Mashuru division over the last ten years. Soils have been degraded and are not capable of supporting sufficient crop yields over the years to come, also reduction in levels of pasture yields for animals have greatly reduced causing competition for available pastures. Reductions in levels of pastures and crops in Mashuru have lead to food scarcity in the region where available food crops have become expensive. Over the last ten years a bag of maize used to cost 500 Kenya shillings but it's now sold at 900 Kenya shillings.

Overgrazing and overstocking of animals in Mashuru has created competition for available pastures this has greatly reduced pasture levels in many rangeland zones in this region. As a result production of milk, meat and other animal's products has reduced drastically over the years in Mashuru.

In Mashuru division pastoralists usually exchange milk and meat for other commodities. Reduction of meat and milk has caused difficulties for most people in Mashuru to be able to develop this region. In the past years a single cow in Mashuru used to produce about 25 liters of milk per day and was sold at 30 Kenya shillings per liter know a single cow in Mashuru produces 8 liters of milk which is sold at 30 Kenya shillings per liter. Such a person used to get 750 Kenya shillings for a single cow but know he receives 240 kenya shillings from the sane cow. Reducing his income with 510 Kenya shillings for a single cow this is a big loss mostly from pastoralist who keep large numbers of herds of cows.

4.3.3 Social factors

4.3.3.1 Migration

Continuous land degradation in Mashuru has resulted to reduced pastures and poor soils for cultivation where some rangelands have been dominated by tuff hard grass species which cannot be taken up by livestock's. Due to this factor this has forced most pastoralists to migrate to other areas out of Mashuru to search for pasture for there animals. Migration of pastoralist communities has also forced many young people to leave schools and look after their animals. Where people have been forced to live in shanty lining conditions with no proper shelter and food. Such shanty housing structures are normally referred by this community as 'Manyattas;

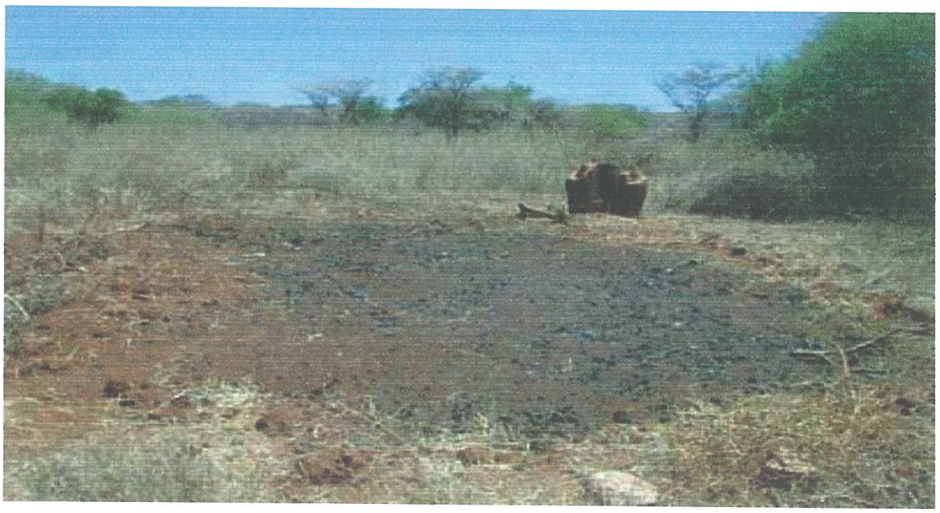
Also migration of people from different parts of the country to Mashuru has lead to reduction of rangelands in these areas. Whereby some rangelands have been transformed into private ranches reducing the grazing fields for regular livestock keepers who graze there animals communally. This has necessitated pastoral communities to move to other regions in search for pasture for there animals where there are bigger grazing fields to graze there animals in other division in Kajiado district.

4.3.3.2 Conflicts

Conflict between pastoralist livestock's and game animals is anther aspect, which has resulted to burning of grass in this region. Where animals hunt livestock game's for food particularly in the dry season. There is also a conflict between the government and the locals near game parks whereby many pastoral communities have invaded parks mostly in the dry periods. As a result they have been fighting with the game rangers for sometime.

The main uses of the rangelands is provision of pasture, wood fuel and building material for housing and fencing materials, making of ornamental walking sticks and clubs, fodder for livestock (especially during the dry season), making furniture, medicine and charcoal. Harvesting of grass by men for brick covering, fencing of cattle 'Bomas', dams and areas under crops and by women for construction of houses has increased in recent years. The rise in human population is causing an increase in utilization of grass the present individual land ownership encourages single household 'Bomas', creating more demand for grass due to increased livestock's

Photo 4: Burnt rangelands patches in Mashuru division



Grassland region prone to severe impacts of fire occasionally: in Mashuru division.

CHAPTER FIVE: SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary

The study was carried out in Mashuru division in Kajiado district Kenya where continuous degradation on rangelands ecosystem is evident, prompting the study on effects of burning of grass ecosystem in Mashuru rangelands. Burning of grass is these region is a common phenomena practiced mostly by pastoralists and cultivators in Mashuru division. Strategies suggested for minimizing degradation of rangelands in Mashuru division aim at promoting good management of pasture levels, water availability and quality, fertile productive soils, animals of god health condition, high production capabilities and fertile levels of yields. All these will be realized if the local people were to be involved and trained on ways and strategies of managing rangelands in Mashuru division. Such strategies include control burning of range environment, distocking, direct water run-off to rangeland field and controlled grazing of livestock's.

A summary of the findings of study revealed that main activities carried out in Mashuru division were nomadic Pastoralism, crop cultivation and marketing of animals and there products. The study also revealed that within these activities there are accompanying practices such as burning vegetation, clearing of land for cultivation, watering, treating, breeding and grazing of livestock's.

The study revealed various reasons why people in Mashuru burn grassland, the reasons given were; to encourage fresh grass re-growth for nutritive grass species, control pests and diseases, control common weeds found in rangelands such as *Lantana Camara,* to create space for cultivation of crops and scare away wild animals as a way of creating a buffer zone between game and domesticated animals. The study also revealed effects of burning grass ecosystem on the environment. Ecological effects of burning rangelands zones led to changes, in natural ecological succession of vegetation over the last ten years increased presence of termites and army worms which is a sign of degraded environment which causes changes in soil structure, changes in species in species composition, animal productivity, water resources and micro climate.

5.2 Conclusions

The major Pastoralist activity in Mashuru rangelands is grazing of cattle, other activities include, crop cultivation and marketing of animals and there products. Accompanying practices are clearing rangelands and burning vegetation in rangelands areas among other practices carried out in this region. From the summary, burning of rangelands in Mashuru division is resulting into severe degradation. This has gone unabated is nearing crisis levels. These trends must be controlled or reversed to avert severe consequences, which might result to desertification.

5.3 Recommendations

Recommendations included; rangeland management and protection, community enhancement, controlled burning of rangelands, distocking o animals, provision of extension services, monitoring, provision of incentives, enacting by-laws to govern use of rangelands in Mashuru division and providing ways for future research studies on ways of improving and maintain rangelands ecosystem in Mashuru division and beyond Mashuru division. Rangeland management protection and conservation should focus on long-term objective plans that look for ways of sustainable development of rangeland in Mashuru division increasing the overall level of land productivity in this region.

Underlying all planning efforts towards rangeland management its obvious that such programs must meet locally perceived priorities rather than externally imposed perceptions this means that adequate background data on local needs, preference and other relevant factors must be considered before any detailed rangeland management plan is undertaken in this region. Important decision is to involve individuals in question where solutions would provide a forward way; this is a means of risk aversion in project implementation.

Controlled burning of rangelands in Mashuru involves timely burning of rangelands, which leaves the soils and soil organisms not affected. It further involves timely burning of rangelands, when burning is carried out, almost at the start of a rainy season. Vegetation growth will grow very fast letting the soil bare for a short period of time avoiding instances of soil erosion whish is a major degrading factor. Through controlled burning of rangelands, pasture weeds can be reduced thus improving the level of pasture composition.

Distocking of animals and overgrazing was found to be one of the major causes of rangeland degradation in Mashuru division reduction in numbers of herds will help in addressing the problem of reduced forage productivity. Culling of old sick animals and those with poor production can also be done to reduce their numbers. Although this is not a common practice in this region where cultural behavior of pastoralists (Masaai) who cherish their animals and prefer number's to quality for prestige.

Extension services should be established in Mashuru divisional headquarters. Extension services aims at advising the people by delivering services and ideas of sensitizing the community on issues concerning rangeland ecosystem. Provision of extension services will help pastoralists to improve their livelihood through improved animal production as well as rich environmental condition in this region there should be massive awareness campaign which aim at informing community members through comprehensive skims which provide financial and technical support. Openly certain difficulties exist among pastoral communities which do not seam to strike attention of external parties.

Awareness campaigns will help people to recognize problems existing and what is needed to solve them. Promotional measures require particular programs which address various needs to the community such as literacy levels and resource availability. Awareness campaigns may cover a wide geographical area where community members acquire information through mass media, extension services, and local leaders such as chiefs or village heads within the region. Considerable efforts and money go to waste if awareness campaigns in grass root levels are not adequately followed.

Human beings need monitoring if much is to be expected, there is a need for monitoring and evaluation mechanism as a tool for environmental management. This will help in assessing environmental effects such as those caused by burning of rangeland ecosystem in Mashuru. Monitoring should be done in order to provide continuity check on actual work being carried out, its related plans and range of progress. Monitoring will help in auditing and evaluation in light to what is set out to be achieved. Monitoring ensures compliance of baseline data on achieved work and progress based on progress. The local authority should work as a monitoring unit in Mashuru division where they should be disseminated to various areas in the region to monitor management of rangelands. This is a defective way of managing and protecting rangelands. Since most of them are well familiar to these areas, thus adoption and acceptance will be much easier.

Provision of incentives will create enthusiasm in managing and protecting rangelands in Mashuru division. Financial incentives should be simple easy to run with clear administration capabilities to those responsible in their management. Individuals holding land titles can be used as securities in money lending institutions for credit facilities. Capital invested can be used in improving rangeland environment through introduction of better and high productive breeds of cattle like 'Boran' this will help in reducing overstocking of livestock. Also fencing of land will allow rotational grazing a practice that entails pasture condition and vegetation diversity.

There should be bylaws which regulate and control cattle grazing by providing maximum numbers of cattle to be grazed in a particular piece of land. Pastoralists in Mashuru division should be educated about the cattle grazing act and follow it in order to minimize the rate of land degradation in this region. The cattle grazing act of (1995) call for each and every one to protect and conserve rangeland ecosystem in Kenya.

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APPENDICES

Appendix 1

TO THE RESPONDENTS

Am a student conducting academic research on Effects of Fire on Grassland, in Mashuru division for partial fulfillment the requirement of the award of Bachelor in Science degree in environmental management? This questionnaire will assist me in gathering, recording and analyzing information on effect of fire in Mashuru rangelands. I therefore kindly request you to participate by providing accurate information that will enable me obtain quality data.

NOTE:

Don't write your name for purpose privacy and confidentiality.

Instructions

FILL IN THE BLANK SPACES [√] AND QUESTION.

Section A:

(Background information of the respondent)

1. Gender: MALE ( ) FEMALE ( )

2. Occupation:

_____

3. Responsibilities:

Section: B

(Environmental observations)

1. How many herds of cattle do most people in Mashuru keep?

(a) Less than 50 ( ) (c) 200 – 500 ( )

(d) 500 and above ( ) (b) 50 – 200 ( )

2. What is the most common activity in Mashuru division?

.....

Give a reason for your answer above?

.....

3. How is land owned in Mashuru division?

.....

4. Common grass species found in Mashuru?

.....

5. What are the common species of plants and animals found in Mashuru?

.....

.....

6. At what periods do burning of grass normally occurs?

.....

.....

7. What reasons prompt people to burn rangelands in Mashuru?

.....

.....

Section C:

(Effects of burning grass on the environment)

1. What environmental changes have you noticed in this region attributed to burning of grass?

.....

.....

2. What other reasons have lead to reduction of rangelands in Mashuru division?

.....

3. How can you comment regarding amount of pasture level and vegetation distribution in Mashuru division for the last five years?

(a) Increased ( ) (c) No change ( )

(b) No change ( )

Give reasons for your answer.

.....

.....

Section D:

(Solutions and ways of improving grasslands and community needs in the area)

1. Suggest measures to control effects of burning grass in Mashuru division?

.....

.....

2. Ways to reduce burning of grassland vegetation in Mashuru division?

.....

.....

3. What ways may improve land productivity by protecting rangelands?

.....

.....

4. Who should take the responsibility of controlling and managing grassland regions?

(a) The government ( ) (b) The community ( )

(c) Individuals ( ) (d) Local authority ( )

(e) Others specify .....

5 A. Actions towards the offenders of rangelands in Mashuru.

(a) Pay fines ( ) (b) Do Community services ( )

(c) Educate them ( )

(d) Others specify .....

B. should they be charged?

(a) YES ( ) (b) NO ( )

Give reasons for your answer,

.....

.....

6. What assistance has the government provided regarding this issue in this division?

.....

7. In your own opinion, what measures should be put in place in order to control and protect rangelands in Mashuru division. .....

.....

8. What have you done in order to reduce burning of rangelands in Mashuru division?

.....

.....

Thank you: For your time, views and cooperation. Together we shall improve our environment now and to future generations to come