ABSTRACT

ANTHROPOGENIC FIRES, FOREST RESOURCES, AND LOCAL LIVELIHOODS AT CHYULU HILLS, KENYA

by Peter Ngugi Kamau

Anthropogenic fires are rife in rural Africa as people use fire to modify landscapes for their livelihoods. Although burning occurs as a very significant practice used in traditional resource management and shows some ecological advantages, human set fires are viewed by conservation authorities as destructive and a cause for environmental degradation. This study gains local perspective from three Kamba and three Maasai villages around Chyulu Hills on why fires are used and their influences on local woody plant resources. Between June and July 2012, I conducted 12 focus group discussions and 6 transect walks with Kamba and Maasai participants who reported 22 reasons why they use fires. Employing an applied research design that supports adaptive collaborative management (ACM), the study validates local knowledge on fire management and promotes opportunities for collaborative learning between park managers and local populations that are viewed critical toward better environmental conservation and livelihood security around CHNP.
ANTHROPOGENIC FIRES, FOREST RESOURCES, AND LOCAL LIVELIHOODS AT
CHYULU HILLS, KENYA

A Thesis
Submitted to the
Faculty of Miami University
in partial fulfillment of
the requirements for the degree of
Masters of Arts
Department of Geography
by
Peter Ngugi Kamau
Miami University
Oxford, Ohio
2013

Advisor _____________________________
(Dr. Kimberly E. Medley)
Reader______________________________
(Dr. Mary C. Henry)
Reader______________________________
(Dr. John K. Maingi)
# Table of Contents

List of Tables ............................................................................................................................ iv

List of Figures ............................................................................................................................. v

List of Acronyms ........................................................................................................................ vi

Acknowledgements .................................................................................................................... vii

Chapter One ............................................................................................................................... 1

INTRODUCTION ....................................................................................................................... 1

Statement of the Research Purpose and Questions ................................................................... 3

LITERATURE REVIEW ............................................................................................................. 6

Cultural-Political Ecology of Anthropogenic Fires ................................................................. 6

Adaptive Collaborative Management (ACM)........................................................................... 7

Participatory Approaches to Gaining Local Knowledge ......................................................... 8

Chapter Three ........................................................................................................................... 12

STUDY AREA ............................................................................................................................. 12

Physical Setting ......................................................................................................................... 12

Cultural Groups in the Chyulu Hills ......................................................................................... 14

History of Land Use and Resource Conflicts in Chyulu Hills ............................................. 15

Kamba Settlements in the Eastern Chyulu Hills .................................................................... 15

Maasai Settlements in the Western Chyulu Hills ...................................................................... 17

Conservation and Conflict at Chyulu Hills National Park ....................................................... 18

Chapter Four ............................................................................................................................. 20

DATA AND METHODS ............................................................................................................ 20

Use of Fires in the Chyulu Hills Landscape ......................................................................... 22

Influence of Fires on Access to Woody Plant Resources across the Chyulu Landscape .... 23

Adaptive Collaborative Management as a Planning Strategy .................................................. 24
Chapter Five

RESULTS

Use of Fire in the Chyulu Hills Landscape

The Fire Season

Who Decides When To Burn?

Past Fire Management Practices

Fires and Woody Plant Resources in Chyulu Hills

Village narratives on fire and woody plant resources

Adaptive Collaborative Management as a Planning Strategy

What similarities or differences in fire management practices exist between the Maasai and Kamba?

What information on fires do you want to share with KWS officials?

How do you think your knowledge on fires can contribute to adaptive collaborative management with KWS?

Chapter Six

DISCUSSION AND CONCLUSION

Fire and local livelihoods in the Chyulu Hills

Local perceptions of vegetation change in the Chyulu Hills

Adaptive collaborative management of fires in Chyulu Hills

Participatory research and fire management

Conclusion

References

Appendix 1

Appendix 2
List of Tables

Table 1. Sample villages selected for the focus group discussions and transect walks………21
Table 2. Guiding questions on the use of fires during focus group meetings..........................22
Table 3. Open-ended questions asked during the transect walks with Kamba and Maasai at the
study villages…………………………………………………………………………………………23
Table 4. Reasons for burning mentioned in focus group interviews……………………………29
Table 5. The fire season and main burning reasons for each month in Kamba
and Maasai villages………………………………………………………………………………31
Table 6. Kamba and Maasai names and uses for woody plants compiled from residents
in Kamba and Maasai villages……………………………………………………………………36
Table 7. Plant uses recorded from local informants in Kamba and Maasai villages at
Chyulu Hills, Kenya and classified into six material-use categories
and ecosystem service……………………………………………………………………………42
List of Figures

Figure 1. Conceptual model of the research problem and study framework for the Chyulu Hills, Kenya.................................................................5

Figure 2. Map of the Study area showing the location of Chyulu Hills in southern Kenya. .....12

Figure 3. Photos comparing Acacia Commiphora bushland in Kamba villages with mixed grassland and Acacia drepanolobium in two Maasai villages.................................21

Figure 4. An image of transect walks conducted in South Kamba and North Maasai villages overlaid on a 2013 natural color composite showing land cover conditions.............45

Figure 5. Photos showing examples of uses for woody plants described during the transect walks in Kamba and Maasai villages.............................................................46

Box 1. Introduction of the research during the meeting between KWS Officials and local participants.................................................................24

Box 2. Introduction of adaptive collaborative management concept during the meeting between KWS officials and local participants.........................25

Box 3. Recommendations for an adaptive collaborative plan between KWS and local residents.................................................................54
<table>
<thead>
<tr>
<th>Acronym</th>
<th>Full Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACM</td>
<td>Adaptive Collaborative Management</td>
</tr>
<tr>
<td>CH</td>
<td>Chyulu Hills</td>
</tr>
<tr>
<td>CHNP</td>
<td>Chyulu Hills National Park</td>
</tr>
<tr>
<td>CIFOR</td>
<td>Center for International Forestry Research</td>
</tr>
<tr>
<td>CPE</td>
<td>Cultural Political Ecology</td>
</tr>
<tr>
<td>EA</td>
<td>East Africa</td>
</tr>
<tr>
<td>KARI</td>
<td>Kenya Agricultural Research Institute</td>
</tr>
<tr>
<td>KFS</td>
<td>Kenya Forest Service</td>
</tr>
<tr>
<td>KWS</td>
<td>Kenya Wildlife Service</td>
</tr>
<tr>
<td>MU</td>
<td>Miami University</td>
</tr>
<tr>
<td>NCST</td>
<td>National Council for Science and Technology</td>
</tr>
<tr>
<td>ROK</td>
<td>Republic of Kenya</td>
</tr>
<tr>
<td>TWNP</td>
<td>Tsavo West National Park</td>
</tr>
</tbody>
</table>
Acknowledgements

No amount of words will be enough to describe the support, guidance and contributions of the different persons and institutions who made the completion of this thesis possible. I was extremely fortunate to have Dr. Kimberly Medley as my supervisor not just because of her expertise in human-environment relationships but also her firsthand knowledge of Kenya where she has conducted enormous research for many years. I will forever be grateful to her for her guidance and mentorship in the course of my master’s studies. I equally thank my committee members, Dr. Mary Henry and Dr. John Maingi whose insightful comments and encouragement gave me the strength and guidance to complete this thesis. I am also indebted to my fellow geography graduate students who were also a source of knowledge and strength throughout my graduate studies at Miami University.

I thank my employer, the Kenya Wildlife Service (KWS) for granting me a two-year study leave to pursue a master’s degree. I also thank the Department of Geography, Department of Botany and the Willard-Sherman Turrell Herbarium Fund at Miami University for financing my field work expenses. I owe a lot of gratitude to Dr. Michael Vincent who works at the Willard-Sherman Turrell Herbarium at Miami University, Ohio (MU) and Mr. Kennedy Matheka of the East African Herbarium (E.A) for handling and identifying the voucher specimens that I collected in the field.

During my field work, I received a lot of support from many people. First and foremost I would like to thank the Kamba and Maasai participants who were eager to share their knowledge with me. Their warm welcome and patience during the focus group meetings and transect walks in their villages will never be forgotten. My gratitude also goes to all those who assisted in translation during this research, Winnie Barrack, Alfred Muia, Loise Sitonik and Joseph Parnyombe. I also thank KWS officials, Robert Muasya, Dr. Shadrack Ngene, Joseph Mukeka, Francis Mbaka, Celdric Khayale and Rose Malenya whose support and words of encouragement ensured a successful fieldwork experience.

To all those who have contributed to my education throughout my life including my relatives, teachers, friends and colleagues I dedicate this work to you.

Peter Kamau.
Chapter One

INTRODUCTION

Fire is an important environmental driver that influences the function of forest ecosystems by directly modifying the structure and composition of vegetation (Kull 2002; Sheuyange et al. 2005). Fire also plays an important role in the livelihood conditions of rural communities around the world (Kull 2004; Cotton 1996). Historically, humans have used fires as an affordable vegetation management tool that enables them to alter the natural environment (Butz 2009; Kull 2002). In Australia, habitat manipulation through the use of fires by the Aboriginal peoples is evidenced in fossil records dating 25,000 years ago (Cotton 1996). In many parts of the world, indigenous communities used fires in the dry season for many reasons: e.g., to stimulate sprouting so as to attract game for hunting; promote palatable herb re-sprouting for livestock grazing; to create new areas for cultivation; to kill disease causing vectors such as ticks; and, to keep away dangerous animals such as snakes (Kull 2002; Butz 2009; Eriksen 2007). Indigenous communities use fires to manipulate the distribution, diversity, and relative abundance of certain plants thereby maintaining healthy ecosystems (Sheuyange et al. 2005). Seasonal burning practices by indigenous communities can prevent damaging late season fires and increase plant biodiversity (Butz 2009). Recent studies on the ecological consequences of herding practices also show that burning landscapes to manage pastures is a good way of maintaining habitats (Angassa and Oba 2008).

Although burning is documented as a most significant practice used in traditional resource management (Cotton 1996) and show some ecological advantages, human set fires are viewed by conservation authorities as destructive to biota and a cause for ecosystem degradation and reduction of plant biodiversity. During colonial days, indigenous burning regimes in Africa disappeared or were significantly changed due to the introduction of fire suppression policies (Kull 2004). European scientists and conservationists argued that traditional burning practices by local people were detrimental to wildlife populations and led to ecological degradation (Eriksen 2007). Moreover they claimed that livestock grazing and pasture burning caused a reduction in forest cover, diminished woodlands and accelerated soil erosion. Indigenous land management
practices were devalued, ignored, and neglected. Colonial management policies placed strict
restrictions on the use of fire by indigenous peoples (Eriksen 2007).

Colonial rule in Africa brought new political and administrative systems that changed the
ways in which African states managed their people and environment. When African countries
gained independence, colonial policies and practices, including approaches to fire management
were retained as the new post-colonial leaders were educated in rigid colonial government
systems (Eriksen 2007). Post-colonial policies were implemented without consideration of local
livelihood needs and the ecological role that fire might contribute towards productive landscape
management. Since fires maintain a balance between woody plants and grasses, fire suppression
resulted in the encroachment of bush and a decline in grass cover over some savanna landscapes
(Angassa and Oba 2008).

More importantly, the consequences of implementing strict fire-control policies in Africa
has been large-scale illegal burning and the occurrence of catastrophic fires that sometimes lead
to huge ecological and economic damage to the land (Sheuyange et al. 2005). Illegally set fires
account for 70% of annual fires in Africa (Butz 2009). In Madagascar, farmers and cattle herders
burn about a half of the country’s grasslands, and about 5000 km² of rain forest and secondary
bush (Kull 2002). Policy debates on anthropogenic fires emphasize the ecologically detrimental
aspects of fire and focus less on the beneficial aspects of fire, presenting a resource conflict in
relation to human livelihoods and the natural ecosystems where they live (Eriksen 2007). In
contrast, political-ecological research on human-resource relationships challenge dominant and
often authoritative narratives linking indigenous practices with land degradation and question the
role of extra-local authorities on sustainable management (Robbins 2004, Kull 2002). As
traditional ecological knowledge becomes increasingly valued in human-resource research, more
opportunities emerge for the effective integration between conservation authorities and local
communities on the sustainable dynamics of fire management (Rodriguez 2007; German et al.
2010).

After many years of policy-directed fire suppression and authoritative control, fire
management in Kenyan rural landscapes remains a big conservation challenge. Chyulu Hills
National Park (CHNP) and surrounding areas provide an interesting case example of the
challenges faced by states in effectively managing anthropogenic fires. In 1983, Chyulu Hills were gazetted as a national park under management by the Kenya Wildlife Service (KWS), restricting resource use to the bottom of the mountain range. The rationale for the park is protection of one of Kenya’s most significant water catchments, the source to Mzima springs (KWS 2008). Across this landscape, local residents continue to use fires as an efficient and cheap means of pasture, woodland, and crop field management in total disregard of land regulations (Okello and Tome 2007). At CHNP, conflicts are intense between the enforcement of official fire suppression policies by conservation authorities and local residents whose situated knowledge dictates using fire for livelihood activities. Fire management policies and practices by state agencies need to be better adapted to reflect the views of local people who set these fires (Rodriguez 2007; Kull 2004). Local views about the role of fires in promoting local livelihoods and local knowledge on how fires influence access to forest resources need to be better incorporated in the fire management plans of the Chyulu Hills landscape.

Statement of the Research Purpose and Questions

My research project sought to gain local perspectives on the role and impacts of fires on local resources in the Chyulu Hills (CH) Kenya (Fig. 1). CH forms a boundary between two ethnic groups; the Kamba and the Maasai, who live on the eastern and western sides of the hills, respectively. Fires are used by both Kamba and Maasai to convert woodland to grassland at CH, illegally within and now outside of the park boundary. My study aimed at gaining a local understanding of where and why people burn in relation to their own access to plant resources and local livelihoods. I employed an applied research design that supports adaptive collaborative management- ACM (Holling et al. 2002; Mclain and Lee 1996; Adger and Tompkins 2004). ACM shows potential to validate local knowledge in resource assessment and planning, improve local management practices through shared learning, and enhance the resilience of the Chyulu Hills ecosystem to enable a sustainable provision of goods and services. The study promotes opportunities for collaborative learning between park authorities and local populations that are viewed critical toward better understanding and managing for livelihood security in the study region (Fig1).

For my study, I proposed three questions:
1. How do residents living near Chyulu Hills use and manage fire to promote their livelihoods (living conditions)?

2. Are fires causing vegetation changes that influence access to important woody plant resources?
   a. How has access to important woody plant resources changed over time?
   b. Are fires influencing access to important woody plant resources?

3. How can the perceptions of the Maasai and Kamba contribute to adaptive collaborative planning that values the viewpoints of all stakeholders and jointly explores fire as a land management strategy?

The first research question focused on how people use fire as a management practice. I conducted focus group interviews with village groups that were guided by a similar set of open-ended questions. These questions were designed to initiate conversations among the group participants about the reasons they use fire and how fire management practices contribute to the maintenance of their livelihood security. The second research question focused on how fire influences access to and the use of woody plant resources as a resource entitlement that contributes to people’s livelihoods in CH. For this question, I conducted transect walks in the villages across their lands and discussed the use of fire in relation to their access to plant resources. The focus was on woody plants as they contribute fodder, food (fruits), medicines, timber, household items, fuel, or ecosystem services. Finally I addressed a third research question to explore how the information gained from the Kamba and Maasai contributes to adaptive collaborative planning with the Kenya Wildlife Service. I organized a meeting that brought together representatives from the six villages, and Kenya Wildlife Service officials working in Chyulu Hills and Tsavo West National Parks. The meeting compared what local participants wanted to be shared and why they thought it was important for sustainable resource planning at CH.
Question 1. How do fires influence livelihood conditions in Chyulu Hills?

Question 2. Are fires causing vegetation changes that influence access to important woody plant resources?

Question 3. How can the perceptions of local people contribute to adaptive collaborative planning that values the viewpoints of all stakeholders and jointly explores fire as a land management strategy?

Fig 1. Conceptual model of the research problem and study framework for the Chyulu Hills, Kenya
Chapter Two

LITERATURE REVIEW

The theoretical-methodological context of this research on anthropogenic fires in CH of Kenya is centered in the human-nature research tradition in geography. I first review cultural-political ecology research that illuminates complex social and ecological issues surrounding anthropogenic fire events, especially the role of local and extra local stakeholders in conflicts over common resources. Fire is interpreted as a manifestation of conflicts over access and control of resources between local communities and government officials. Second, the review provides an applied context for adaptive collaborative management as a conservation tool that emphasizes the inclusion of all stakeholders and their viewpoints on decision making. Third, I conclude the review by discussing participatory research methods that provide opportunities for local residents to share their knowledge in relation to livelihood conditions as an important contribution to adaptive collaborative management and human-nature research.

Cultural-Political Ecology of Anthropogenic Fires

Cultural-political ecology (CPE) is an approach to human-environment research that examines how people negotiate, cooperate, or fight over access, control, use, and character of natural resources while focusing on historical, regional, and ecological contexts (Kull 2004). CPE emerged as a response to concerns that social, economic and political contexts were being ignored in the analysis of environmental issues (Blaikie and Brookfield 1987). The approach pays more attention to political influences on human environment interactions and the behavior of local resource users such as farmers is seen to be influenced by larger social institutions and structures (Blaikie 1985). CPE discourse insists that changes in society and environment are not simply explained by local adaptive processes, but are socially constructed across scales. Nature and societies are undivided and natural ecosystems are not just ecological but also inherently political (Robbins 2004; Walker 2005).

CPE as a radical approach to the study of human-environment relations is upsetting the status quo by questioning conventional narratives favored by state and international authorities. For example, CPE research is challenging dominant deforestation narratives with counter narratives that focus more on the realities of local people and incorporate the traditional
knowledge of the local people in the analysis (Adger et al. 2001). Conflicts between local communities and state conservation agencies over common resources occur because dominant extra-local narratives of environment and management of natural resources have replaced local narratives (Ostrom 2008). Dominant narratives blame deforestation on indigenous land management practices such as the use of fires by rural farmers, but these claims are being challenged. For example, Fairhead and Leach (2000) use archival and field research to argue that some indigenous land management practices have led to the expansion of forests in West Africa. Local residents described how forest patches were created by local farming and fire setting practices such as early burning that caused the progressive expansion of forest into savanna in the last century (Fairhead and Leach 2000). Air photographs corroborated the oral evidence, showing that the forests of Kissidougou, Guinea expanded into savannas. It’s also generally accepted that burning vegetation early in the dry season prevents later fires, which may be catastrophic due to the build-up of wood fuel.

Kull’s CPE research in Madagascar also discredits the dominant narratives that are used to explain fire-caused deforestation in Madagascar (Kull 2004). In his analysis, fire in Madagascar is seen as a powerful agricultural tool at the hands of the local people. Fires aid in forest maintenance as in the case of tapia (Uapaca bojeri) forests across Madagascar’s highlands. Burning favors the dominance of the pyrophytic tapia and protects valuable silkworms from parasites (Kull 2004). Similar research in Northern Ivory Coast indicates that burning early in the dry season and livestock grazing suppresses grasses and allow fire tolerant trees to survive, thus contributing to afforestation (Fairhead and Leach 2000). Robbins (2004) argues that processes of afforestation in savannas are linked to anthropogenic fire regimes, thus challenging colonial and post-colonial forest policies that cut off people from their resources. Current literature now shows that not all anthropogenic fires cause ecological degradation. Indigenous burning is critical to maintenance of mosaic landscapes and a high diversity of species (Laris 2006; Sheuyange et al. 2005).

Adaptive Collaborative Management (ACM)

The shift from equilibrium to non-equilibrium views of social ecological systems provided support for management approaches that recognize complexity and unpredictability
Management needs to be sensitive to unpredictable interactions between people and ecosystems as they evolve together. Adaptive collaborative management (ACM) was introduced as a natural resource management strategy in the 1970s (Adger and Tompkins 2004) and particularly promoted by the Center for International Forestry Research (CIFOR) in the 1990’s. One of the central ideas of ACM is that rights and responsibilities should be shared among those with a claim to the environment or a natural resource (Colfer 2005). Popularity of ACM principles grew as current environmental policies began to move away from ‘top-down’ directives towards consensus based processes and community participation in planning, implementation, and monitoring of conservation projects (Holling et al. 2002).

Early conceptualizations of ACM focused on power sharing between the state and local resource users, but most recently a lot of emphasis is being put on knowledge generation, social learning, and adaptation for transformative changes (Berkes et al. 2002). Humans do not know enough to manage ecosystems. ACM promotes learning that is important in the search for a durable and sustainable relationship between humans and the natural world (Shindler 2009). Thus, management in ACM happens in the face of incomplete knowledge by engaging in a continual cycle of action, learning, and adjusting understanding. Knowledge sharing is key in this cycle and conversation among stakeholders facilitates the flow of this knowledge (Holling et al. 2002). Adaptive collaborative management differs from command and control approaches to resource management because the planning strategy incorporates the views and knowledge of all, especially local stakeholders, and addresses uncertainty by using management as a tool to gain critical knowledge (McLain and Lee 1996).

**Participatory Approaches to Gaining Local Knowledge**

Participatory research is based on the assumption that ordinary people are capable of intelligent analysis of their actions and that their knowledge is relevant and necessary (Slocum et al. 1998). Participatory research emerged in geography and other social sciences as a critique of research approaches that excluded the researched people in their research process. The ethics, purposes, and outcomes of research conducted on behalf of other people were being questioned (Chambers 1994; Cooke and Kothari 2001). Participatory research can be seen as an opportunity
for rural people to share and enhance their knowledge of life conditions, and to plan and act together (Chambers 1994).

In participatory research, researchers become facilitators of the research process, in order to learn and share knowledge with the local people (Medley and Kalibo 2005). Participatory data collection methods include semi-structured interviews, focus groups, participant observation; and collaborative activities that serve to compile and share new learning about a place. For example, transect walks give a researcher a visual experience of a study location in relation to the physical environment and human activities by discussing landscape conditions and changes with participants (Slocum et al. 1998). They also provide a chance for a researcher to talk with residents while walking across landscapes about issues of research interest. During a participatory assessment of resource use at Mt Kasigau, Kenya, Kalibo (2004) conducted transect walks with villagers to gain local knowledge of plant resources. Participatory ethno-botanical methods support local-learning practices described above but also require participants to collect voucher specimens of woody plant species for positive identification (Cotton 1996). Such methods have been used to explore local knowledge of plant uses at Mt Kasigau, Kenya (Medley and Kalibo 2005) and are elaborated on in the Plants and People program formerly supported as a collaboration among the Kew Royal Botanic Gardens, UNESCO, and the World Wildlife Fund (Nemarundwe and Richards 2002).

Longhurst (2010) describes a semi-structured interview as an in-depth informal conversation between the interviewer and the interviewee about a particular topic. Usually the interviewer has a set of questions that guide the conversation between him/her and the respondents but respondents are given a chance to explore the topic as they like and answer the questions in their own words rather than a ‘yes or no’ type answer. For example, semi-structured interviews were used by Butz (2009) to collect data about local people’s perception of anthropogenic fires and about historical and existing fire management practices. This study identified individuals who had relatively more knowledge about fires and engaged them in unstructured interviews. It also took advantage of village gatherings to collect data on changes in traditional fire management, pastoral herd sizes, human populations over time, communal
decision making processes, and transmission of traditional ecological knowledge through
generations.

According to Longhurst (2010), a focus group is a meeting of about six or twelve people,
whereby a discussion is held about a particular topic that has been set by the researcher. It is an
informal conversation among the people who are conversant with the topic and the researcher’s
role is to keep the group focused on the topic and take note of the important points in the
discussion. In focus groups, the researcher does not direct the discussion but allows participants
to discuss the topic in whatever direction they like. A good focus group consists of people who
are known to each other so that they are able to interact freely during the discussion. They should
also be knowledgeable about the topic of study. Focus groups have been used by researchers
especially when they want to orientate themselves to a new field. Longhurst (2010) used focus
groups in a study of pregnant women’s experiences of public spaces in Hamilton, New Zealand.
There was no existing literature on this subject and she used focus groups to learn about the
project parameters before employing other methods. She didn’t know the words pregnant women
in Hamilton use to refer to their bodies, and by conducting the focus groups she learned the right
words to use while employing other data collection methods.

Participant observation is done by the researcher by spending time with or living
among the people being researched and observing their behavior in relation to the subject being
studied (Laurier 2003). The researcher may take field notes, pictures, or take video recordings of
the events being studied. In a study of plant diversity at Mt Kasigau Kenya, Medley and Kalibo
(2005) spent time with local people in order to gain local knowledge about woody plant uses.
They did participant observation by walking through villages and taking part in local community
activities such as the collection of fire wood and grass for thatching. Cotton (1996) suggested
that research of an anthropological nature should allow a reasonable amount of time so that the
researcher is able to participate in the daily life and customs of people they are studying. This
means that participant observers of human-resource relations should take a fair amount time in
the field or they will come up with information that is misleading (Cotton 1996).

Participatory research methods generate data that are useful, accurate, and more capable
of addressing the communities’ real needs (Chambers 1994; Breitbart 2003; Slocum et al. 1998).
Participatory research tools can support the empowerment of local people who are sometimes trained as personnel to aid in research and help to bring out the perspectives of local people whose views have been ignored for a long time. Through participatory approaches, local knowledge is validated and incorporated in conservation research and development planning (Medley and Kalibo 2007). Participatory methods are cost effective since they often use locally available materials. They also promote unity among community members and enhance cooperation between local people and external agents (Breitbart 2003).

Participatory methods are often faced with a lack of active participation by people whose views have been ignored for a long time and thus have developed a culture of silence. They also may not have the experience of expressing their views (Breitbart 2003). Breitbart (2003) advises that researchers who are used to the culture of expression should be careful not to dominate the research process since effective participatory research requires everyone’s full participation. Power relations among participants influence the accuracy of data collected from participatory methods (Breitbart 2003). Studies conducted in Africa using participatory approaches show that in mixed groups of men and women, men’s views tend to be dominant and women’s views less considered (Goebel 1998). It is therefore important to consider power differences among people differentiated by age, gender, and class. To ensure that all perspectives are heard, a researcher may decide to divide participants into different groups. Moreover, participatory methods may not always lead to inclusion of people’s knowledge and sometimes may mean ‘a way to make people do what the researcher wants’ (Cooke and Kothari 2001). Due to relatively less bargaining power of local people, participatory methods have been accused as means of acquiring and manipulating new knowledge rather than as a way of including indigenous knowledge in development planning discourse (Goebel 1998).
Chapter Three

STUDY AREA

Physical Setting

The Chyulu Hills (CH) are located in Kibwezi and Loitoktok regions of southern Kenya, where the top of the hills form the boundary between the two regions (Fig. 2). The two regions fall within Makueni and Kajiado counties respectively. The Hills are located about 190 km south-east of Nairobi and extend roughly northwest-southeast between Nairobi and Mombasa. The eastern flank of CH forms part of the CHNP (Fig 2). The hills rise abruptly from an upland plain at about 1000 m to a maximum altitude of 2175 m. They are a narrow Quaternary chain of volcanoes formed through eruptions that took place less than 10,000 years ago (Ritter and Kaspar 1997; KWS 2008).
The region surrounding CH is classified as arid to semi-arid (Muriuki et al. 2011) but higher rainfall and cooler temperatures on the hills do support montane forests. Rainfall is bimodal; long rains occur between March and May while short rains occur between October and December (ROK 2008). Lower elevations around the CH areas receive 400 –500 mm of rainfall but records from the top of the hills are around 1000 mm (Solomon et al. 1991). Coolest temperatures are from May to July, following the long rains, and the hottest months are between September and February. CH hold no permanent surface water but rainfall percolating through the porous rocks feed many permanent springs in the surrounding plains. These springs include Kiboko, Makindu, Umanyi and the largest of all, Mzima springs, which supplies water to Mombasa about 300 km away.

The eastern side of the Chyulu Hills where the Kamba villages occur are dominated by Acacia-Commiphora bushland at elevations below 1100 m. Common species include Acacia tortilis and Acacia mellifera. At higher elevations, semi-evergreen bushland and then evergreen forest occurs as small patches, mostly in concavities, in an open grassland landscape. On the western side of the Chyulu Hills where the Maasai villages occur, dry grassland mixed with Acacia drepanolobium occurs at lower elevations below 1300 m. At higher elevations, patches of semi-evergreen bushland transition to evergreen forest patches that are surrounded by open grassland which dominate the upper slopes. Montane forest patches are better developed in the southern part of the hills, where elevations are higher and receive more rainfall (KWS 2008). Higher precipitation and cooler temperatures at higher elevations also promote the establishment of miraa (Catha edulis). This woody plant species is highly extracted for its commercial value and associated with fires that occur at the top of the Chyulu Hills annually during the dry season.

CH are important for biodiversity conservation and were recently nominated as a World Heritage Site to the United Nations Scientific and Cultural Organization. They are home to endemic bird species that include the Shelley’s francolin, white-starred robin and the orange ground thrush, and also form an important wildlife migration corridor between the Amboseli and Tsavo plains. Some mammal residents include the African elephant, rock klipspringer, and the African buffalo (KWS 2008). The East African sandalwood (Osyris lanceolata), which is among
the plants protected by the International Convention on Endangered Species (CITES), is also found and was heavily exploited in the hills between the years 2000 and 2005.

Cultural Groups in the Chyulu Hills

The eastern side of CH, in Kibwezi, Makueni County is inhabited by Kamba agro-pastoralists. Kibwezi has an estimated population of 200,616 people, and about a third of this population live in village settlements adjacent to CHNP (Fig. 2; ROK 2010). Crops grown include a variety of drought resistant grains such as maize, sorghum, millet, beans, and pigeon peas. Livestock are reared for milk and meat, including local breeds such as the Small East African Shorthorn Zebu cattle, Red Maasai sheep, and the Small East African Goat. Woody plant resources are critical to the Kamba who extract them for herbal medicine, charcoal, and wood carving activities. Due to the proximity of the eastern side of the CH to the Nairobi-Mombasa highway, charcoal and wood carvings are easily transported to Nairobi and Mombasa where demand for these products is high. Miraa (Catha edulis) is also extracted from the hills by the Kamba and sold in nearby towns like Kibwezi and Makindu. Although the population of small game in the CH has declined sharply, poor households still regard bush-meat as an important source of protein (Mosse 2003).

The western part of the hills, in Loitoktok, Kajiado County is settled by the Maasai and includes Mbirikani and Kuku group ranches that they own and manage for pastoralism and ecotourism activities (Fig 2). Mbirikani and Kuku group ranches have a combined area of approximately 2427 km² and an estimated human population of about 15,000 people and approximately 150,000 heads of cattle (pers.comm with group ranch officials). The Maasai are traditionally pastoralists who engage little with farming and live in scattered semi-permanent villages or bomas. Most of the livestock is sold in local markets, mainly in Kibwezi and Loitoktok. Although pastoralism is still the main occupation of Maasai living in Mbirikani and Kuku ranches, they are also diversifying their income sources. Farming now occurs in wetland areas with more reliable rainfall and tourist facilities are now established in each ranch.

The CH region has a long history of conflict between the Kamba and the Maasai (Mosse 2003). This conflict arises from cases of cattle theft and disputed grazing rights between the Maasai and the Kamba. Other causes of conflict in this region include land tenure insecurity that
is manifested in squatter settlements especially on the eastern side (Muriuki et al. 2011). In 1990 and 2007, the Kenya government sectioned off part of land belonging to Kenya Agricultural Research Institute (KARI) to settle squatters who had lost land after the establishment of CHNP.

Drought is a major cause of poverty in the CH, and the frequency of crop failures and/or livestock loss is being exacerbated by climate change (ROK 2008). According to the 2009 Kenya population and housing census, Kibwezi and Loitoktok ranked among the poorest regions in the country with more than 64.3% poverty level (ROK 2010). The population is mostly below 15 years (59.5%) and the population was projected to rise at 2.8% per year (ROK 2008). The region lacks basic infrastructure such as piped water, paved roads, and electricity. The people living around CH are still heavily reliant on natural resources for their livelihood needs. Fire is an important land management tool that supports agro-pastoral livelihoods in the Chyulu landscape.

History of Land Use and Resource Conflicts in Chyulu Hills

Kamba Settlements in the Eastern Chyulu Hills

Prior to the arrival of the British at the end of the 19th century, the eastern slopes of the CH had sparse settlements of Kamba people who had moved from densely populated highlands in Machakos in search of new land for farming and hunting (Muthiani 1973). Individuals exercised use rights on communal land where a low population and sufficient land resources supported the shifting cultivation of traditional grains such as sorghum and millet (Muthiani 1973). Land that could not be used for cultivation was still appropriate for the grazing of cattle, sheep, and goats. Bushmeat hunting and the collection of wild fruits further supported local subsistence, and the Kamba traded in local goods, including cane beer, medicinal herbs, ivory, and millet with people from other parts of pre-colonial Kenya. The CH attracted settlement due to moderately fertile volcanic soils, cooler temperatures that allowed crop growth under otherwise semi-arid conditions, an abundance of grass for livestock, and a diversity of extractive resources (Muriuki et al. 2011). The Kamba relied on water from Umanyi spring in the CH, which was also an important cultural and sacred site for conducting rain making ceremonies.

Colonization affected settlement patterns in Kibwezi and adjacent areas. The railway line connecting Nairobi and Mombasa passed through Kibwezi and this acted as a catalyst for
interaction between the Kamba and British immigrants. Colonial authorities gained interest in the region due to the abundant wildlife, and in the 1920s CH were included in designated crown lands that extended to Tsavo West National Park. The area was closed for human settlement and the people who were evicted from the hills settled lower on the eastern slopes (Muriuki et al. 2011). However, the complete removal of settlements by colonial authorities was incomplete and population pressure from the surrounding Kamba lands (e.g., Ukambani) forced people to continue to ‘illegally’ settle in the hills (Mosse 2003).

Communal ownership of land over much of Kenya came to an end when the colonial government implemented the Swynnerton Plan in 1954, which aimed at providing tenure security to Kenyans and to address the problem of land scarcity in native reserves. The program resulted in the creation of landless people, some of whom went to settle in CH as squatters (Okello and Tome 2007). Village councils comprised of atumia (men) would allocate immigrants land in the CH after paying a small amount of money (cuu wa atumia). These immigrants came with varied interests, including hunting, cultivation, and charcoal trade that triggered massive clearing of dense bush lands. The acreage an immigrant household managed depended on family labor available to clear and cultivate the essentially ‘free land’ (Muriuki et al. 2011).

After independence, the new government re-opened parts of the eastern Chyulu Hills for additional settlements between 1963 until the early 1980’s, backed by support from the local county council and politicians. During that time, the Ministry of Education also deployed teachers to work in schools that had been established by villagers (pers.comm. with a former teacher who lived and worked in Chyulu Hills before park establishment). The outcome was rapid demographic change and by the mid-1980’s, the population growth rate of the then Kibwezi location was twice the national growth rate (Muriuki et al. 2011). Land tenure arrangements in Chyulu Hills remained insecure after independence where no official allocation of land had taken place by 1980. Most of the population arrived as squatters and still do not have official documents for land ownership. By 2009, only 5% of the households on the eastern side of CH possessed title deeds from the Kenya Ministry of Lands (Muriuki et al. 2011). Land tenure insecurity has been identified as a major reason for rapid land cover change in the CH, between
1967 and 1999, where native vegetation (dense forests, open forests, bushland and shrublands) decreased from 91% to 36%. In the same period, the area under cultivation expanded by approximately 40% (Muriuki et al. 2011).

Maasai Settlements in the Western Chyulu Hills

Before the establishment of colonial rule in Kenya in the 1890’s, the Maasai pastoralists utilized grazing lands on the western side of CH. They owned large herds of cattle, sheep and goats, and these animals played a central role in their society and economy. The Maasai moved extensively with their animals across grazing lands that were communally owned and without restrictions. During the wet seasons they grazed their herds in the Amboseli and Tsavo plains adjacent to the CH and when the dry season came, they would move with their herds to the CH and nearby swamps in order to ensure livestock survival (Campbell et al. 2001). Large land areas were burned by the Maasai to prevent livestock pests and diseases, and to ensure visibility across the grazing lands (Solomon et al. 1991).

Land policies implemented by British colonial authorities led to a loss of control over traditional grazing land among the Maasai living west of the CH. First, the colonial government established the West Chyulu Game Conservation Area on the west side of CH that was administered by the trustees of Kenya National Parks (Okello and Tome 2007). Although the Maasai retained grazing rights and continued to settle in the area, they had technically lost their traditional ownership of this land. Second, the National Park Ordinance in 1945 set the stage for the establishment of national parks in Kenya, beginning with the formation of Tsavo West National Park. The Maasai consequently lost access to lands that formerly provided dry season pasture for livestock in the western CH (Matheka 2008).

After independence, Kenya introduced a new system of land management for pastoral areas in CH. The West Chyulu Game Conservation Area was adjudicated into ranches that provided freehold title deeds to designated groups of Maasai (Solomon et al. 1991). Each group ranch has registered permanent members and members are not allowed to belong to more than one group ranch. Group ranches were viewed as a radical attempt to modify Maasai pastoralism toward a less nomadic commercial system (Ntiati 2002). The West Chyulu conservation area was adjudicated into Mbirikani and Kuku group ranches, which border the western park boundary for
the Chyulu Hills (Fig. 2). Each group ranch is headed by a democratically elected committee that oversees pastoral management and resource use. Only registered members of a certain ranch are supposed to utilize resources in that ranch, but the Maasai still acknowledge the need for mobility during drought and thus strict boundary maintenance rules are relaxed during these times (Ntiati 2002).

Conservation and Conflict at Chyulu Hills National Park

In 1983, the Kenya government gazetted 400 km$^2$ as Chyulu Hills National Park, and all those who had settled in the gazetted area were evicted from the newly protected lands. The park boundary was later extended in 1995 by another 380 km$^2$ to better conserve wildlife resources and create a buffer zone between Maasai and Kamba communities who were contesting grazing rights in the region (Mosse 2003). All national park lands in Kenya are managed and regulated by the KWS, the state agency for wildlife conservation.

The establishment of the park was done without consultation with the Kamba or Maasai residents, who were settled and/or relied on the grazing and extractive resources of the designated protected area. During the evictions, many Kamba residents suffered massive losses when schools and residential houses were destroyed without compensation. Some Kamba evictees were resettled in a lower and drier part of Kibwezi district, but most received no compensation. None of the Maasai received access to alternative lands, promoting continued conflict between the ethnic groups over resources and their relative recognition by the state government (Mosse 2003).

The aim of establishing CHNP was to prevent habitat destruction and biodiversity loss (KWS 2008), but current conflicts over access to and control of land resources in the protected area among stakeholders (e.g., local communities and the KWS) seriously threaten these conservation objectives. Nearby community residents continue to rely on the CH for extractive resources and grazing lands, and often illegally carry out these activities within the protected area. KWS responds by arresting those found in the park illegally, discouraging their access to resources that are critical for their livelihoods. Moreover, a protected elephant population in the park raids surrounding farms. Illegal fires, the focus for this study, are an important
manifestation of this conflict as it threatens the protected resources but potentially supports the livelihoods of peripheral populations.
Chapter Four

DATA AND METHODS

This study employed qualitative research methods to gain local perceptions of fire use among communities living around the Chyulu Hills and to examine how fires influence access to important woody plant resources. I conducted field research during the months of June and July 2012, working within a 10 km buffer zone from the Chyulu Hills National Park (CHNP) boundary. The research fulfilled the requirement of informed consent, which was approved by the Institutional Review Board at Miami University (Appendix 1). Upon arrival to Kenya, I gained a research permit from the National Council for Science and Technology in Kenya registered as NCST/RCD/14/012/800 (Appendix 2). All communications were conducted in Kiswahili, but I relied on local field assistants who were conversant in the local languages of the two ethnic groups and could assist in translation when necessary.

I first visited the local assistant chiefs and informed them about my intentions to engage village groups in research. They gave me information about the groups that existed in the sample villages under their respective jurisdiction. I selected groups that had a local focus for their mission, had members available for focus group meetings, and included a diversity of livelihood activities among the members. Some of the groups were mixed while others were gender specific. In the north and south Kamba villages, men and women participants of the focus groups were members of the same village group. The assistant chiefs contacted the leaders of the various groups, and I held a meeting with them to select ten men and women who would participate in the focus group discussions. Emphasis was put on selecting adult participants who had lived in the respective villages for a sufficient amount of time so as to understand the use of fire in their village of residence.
The six villages selected were located east and west of CHNP and stratified north to south along the Chyulu Hills (Fig 2). The villages differ in land cover conditions, depending on altitude as it influences their rainfall and temperature conditions, and disturbances attributed to past land use activities (Table 1; Fig. 3).

The east side of the Chyulu Hills is dominated by *Acacia-Commiphora* bushland on mostly lateritic soils, which characterize the land surrounding the Kamba villages, but open grasslands with *Acacia drepanolobium* on black cotton soils predominate on the west side of the Chyulu Hills where the Maasai villages occur (Fig. 3). The second Maasai village was located at a higher elevation than all the other villages and occurred adjacent to disturbed montane forest dominated by *Pappea capensis* (Fig 3). Since
the use of fire remains contentious around the Chyulu Hills, the villages selected were assigned names and their locations were not precisely identified (Table 1). All the villages selected were within 10 km from the park boundary.

**Use of Fires in the Chyulu Hills Landscape**

To gain an understanding about the use of fires, I held twelve focus group meetings on separate days with groups of women and men in the six villages.

These meetings took place at village venues selected by leaders and lasted between 4 to 5 hours. At the start of the meetings, I verbally asked for consent from the participants and stressed that their participation was voluntary; they could leave at any time and any information they shared would never identify their village or them as individuals. I guided the meeting with open ended questions that explored the different reasons local people use fires, and how uses differ among village residents over the seasons and over the long term (Table 2). My analysis of their responses compared differences between men and women, differences between Kamba and Maasai communities, and differences among places and over time. I allowed participants to say as much as they wanted about their use of fires and used follow-up questions for elaboration and clarification during the interviews. My compilation of the findings, however, concentrated on responses that had group consensus.

| Table 2. Guiding questions on the use of fires during focus group meetings. |
|-----------------------------|-----------------------------|
| 1 | How do people in this village use fires in their livelihood activities? |
| 2 | When do these fires occur? |
| 3 | Who decides when to burn? |
| 4 | How long have people been using fires in this village? |
| 5 | Is the use of fires different now than it was in the past? |
Influence of Fires on Access to Woody Plant Resources across the Chyulu Landscape

The second research question investigated whether fires are causing vegetation changes that influence access to important woody plant resources in the study area. I first participated in transect walks with focus group members in all the six villages. I consulted with group leaders during focus group meetings and selected five men and five women from each village to participate in transect walks and semi-structured interviews. The volunteers suggested dates that were convenient for them and meeting points. In total, 63 people participated in transect walks: ten people from each village; myself; and two field assistants. The six walks were conducted on different dates, starting in the three Kamba villages and later in the three Maasai villages. To introduce the question to participants, I used a 2007 Landsat image covering the Chyulu Hills to show vegetation cover and fire scars. I then asked participants to guide me along a transect across their home area that showed the diversity of these land-cover conditions.

GPS locations were used to measure the length of the transect walks and areas of recent burn and old burn sites. The walks started at 9.00 am in the morning and lasted at least four hours. They ranged from 3.2 km to 4.5 km in length and were done along village roads that led across people’s homesteads, farms, grazing fields, village market centers, and resource collection areas. While walking with participants, they described activities that involved the use of fire, identified and described uses for woody plant resources, and identified woody plant resources that were impacted by fires as guided by open-ended questions (Table 3). These questions were

<table>
<thead>
<tr>
<th>Guiding questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. How was vegetation in this village in the past?</td>
</tr>
<tr>
<td>2. What woody plant resources do people use in this village?</td>
</tr>
<tr>
<td>3. Where do they extract these woody plant resources?</td>
</tr>
<tr>
<td>4. Are these woody plant resources affected by fires?</td>
</tr>
<tr>
<td>5. Are fires increasing or reducing access to these plant resources?</td>
</tr>
<tr>
<td>6. Have fires caused the introduction of new species in this village?</td>
</tr>
</tbody>
</table>
important in the analysis of villager’s perceptions on how fires are influencing access to woody plant resources that are necessary for their livelihood needs.

After each village transect walk, I recorded a list of all woody plants mentioned by participants and highlighted those whose access were being influenced by fires. Photographs of woody plants were taken and their uses and local names recorded. Voucher specimens of the woody plants were also collected and taken for identification at the East African Herbarium in Nairobi and later deposited at Willard-Sherman Turrell Herbarium at Miami University, Ohio (MU). Confirmations of these plant vouchers were completed by Mr. Kennedy Matheka at the East African Herbarium (E.A).

Box 1—Introduction to the Research

“As you are all aware, I am conducting research about fires that occur in the Chyulu region. This meeting is part of this research and I will be writing all the issues discussed in this meeting for the purpose of compiling a masters’ thesis. Nobody will be victimized for his her opinion. My goal in this research is to gain knowledge on how you use fires in this region and demonstrate that your knowledge on fire use is important. Recognition of your knowledge on fires by authorities will lead to your inclusion in fire management efforts in CH. Right now there is no dialogue between authorities and local people on how to manage fires because the authorities believe that you use fires in a way that is harmful to the environment. The research is intended to explore and validate other opinions, including those that say fires have some benefits too. My applied research purpose is to promote collaboration in fire management between the authorities and local people.”

Adaptive Collaborative Management as a Planning Strategy

The third question in this study explored how the perceptions of Kamba and Maasai on fires contribute to adaptive collaborative management with the Kenya Wildlife Service (KWS) at the Chyulu Hills. On July 26th 2012, I organized a five-hour meeting between community representatives and officials from the KWS that was scheduled at the headquarters of CHNP. I first collaborated with leaders of men and women groups to identify five representatives from each of the six villages included in my field research. These representatives were members of the men and women groups that I worked with during the focus group discussions. The north and south Kamba villages, and the south Maasai village were each represented by two women and three men. The middle Kamba village,
and north and middle Maasai villages were each represented by three women and two men. The meeting comprised a total of 30 community members with equal representation by women and men participants. This research covered transport expenses for the Kamba and Maasai to the venue of the meeting and back to their villages. Three KWS officials participated in the meeting, including the warden in charge of CHNP and community wardens from CHNP and Tsavo West National Park (TWNP). All participants communicated effectively in Kiswahili and used that language during the meeting.

I started off the meeting by thanking the participants for attending and then asked members to introduce themselves. I stated that my role in the meeting was that of a moderator and that all the information I would gather during the meeting would be used for the sole purpose of my academic research. I provided a brief description of how the research might contribute to fire management decisions and relations with authorities (Box 1). I then gave a brief overview of adaptive collaborative management and elaborated on how the planning approach formed part of my applied research framework (Box 2). I emphasized that the meeting focused on gaining knowledge from village representatives and not the KWS officials.

Three open-ended questions guided the group discussion during the meeting. I first asked participants to describe the similarities or differences in fire management practices that existed between the Maasai and Kamba. I posed this question to help participants develop a common and comparative understanding of their practices in CH and also promote transparency and accountability in the sharing of information about fires in the CH. I used responses to this

---

**Box 2- Adaptive Collaborative Management**

“Adaptive collaborative management is a planning strategy applied for the management of natural resources such as forests, water, and wildlife. This strategy was introduced in the 1970’s as a response to failures by management approaches that are based on central authority, for example KWS and Kenya Forest Service (KFS). ACM by design values the views and knowledge of all those who have a claim to a particular natural resource and promotes the sharing of rights and responsibilities over natural resources among stakeholders. Management of natural resources by this approach takes place in a continual cycle of action and learning. Management decisions are adapted to the prevailing conditions.”
question to validate the information that I had recorded during the focus group meetings and transect walks, including reasons for using fires and impacts of fires on woody plant species. I was also keen to get additional information that I had not recorded in focus groups and transect walks. Second, I asked participants what information on fires they wanted to share with KWS. This question was critical because it gave participants a rare opportunity to express their perspectives on fire management in the presence of KWS officials. Third, I asked participants to describe how their knowledge would contribute to adaptive collaborative management with KWS. This question was posed in order to explore how local people’s knowledge on fires can be translated and used from their perspective in the implementation of adaptive collaborative plans between KWS and local residents.

By consensus participants agreed to allocate one hour of discussion to each question and one of the participants was chosen as the time keeper. However the discussion on the three questions took about four hours. I facilitated the meeting when participants would raise their hands to give a contribution to each of the three questions. I also prompted participants in case I needed clarification on the issues discussed. I encouraged participants to be open and transparent while giving their responses in the spirit of collaboration and consensus building. I made qualitative notes on who was participating and if there were equal opportunities for participation by representatives from the Kamba and Maasai villages and also by gender. I deliberately ensured participation by both gender by picking a man and woman participant in succession. Participant’s responses to the questions and follow-up discussions were recorded in a field notebook and eventually translated to English for qualitative analysis.
Chapter Five

RESULTS

Use of Fire in the Chyulu Hills Landscape

Participants in focus group discussions identified 22 different reasons for why fires occur on lands surrounding their villages and 21 of the reasons were purposely set for specific uses (Table 4). Most of the reasons were mentioned by focus groups in more than one village. The two most important reasons reported by all villages for burning were to stimulate new and more nutritious pasture for livestock and for harvesting honey. Other frequently reported reasons for burning include killing of pests and diseases, clearing bush to improve visibility for the movement of livestock and people, and clearing new land areas for cultivation especially by immigrant small scale farmers (Table 4).

Kamba villages reported more reasons for burning than the Maasai villages. The Maasai use fire mostly to promote productive pasture and facilitate the movement of cattle across lands. The Kamba villages reported reasons for burning that are related to extraction activities such as honey collection, hunting, charcoal and miraa (*Catha edulis*) production. Only one Kamba men’s group reported that they used fires as a form of protest, but it was clear that their reasons for fires included lands inside and outside of the park:

“People in this village light fires in the park as sign of revenge against Kenya Wildlife Service (KWS). When Chyulu hills were officially declared as a National Park, people living in the hills could not imagine leaving their volcanic fertile land to go and settle in semi-arid lands where means of living was uncertain. Those who delayed to move out were ruthlessly evacuated by authorities and their houses set on fire. This merciless eviction led to psychological conflict between the community and the KWS Staff and the local communities still perceive KWS as their enemy. Due to this bitterness, which is passed on to younger generations, some people light fires as a sign of resistance against KWS.”

Charcoal burning, which is a major source of income for the Kamba in Kibwezi district (Muriuki et al. 2011) is an important cause of fires reported in the Kamba villages. Land fires
from charcoal production are both intentional and accidental. For example, one Kamba villager reports:

“We rely on charcoal burning for our incomes in this village, although the authorities are very much against it. Most of us are not educated and therefore cannot get good jobs. We use fire to burn the wood and make charcoal, and sometimes when an inexperienced charcoal maker doesn’t cover the ndubia (charcoal kiln) with enough soil, a fire might escape and end up burning the surrounding bush or spill over to neighboring farms. So some of the fires you see here are accidental.”

Accidental fires that escape from personal fires are also a common occurrence in the Chyulu Hills landscape. According to participants, wood carvers and herdsmen were largely responsible for these fires as they usually spend prolonged times away from their homes and use fire for most of their activities such as cooking, light at night, and keeping themselves warm during the cold season. During such events and especially when there are strong winds, fires get out of control and burn vegetation in the landscape. Of special interest, are the illegal fires that are reported to promote the growth of miraa (*Catha edulis*), which is illegally extracted and sold. These fires mainly occur within the CHNP where miraa is extracted illegally. Miraa shrubs were found growing near all six villages but no fires were associated with the plant’s growth at those locations.
While perceptions on the use of fires by both men and women seemed to mostly agree, some differences emerged from the focus groups. The women focus groups for both Kamba and Maasai villages gave fewer reasons for burning compared with the men. Two Kamba men’s groups reported the cultivation of “bang” (*Cannabis sativa*) as a reason for burning while no women’s group mentioned the reason during the discussion. Burning as a sign of resistance to
KWS was also mentioned by a men’s group in one of the Kamba villages; men were generally more vocal than women in expressing the lingering resentment against KWS. For Maasai men, pasture maintenance was the most important reason for burning, but Maasai women also mentioned firewood collection, clearing bush for homestead establishment, and agriculture as reasons for burning.

**The Fire Season**

Burning in both Kamba and Maasai villages mainly occurs between the months of May to October (Table 5), which are usually the driest months. Fires in May were reported by four out of the twelve groups involved, and all groups identified June through to October as prone to fires. May, June and July experience small fires while bigger fires occur in September to mid-October. Early dry season fires that occur in May and June were mainly associated with honey harvesting in both Kamba and Maasai villages. Late dry season fires that occur in September and October are larger and are used to promote grassland productivity and palatability for livestock.
Accordingly, the Kamba, who practice honey and other extractive activities, reported more early fires than the Maasai. Another notable difference is that the Kamba prefer early season burning for pasture regeneration while Maasai generally prefer burning late in the dry season to promote faster grass regeneration in the next rainy season. For example, one Maasai male participant described his support for late season burning:

“Between May and July the grass is a bit dry but animals will still eat it, from August the good grass becomes scarce and very little palatable grass is left. Burning of pasture is mostly done during the month of September and October in this village. During this period the remaining dry grass is completely dried up by
the sun and is avoided by the cows and goats. When you burn this grass just before the rainy season, fresh grass will grow and the animals will feed on the new more nutritious shoots."

Maasai participants suggested that the time of burning impacts the quantity and quality of forage for livestock. Other reasons for burning that were not associated with any particular livelihood activity could not be tied to a fire season. For example, in Maasai villages, the use of fire to scare away predators or kill dangerous animals such as snakes is not seasonal and was reported to happen at any period of the year.

Who Decides When To Burn?

Decisions to burn in the Kamba villages are largely individual. In these villages, adults light fires in their own farms when they want to and they only have to make sure the fires do not encroach on other people’s farms. Communal practices have now been ignored since land is privately owned. In Maasai villages, decisions to burn are both communal and sometimes official as in the case when group ranch officials prescribe controlled burning within the group ranches. Controlled burning is mainly done to prevent late season catastrophic fires. As one Maasai man reported:

“Two weeks ago there was a meeting among group ranch officials and they decided to burn areas surrounding the lodge and the local primary school so as to prevent damaging fires. Two men were hired to do this job and I happened to be one of them. We lit fires around the two places and watched over them to ensure there was no damage to property.”

Since the land is communally owned in Maasai villages, decisions to burn pastures are made by grazing committees. In all the villages that I visited, all members of the grazing committees were men. The committees are responsible for making decisions about pasture management at the village level. Some instances of fire use such as burning to clear the pathways or make a new homestead do not require approval by the committee; individuals are only required to be cautious so that the fire does not extend beyond their defined boundaries. Individuals who burn pastures in the village without authority from the elders may be asked to
pay a fine, which is usually a goat or cow that is given to the community. When an animal is paid as a fine, the village elders may decide to donate it to the poor or slaughter it during village ceremonies. Maasai herd boys (morans and layoni’s) are permitted to start fires during grazing if these fires are beneficial to livestock. Sometimes the herd boys will be out in the grazing fields at a great distance from their homesteads. In such a case, the leader of the group who is usually the oldest moran directs the use of fire.

**Past Fire Management Practices**

Information gathered during focus group discussions indicate that the Chyulu Hills landscape has been shaped by many years of burning by the local people. In the past, the use of fire was an important part of land use and was controlled by certain cultural traditions. Participants in all the focus groups could not indicate a specific time period when people started using fires in the villages, but they agreed that human-set fires existed in the villages since the pre-colonial period.

In the Kamba villages, fire was traditionally used for hunting purposes. Burning was done to provide open spaces where herbivores especially antelopes like to feed on new grass sprouts. Burning of large areas was also done to divert big game such as rhinos and elephants into small unburned areas for easier hunting. This kind of burning was carried out by small groups of hunters who traversed the landscape in search of animals for hunting. Traditional burning practices reported in the Kamba villages also reflect the agro-pastoral livelihoods of the Kamba people. Fires were used to clear new lands for farming and settlement. Burning was also done to convert bushland to grasslands for grazing and to stimulate the growth of more palatable forage for livestock. Burning in settled areas required authority from atumia a ndua (village elders) but burning for hunting by asyimi (hunters) did not require authority since it was mostly done on unoccupied lands. Protection of important woody plants was a significant aspect of traditional fire management; plants considered valuable for food such as wild fruit trees, those with medicinal value, and also those used for animal feed were protected from fire. Examples of such tree species are *Acacia tortilis* and *Balanites aegyptica*. It was also a taboo to start fires around traditional shrines and water sources, and the failure to observe these community rules
would attract penalties, ranging from a fine of a goat to a ruthless fatal wrath of ‘King’ole’ (a communal court which is convened when a serious offence is perpetrated against a community).

Despite considerable consensus among the participants in Kamba villages about past fire management practices, subtle differences between men and women and between villages were apparent. When women in Kamba villages were asked to discuss the use of fire in the past, their responses focused more on household food production activities such as preparation of new and old plots for farming and bush meat hunting. Only one women group associated the use of fires in the past with ivory hunting. On the other hand all the three men’s groups identified ivory hunting and encouraging grass regrowth for cattle as important reasons for fire use in the past. Traditional ivory hunters used fire to communicate among the hunters and control the movement of elephants and other wildlife.

Historically, the Maasai living in the Chyulus burned before the short rainy season which starts in late October to encourage the growth of new grasses. According to participants in Maasai villages, burning was entirely a communal activity and was mainly aimed at maintaining healthy grazing lands. Burning was done during every dry season and the extent of burning for each year depended on the state of the grazing lands. They started fires in the evenings or early in the morning when the wind was minimal and the temperatures were low to prevent damaging fires. Village elders made decisions on when and where to burn, and before a fire was started they disseminated the news in the village so that everybody was put on alert. Fires were usually not started near bomas to prevent fire accidents and also in forested areas, which contained important plant materials used as medicine, building materials, or firewood. Young men were supposed to watch over the fires to ensure that the fires were not destructive. Individuals who started fires without authority from elders were required to pay a fine of livestock (goat, sheep or cow) depending on the severity of the fire. Traditional fire management practices are being altered in Maasai villages and the use of fire is declining as a result of campaigns conducted by conservation trusts operating within Kuku and Mbirikani group ranches. As one woman reported:

“The trust officials and hoteliers are urging us not to start fires because tourists complain when they see the fires. A few years ago, a lodge was completely burnt
by fires and that’s why the lodge owners and trust officials don’t want to see fires.”

From the discussions held with women in Maasai villages, it was clear that traditionally, women perceived the use of fire as a men’s affair. Their responses indicate that fire use in Maasai villages was mainly done for pasture management and since adult and young men (morans) are responsible for the cattle and grazing, women had very little to do with fires. According to women, men were responsible for monitoring the health of pastures, the presence of ticks, and rainfall patterns in order to make decisions on when and where to burn. When men were giving their responses about the past use of fire, they did not mention women household roles like gathering fire wood and managing homesteads. This was the case in all three men’s groups. Nevertheless, past use of fire by women in Maasai villages was reported by all women groups, especially clearing new areas for homestead construction and keeping the compound free from bush. Probably due to the relatively longer period of occupation of the CH by the Maasai compared to the Kamba, their responses confirmed a longer period of fire use.

Fires and Woody Plant Resources in Chyulu Hills

Narratives from participants during the transect walks indicated that residents of Maasai and Kamba villages surveyed rely heavily on the woody plant resources for their day to day needs and many of these resources are influenced by their fire practices. The focus-group participants identified 25 useful plants during the six transect walks conducted in Kamba and Maasai villages whose access was influenced by fires. These plant species occur in 18 families and 22 genera (Table 6). All plant families had only a single species except Anacardiaceae with two species and Fabaceae with seven species, including 5 in the genus Acacia (Beentje 1994). In cases where a plant species had more than one common name, the group selected the name that was most local and popular around the Chyulu Hills. Of the woody plants confirmed, 14 plant species occurred as large trees, 4-15m in height, 3 species as small trees below 4 m in height, and 8 species as shrubs with multiple stems and below 4 m in height. Transects conducted in Kamba villages recorded a higher number of plants whose access is influenced by fire than those conducted in Maasai villages. Out of the total 25 plants species, 23 plant species in 16 families and 20 genera were recorded in Kamba villages and 15 species in 11 families and 12 genera were
recorded in Maasai villages (Table 6). Most plant species, 23 of 25, were found in Acacia-
Commiphora bushland, which mostly surrounds the villages. Thespesia garckeana and
Trichodesma zeylanicum were not found in Acacia-Commiphora bushland. Thespesia garckeana
was only found in open grassland and Trichodesma zeylanicum was only found in montane
bushland. All but one species, Lantana camara, are native to Kenya. Lantana camara is a
common nonnative shrub in Kenya that occurs on disturbed-open lands, and at the CH the
participants pointed it out in area of recent burns.

Table 6. Kamba and Maasai names and uses for woody plants compiled from residents in Kamba
(k) and Maasai (m) villages. These plants include trees, shrubs, and woody herbs that
participants reported were influenced by fire practices. Plant uses for the Kamba (k) and Maasai
(m) are categorized as food for humans, fodder for livestock, construction, technology, remedy,
fuel, and ecosystem services (Prance et al. 1987, Medley and Kalibo 2007) and the Latin names
follow Beentje (1994). All plants are indigenous except Lantana camara. Voucher numbers by
the author (PK) are reported for plant collections confirmed at the East African Herbarium and
deposited at the Turrell Herbarium Miami University (MU).

<table>
<thead>
<tr>
<th>Family</th>
<th>Species</th>
<th>Description</th>
<th>Use(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anacardiaceae</td>
<td>Lannea schweinfurthii (Engl.)-Engl; shrub or tree; bushland; PK8. Muuasi (KAMBA).</td>
<td>Leaves used as tea leaves (k); trunks make timber (k); bark is boiled for coughs (k); charcoal and firewood (k); shade (k).</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rhus natalensis Krauss- shrub or tree 1.5-6 m; bushland; PK12. Mutheu (KAMBA), Olmisigiyoi (MAASAI).</td>
<td>Fruits and leaves are edible (k, m); food for goats (k,m); used as tooth brush (k); powder from crushed leaves is boiled to treats stomach ache (k,m); during naming ceremonies a sheep is slaughtered under this tree as a symbol of good luck (m).</td>
<td></td>
</tr>
</tbody>
</table>
Balanitaceae

*Balanites aegyptiaca* (L.) Delile- tree; evergreen bushland; PK21. Mulului (KAMBA), Olokwei (MAASAI). Fruits are edible (m); trunk used for hut construction (m); fruits and roots eaten as aphrodisiacs (k); bark treats heartburn (m); firewood (k, m); shade (k, m).

Boraginaceae

*Trichodesma zeylanicum* (Burm.f.) R.Br- woody herb; montane bushland and open grassland; PK31. Enterepenyi oo indoo (MAASAI). Roots make a decoction that aids in wound healing (m).

Burseraceae

*Commiphora africana*- (A. Rich). Engl.-tree; deciduous bushland/ evergreen forest; PK27. Ikuu (KAMBA), Oloishimi (MAASAI). Gum used as food (m); leaves are goat food (k, m); timber (k); making wooden spoons (k, m); hut construction (wood not eaten by termites) (k, m); live hedges (k,m); fruits treat gum diseases when chewed (k); firewood (k, m), charcoal (k); shade (k, m), attracting rain (m).

Combretaceae

*Terminalia brownii* Fresen- tree about 4-15 m high; Acacia-Commiphora bushland; PK22. Muuuk (KAMBA). Poles for construction since it’s termite resistant (k), timber (k); mostly used for making wooden mortars (*ndii*) and pestles; making beehives (k); bark solution treats yellow fever, coughs and chest pains (k); firewood, charcoal (k).

Ebenaceae

*Diospyros consolatae* Chiov.- shrub or tree 1.5- 10m high; evergreen bushland/semi-evergreen thickets. PK4. Muti-muilu (KAMBA). Timber (k); charcoal (k), firewood (k).

Fabaceae

*Acacia mellifera* (Vahl) Bentham-small tree; in lava within bushed grassland and dry woodland; PK6. Muthiiya (KAMBA), Oiti (MAASAI). Leaves are eaten by goats (k, m); leaves used to
ferment milk (k); used for hut making and fencing, livestock enclosures (k, m); timber for chairs (k); charcoal - high quality (k), firewood (k,m).

*Lonchocarpus eriocalyx* Harms- tree about 10 m high; closed *Acacia-Commiphora* bushland; PK2. Mung’uuthe (KAMBA). Boiled bark solution used as medicine to relieve chest and stomach pains (k).

*Cassia abbreviata* Oliv- tree up to 12 m high; bushland; PK20. Muale Ndathe (KAMBA). Boiled leaves treat malaria (k); firewood (k).

*Acacia tortillis* (Forssk.) Hayne- tree about 2-18 m high; *Acacia-Commiphora* bushland/ open grassland; PK23. Mwaa (KAMBA), Oltepesi (MAASAI). Ripe fresh seed pods eaten (m); pods are food for livestock (k, m); fiber used for basket weaving among women (k); used for cattle enclosures (bomas) (k, m); boiled infusion of bark used for treating diarrhea, coughs and chest pains (k, m); charcoal (k), firewood (k, m); planted as a hedge around homesteads and farms (k, m), shade (k, m).

*Acacia nilotica* H. Karst- tree with scattered branches about 4 m high; *Acacia-Commiphora* bushland and wooded grassland; PK 24. Musemei (KAMBA), Olkiroriti (MAASAI). Fruits edible (m); bark and roots boiled, mixed with milk, and taken as food to improve digestion (m); poles used for construction of *manyatta* (m); bark (sweet) chewed to treat venereal diseases, coughs and chest pains (k); charcoal (k), firewood (k).

*Albizia amara* (Roxb) Boivin- tree more than 2-13 m; *Acacia-Commiphora* bushland; PK25. Kiundua (KAMBA). Food for goats (k); hard wood used for timber (k); charcoal, firewood (k).

*Acacia senegal* (L) Willd- shrub; dry *Acacia-Commiphora* bushland/grassland; PK26. Mung’ole (KAMBA), Oldekesi (MAASAI). Gum is eaten as food (m); food for goats (k, m); used for timber (k); fencing (k, m); juice obtained from fruits used as eye medicine (k), bark infusion is used for diarrhea and malaria (m); firewood (k, m); charcoal (k).

**Lamiaceae**

*Hoslundia opposita* Vahl- shrub about 1 m high; disturbed bushland and wooded grassland;
PK15. Musovi (KAMBA), Olemoran (MAASAI). Fruits eaten (k, m), leaves used for making traditional tea (m); green leaves infusion applied on open wounds, e.g snake bites (k); firewood (k, m).

**Oleaceae**

*Olea europaea* L.-evergreen tree or shrub; evergreen forest; PK5. Muthata (KAMBA), Oloirien (MAASAI). Used for construction of huts (k, m); tools for branding animals (m), used for cleaning calabashes that store cow milk (k, m), used for making maasai clubs (m), branches are used as a platform for cooking/roasting meat; traditional tooth brush (m); used in ceremonies (especially circumcision and wedding ceremonies) to bring good luck, traditionally animals are slaughtered under this tree during important ceremonies (m); firewood (k, m).

**Malvaceae**

*Thespesia garckeana* F. Hoffm- tree; open grassland; PK30. Ormotoo (MAASAI). Fruits used for preparing soup that make herders/warriors endure hardships in the wilderness (m).

**Rutaceae**

*Zanthoxylum chalybeum* Engl.- tree to 10 m high; wooded grassland/bushland; PK19. Mukenea (KAMBA). Bark used to make tea (k), twigs used as toothbrush (k); Boiled bark solution is a pain killer to relieve chest pains (k); firewood (k).

**Rubiaceae**

*Gardenia ternifolia* Schumach. & Thonn.- shrub or tree 2-10 m; bushland;PK14. Mukumuti (KAMBA). Fruits are edible (k); leaves used as livestock food (k); boiled roots treat heart burn, chest pains (k).

**Rhamnaceae**

*Ziziphus mucronata* Willd.- thorny shrub or small tree; bushland and wooded grassland; PK7. Mukaakaa (KAMBA), Olperetini (MAASAI). Fruit edible (k, m); bark is used to make tea which is a remedy for stomach illnesses (m).
Sapindaceae

*Pappea capensis* Eckl. & Zeyh- shrub or tree 2-9 m high; evergreen forest PK1. Kiva (KAMBA), Olkisikong’o (MAASAI). Kiva means bursting in Kamba because the edible fruits ‘burst’ when ready (k), fruit edible especially by *morans* while grazing in the wild (m), bark used to make tea, added to soup to make Maasai warriors more brave; food for livestock (k, m); timber (k); the wood is believed to be very durable and is thus used for making hooks for beehives, bows (k); treats chest complications (m), medicine for stomach illnesses (m); firewood (m, k); charcoal (k); shade (k).

Solanaceae

*Solanum campylacanthum* Hochst. ex A. Rich. woody herb; disturbed wooded bushland, along foot and animal paths and in crop farms;PK 32. Mutongu (KAMBA). Leaves used to clean gourds (k), fruits squeezed into the nose of bulls to wake them up during plowing (m), root juice used to heal stomach aches (k).

Ulmaceae

*Trema orientalis* (L.) Blume- small tree; disturbed bushland (one of the first woody plants to establish) PK18. Muthambuka (KAMBA). Bark used to make ropes (k); bark used to make a concoction that treats yellow fever (k); charcoal (k), firewood (k); good for providing shade (k).

Verbenaceae

*Lantana camara* L. - shrub; disturbed bushland/ crop farms/ roadsides/neglected pasture; PK29. Mukiti (KAMBA), Ormagirigiriani (MAASAI). Fruits eaten by children (m); food for livestock (k, m); cattle enclosures (m), fruits used to make dye for baskets (k); burnt as animals enter an enclosure- it’s believed that the aromatic smell cleanses and ‘blesses’ livestock (m); hedge planted around small farms (m)

All plants mentioned by village residents had more than one use. Together they cumulatively reported 76 uses in 7 use categories (Table 7). I recorded differences in the use of
woody plant resources between Maasai and Kamba villages. Of the 25 plant species recorded in both villages, 12 species were used as food in Maasai villages, as compared to 6 species in Kamba villages. There was similarity in the number of plant uses and number of uses for the fodder category in Maasai and Kamba villages. In the remedy use category, plant species used by the Kamba for medicine were 12 compared to only 6 as recorded in the Maasai villages. Kamba villages recorded more uses for fuel (27) and remedy (18) compared to Maasai villages. Kamba villages reported widespread use of woody plant resources for charcoal making while the Maasai villages reported only select plants for firewood. Generally, a greater diversity of woody plant species potentially affected by fire was noted in the Kamba villages than in the Maasai villages.

Along the transects, it was evident that most houses were constructed and roofed using woody plants harvested locally (Fig. 5). The most important woody plant resources used for construction were reported to be on the decline in the villages. As one participant observed in the south Kamba village, some villagers illegally extract plants from CHNP to supplement what they don’t have in their farms:

“People go to the park at night to harvest poles for house construction, as you can see in this village, we have very few Muuku (Terminalia brownii) and Ikuu (Commiphora africana) remaining as people have cut most of them. They go to the park at night to reduce the risk of being caught by KWS officials.”
Most locally made household technology items observed during the transect walks, including walking sticks, clubs, traditional hives, brick making presses, digging tools, stools, and mortars were also made of woody plants found in the CH (Fig 5). All the households visited during the transect walks used firewood and charcoal for cooking and keeping warm during the nights. The recorded plants play a significant role in the health of the residents of the villages surveyed. As noted above, 22 of the 25 plant species had medicinal uses; the most common illnesses reported were fever, and gastro-intestinal and respiratory problems, which are cured by local plants. Two species were especially reported to be significant in Kamba and Maasai villages, respectively: *Acacia tortilis* was found along all the transects in all Kamba villages and

<table>
<thead>
<tr>
<th>Use category</th>
<th>Recorded uses</th>
<th>Kamba plant species (Number of uses)</th>
<th>Maasai plant species (Number of uses)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food</td>
<td>Fruits, leaves for tea, roots eaten, leaves edible, gum edible, fresh pods, edible seeds, bark for tea and soup.</td>
<td>6 (7)</td>
<td>12 (13)</td>
</tr>
<tr>
<td>Fodder</td>
<td>Leaves eaten, cut for browse, fruits and pods eaten.</td>
<td>9 (9)</td>
<td>7 (8)</td>
</tr>
<tr>
<td>Construction</td>
<td>Timber, poles/posts, roof rafters, cross poles, fences/cattle enclosures.</td>
<td>9 (14)</td>
<td>7 (12)</td>
</tr>
<tr>
<td>Technology</td>
<td>Milk fermenting, branches for fencing, leaves as dye, bark as dye, bee hive making, bee hive hooks, wooden spoons, animal carvings, stools, Maasai clubs, cleaning gourds, toothbrush, basket weaving among Kamba women, bows, poison for hunting.</td>
<td>11 (14)</td>
<td>3 (6)</td>
</tr>
<tr>
<td>Remedy</td>
<td>Roots, leaves, bark boiled, crushed or squeezed either individually or with other medicinal plants to cure and/or prevent human illnesses (malaria, bleeding, wound healing, gum diseases, diaphragm problems, fever, yellow fever, heart burn, headaches, stomachaches, snake bites, sore throats, chest pains, eye pains, sexually transmitted diseases, aphrodisiacs and livestock illnesses (appetite problems, internal worms, birth complications)</td>
<td>12 (18)</td>
<td>6 (7)</td>
</tr>
<tr>
<td>Fuel</td>
<td>Fuel wood, charcoal.</td>
<td>16 (27)</td>
<td>9 (9)</td>
</tr>
<tr>
<td>Ecosystem services</td>
<td>Aesthetic value, used in ceremonies to bring good luck, attracts rain, shade around homes, hedges around homesteads and enclosures, shade for plants, perfume, strong branches for hanging beehives.</td>
<td>3 (3)</td>
<td>5 (7)</td>
</tr>
</tbody>
</table>
had uses in all the use categories and, *Olea europaea* was found to be central to Maasai cultural life.

**Village narratives on fire and woody plant resources**

Participants in the transect walks indicated that fires in the CH landscape cause vegetation changes that influence their access to woody plant resources. In the north and south Kamba villages, participants described how the first settlers in the villages used fires to clear tall grasses and bush in order to create land for cultivation. Their narratives indicate that these two villages were dominated by tall grass prior to settlement and cultivation. Settlement, cultivation and intermittent use of fires to suppress the grasses encouraged the establishment of certain plant species, notably muuku (*Terminalia brownii*), mulului (*Balanites aegyptica*) and muthiiya (*Acacia mellifera*). These species were observed to occur on farms across the two villages.

Invasive shrubs like non-native *Lantana camara* and *Barleria eranthemoides* occurred in recently burned areas along all the transects walked with Kamba and Maasai residents. In the middle Kamba village, participants showed old and recent burned areas in the bush land where the invasive shrubs, mukiti (*Lantana camara*) and thangila (*Barleria eranthemoides*) dominated the landscape. They described how livestock farmers used fires to discourage the expansion of bush and therefore promote grass growth for cattle grazing:

“As you walk across this village and even the park, there are many trees you won’t see because the bush is diminishing; previously we had many kiva (*Pappea capensis*) and Miaa (*Acacia tortillis*). These species have declined because of burning, people burn their farms and the park to remove the bush and therefore ensure the availability of grass for their animals. There are also those who burn to kill pests such as ticks in their farms and in the process young trees are killed’’.

Charcoal kilns were observed along all three Kamba village transects. Participants identified charcoal burning as a major source of fires that occur around these villages and blamed the activity for the decline of certain plant species, including mwaa (*Acacia tortilis*); muuasi (*Lannea schweinfurthii*) and musemei (*Acacia nilotica*). Participants ranked the trees species
according to how they were preferred for charcoal making: muthiiya (Acacia mellifera); muuku (Terminalia brownii); mwaa (Acacia tortilis); and kiundua (Albizia amara):

“A bag of charcoal made from mwaa (Acacia tortilis) cost a hundred shillings more or higher than charcoal from other tree species due to the better quality”.

Participants in all the three Kamba villages also mentioned the decline of muvingo (Dalbergia melanoxylon), which is commonly used for making wood carvings. They attributed the decline in this species, however, to their over harvesting and not to fires.

Participants from the three Maasai villages also explained the role played by fires to maintaining grassland around their respective villages. For example, in the north Maasai village, they showed old and new fire scars along the transect (Fig 4); Burning is done mainly to encourage the growth of fresh grass that is believed to fatten livestock and kill disease vectors, especially ticks. Participants in the transect walk recalled stories from older people about patches of bushland that occurred in the village about 100 years ago that were transformed into wooded grassland through burning. They noted that several species are declining around the village as a result of burning like oloirien (Olea europaea) and ormotoo (Thespesia garckeana). During the transect walk, we only observed one olorien (Olea europaea) tree that occurred near the boundary between the village and the park.
As observed during the transect walk in the middle Maasai village, fires also occur when residents clear the bush to create new farming land. This village had more agricultural potential than other Maasai villages surveyed due to its location at a higher elevation. New residents are moving into this village as Maasai diversify their livelihoods activities to crop farming. Participants in this village described the decline in tree species as a result of fires. They showed areas that were previously covered by evergreen forest that had been converted to farmland through burning. Species reported to be declining in the village include orkisikong’o (*Pappea capensis*), and oloirien (*Olea europaea*). They explained that ormagirigiriani (*Lantana camara*) colonizes recently burnt areas and is a common food for goats. Residents also plant this species around cattle enclosures because its cuttings resprout and grow easily.

Villagers who participated in the transect walk in the South Maasai village reported that open grassland that occurs in the village are a consequence of fires and grazing. According to them, the effects of fires and browsing by cattle reduced the presence of bush and ensured the

![South Kamba village](image1)
![North Maasai village](image2)

*Fig 4. An 8km transect walk in South Kamba village and a 4.9 km transect walk conducted in North Maasai village. The transects are overlaid onto a 2013 natural color composite image to show land cover conditions.*
availability of grass for livestock. As one participant noted, fires have a direct effect on
the vegetation that occurs in the village:

“Fires kill young shoots of ormotoo (Thespesia garckena) and oltepesi (Acacia tortilis). That’s why you don’t see these trees in this village. Our animals especially goats also eat the young tree shoots. That’s why our land look open with few trees.”

According to explanations provided by participants along the transect walks in both Kamba and Maasai villages (fig 4), the establishment of CHNP reduced local people’s access to woody plant resources in the landscape. One of the impacts of reduced access to woody plant resources was an increase in fires. They explained that prior to establishment of the park, access to firewood was easy and women would fetch firewood in the forested parts of what is now CHNP. Due to restrictions on utilization of woody plant resources, extraction of firewood in the park has become very limited. This has led
to a build-up of dead wood fuel in the park. According to participants, the availability of large amounts of dead fuel in the park is a major cause of large fires that occur during the dry season. One participant from the middle Kamba village stated:

“If KWS allowed us to collect firewood in the forest as people used to do before the park was established, the fires that occur in the forest would be much less. I was one time hired by KWS to participate in fire-fighting in the park and what I realized is that we were engaging ourselves in a futile exercise. This is because even after stopping the flames, the dry logs kept burning and when there was a blowing wind, the fire was stoked again and we were not able to completely put out the fire”.

The participants pointed out that the removal of dry biomass would reduce the risk of intense fires in the CH landscape.

The reciprocal relationship between fire and access to woody plant resources in the Chyulu was also clearly manifested in the competition for grass among the Kamba and the Maasai. Participants from Maasai villages reported that some members of the Kamba community burn grass on the eastern slopes of the CH so as to keep the Maasai away from these areas. An elderly Maasai participant explained:

“There exists tribal hatred among the Kamba and the Maasai living within the CH. This hatred is caused by competition for grass. The Kamba thinks that the Maasai are favored by KWS and that they are not arrested for illegally grazing in the CHNP. However this is not true because we also get arrested just like the Kamba. Due to this hatred, the Kamba burn so that Maasai cattle do not have access to the grass”.

Their narratives indicate that while fires influence access to woody plant resources in the CH, conflicts over access to woody plant resources between the Kamba and Maasai, and between the two communities and government officials, often more directly influence the fires that occur in the CH landscape. In the transect walks conducted in the Maasai villages, no active fires in the villages were witnessed but fires were spotted in other Maasai villages that were also near the
park boundary. There were also fires seen within CHNP that participants said were probably started by Maasai or Kamba herders who use the park as a grazing area during the dry season. While participants in both Kamba and Maasai villages were hesitant to discuss fires that occurred in CHNP, probably due to fear of victimization, it was clear from their descriptions that the fires occurring in the park influence their access to woody plant resources. For example, burning at high elevations in CHNP promotes miraa (*Catha edulis*) which is an important extractive resource collected and sold by the Kamba. Species perceived to be declining in the villages due to fires such as *Acacia tortilis*, *Olea europaea*, *Acacia mellifera* and *Pappea capensis* were also said to be declining in the park for the same reason.

**Adaptive Collaborative Management as a Planning Strategy**

Three guide questions formed the basis for discussion during the adaptive collaborative management meeting between local residents and officials from KWS. Discussions on each question have been described in the sections below.

**What similarities or differences in fire management practices exist between the Maasai and Kamba?**

Most contributions made in response to this question validated the information that I had gathered in focus group meetings and transect walks in the sample Kamba and Maasai villages. Participants agreed that fires are used in the CH as a means of managing the land to meet livelihood needs. Both the Kamba and the Maasai valued burning as a practice that ensures the availability of fodder for livestock during the dry and wet seasons. They rely on fires to kill pests and eliminate diseases that threaten the health and survival of their livestock. Participants confirmed that fires are used to clear bush so as to open new land for cultivation. Fires are also used to eliminate unwanted crop residue and weeds in preparation for a new planting season. Fires used for honey harvesting activities by both the Maasai and Kamba sometimes escape to accidentally burn vegetation around farms.

Participants highlighted differences in timing of pasture burning by the Kamba and Maasai. In Kamba villages, burning starts early in the dry season from the month of July but the Maasai prefer late burning towards the end of the dry season in the months of September and
October. According to participants, the Kamba burns do not depend on the rains and are practiced to meet their immediate needs for pasture. The Kamba burn old grasses in order to promote tender young shoots that ensure the survival of their animals during the dry season. In contrast, the Maasai burn shortly before the rains in order to get rid of disease-carrying ticks, control the growth of unpalatable grasses and promote the growth of fresh grass that emerges with the first rains. For the Kamba, burning is a short term measure to ensure livestock survival during the dry season while for the Maasai, burning is a strategy to maintain healthy grasses over the long term.

Some of the conflict that exists between the Kamba and Maasai over the control of natural resources in CH came out during the discussion. The Maasai participants seemed to point an accusing finger at the Kamba and blame them for the fires that occur especially in CHNP. The Maasai informed the meeting that activities such as charcoal burning and small game hunting, which are major causes of fires, did not happen in Maasai villages. Participants from Kamba villages conceded that these activities were more common in Kamba villages but also argued that since the Maasai owned more livestock than the Kamba they were inclined to burn more to ensure the availability of fodder for their animals. Participants however agreed that burning of areas within CHNP for purposes of planting Cannabis sativa and stimulating the growth of Catha edulis is done by people from the Kamba community. There was agreement in the meeting that residents from the Maasai community do not burn areas within CHNP for these reasons. It was also reported that some fires occur in CHNP due to the conflict between the two groups. In such cases, grass is burned by the Maasai or Kamba so as to prevent members of the other group from grazing their animals in a particular area.

Unanimously, fires were blamed for the decline of woody plant species that support livelihoods in the CH, including Acacia tortilis; Lannea schweinfurthii and Acacia nilotica. Participants from Kamba and Maasai villages agreed that continuous burning discouraged the growth of grass and bush and encouraged herbaceous plants and invasive shrubs. However they all agreed that an absence of burning could also have severe effects on the vegetation of CH if a large fire occurred. For this reason they argued that although fires had damaging impacts on the woody plant species, they were important for their livelihoods. To them, fire is an ecological
factor that could not be eliminated. Views from both sides indicated that minimal fires were necessary in the CH for reducing bush encroachment and ensuring that catastrophic fires do not occur around the villages and in the protected area. Participants also suggested that removal of deadwood for subsistence is a sustainable activity that helps reduce fires in the protected area. The majority of participants argued that prohibition of firewood collection and grazing in CHNP were partly responsible for the intensity of fires that occur within CHNP.

What information on fires do you want to share with KWS officials?

Participants showed a lot of enthusiasm while answering this question. They were keen to inform KWS officials about the various reasons why they used fires and why fires were important to their livelihoods. However, participants also noted that the fires in the CH landscape had been a cause of conflict between local people and KWS officials. They appreciated the need for dialogue around the issue of fires between KWS officials and local people. Their views on what information they wanted to be shared varied from one participant to the other but there was general agreement on many issues that the local participants wanted to share with KWS. For example, one Kamba village representative stated:

“I have lived in the CH since 1964 and every year during the dry season, there are fires in farms and also on the slopes of the hills. We depend on fires for honey harvesting, miraa production, wood carvings, charcoal burning, cattle grazing, and many other things. What I want to tell the KWS officials is that we as a community know that fires can be damaging to the environment but some of us are unemployed and thus rely on forest products for our survival. We will continue to use fires to extract forest resources because we do not have an alternative.”

These comments elicited mixed reactions from some Kamba participants, most participants supported the comments but a few disagreed. One of the participants from the middle Kamba village who disagreed replied:
“I do not agree that we have to use fires. These fires are threatening our survival. When I settled in the CH in the 1980’s, there was enough rain and I used to harvest enough food for subsistence and selling. These days, I hardly harvest enough food to feed my family. Rains have disappeared because of fires and now we depend on relief food. We, the Akamba, have been burning charcoal but we have remained poor, and unless we stop burning our forests we will continue to experience more drought conditions in this area.”

Discussion among the Kamba then turned to a heated debate between those who were in favor of and those who were against fires. I interrupted participants on several occasions to ensure that their contributions were focused on the topic.

Participants from Maasai villages seemed to be more in agreement about what they wanted to share with KWS than participants from Kamba villages. Participants from Maasai villages were generally more supportive of fires than those from Kamba villages. As one representative from a Maasai village commented, fires are central to Maasai socio-economic life:

“Our animals depend on the CH and we use fires to help our animals survive. If we the Maasai do not burn grass during the dry season, our animals will starve and die of thirst because we do not have rivers around to supply our animals with water. Our villages will be covered with bush and this will be dangerous for us because it will promote attacks by snakes and predators, including lions and hyenas. If the land is left un-burnt for a long time and a fire outbreak occurs, the fire is uncontrollable due to the excess amount of bush. According to me, it will be very difficult for the Maasai to live without using fires. What we can do is to prevent the fires from damaging the forest, which we need for medicine and rain making. I want to tell KWS officials that fires are beneficial to the Maasai people.”

Another participant from the north Maasai village argued that fires were not causing the loss of forest cover and that the CH landscape would be worse off without fires. He stated:
“Many people say that fires in the CH result in a loss of forest cover. I do not think fires have a major impact on forest cover in the hills. I have been keenly observing the Chyulu forest over many years and I cannot say that forest cover has declined. I would like to inform KWS that if fires and grazing are completely stopped in the CH, there will be devastating effects on the forest if a large fire occurs due to the buildup of fuel.”

In this discussion, both Kamba and Maasai participants seemed to support the view that burning activities carried out by local communities in the dry season were critical to preventing vast fires that would occur if no burning was done at all. They argued that early burning creates a fragmented landscape that acts as a natural fire break during the late dry season. Although some participants disagreed, the majority felt that fires support the diversity and productivity of vegetation in the CH. There was consensus among the local people that large fires would have severe effects on plant species and therefore minimal fires were necessary. During this discussion, the KWS officials restrained from making contributions and were keenly listening and taking notes. The local people suggested follow up meetings between them and KWS officials so that both sides can further discuss the issue of fires and come up with sustainable solutions.

How do you think your knowledge on fires can contribute to adaptive collaborative management with KWS?

Responses to this question varied among the participants, partially related to how they understood the question. Initially, participant’s responses focused on suggesting development projects that they thought KWS should help them implement in their localities. Such projects included improving local infrastructure such as schools and roads. Other participants raised issues of human wildlife conflict and how they expected KWS to mitigate the conflict. They felt that human wildlife conflict in the region had contributed to poverty and argued that they did not enjoy the benefits of wildlife conservation. While these issues were important for collaborative planning between the local people and KWS, I informed them that they were outside the scope of my research. I reminded them that my research focused on fires. To keep the meeting on track, I
reviewed the strategy of adaptive collaborative management and stressed that the ultimate goal of my research was the collaborative management of fires in CH.

Although the phrase ‘adaptive collaborative management’ was new to most participants in the meeting, they were aware of their important role as stakeholders in the management of natural resources in the CH. Participants in the meeting agreed that their wellbeing as residents of the CH depends on improved management of natural resources in the region. They recognized that the CH landscape has undergone rapid land cover change since the 1960’s and expressed their desire for a sustainably managed CH ecosystem so as to ensure the continued provision of essential goods and services. A representative from a Kamba village observed:

“Chyulu is our home and we depend on the hills for our survival. We have been experiencing droughts in recent years and I think this is because the rate of tree cutting in our villages is unprecedented. Our streams have dried up because we have exposed them to the sun by cutting trees. We must start thinking about our environment because we have nowhere else to go when all the springs and trees are gone.”

Participants agreed that resource management in the CH can only be achieved through collaboration among a diverse set of actors, including local communities, government agencies, and non-governmental organizations who should share responsibilities for management. They noted that traditionally natural resources such as trees, forest resources, and rivers in both Kamba and Maasai villages were under the trusteeship of elders who made decisions on how these resources were utilized. The elders made decisions on which trees to cut for building houses and other uses, where and when to burn, and where to take animals for grazing among other decisions. The participants agreed that this system of traditional management worked well because it was every elder’s responsibility to ensure that the rules were followed. They argued that government agencies ignored the traditional authority of elders and that elders in both Kamba and Maasai villages were not consulted on the management of natural resources in the CH. They suggested that involvement of local elders can help mitigate the existing conflict between KWS and local people over the management of fires in the CH.
Participants in the meeting stated that a significant number of people who live in the CH rely heavily on woody plant resources for their livelihoods, including wood for fuel, charcoal burning, carvings, and herbal medicine. As these resources diminish in settled areas, there is a tendency for the people to encroach into the protected areas, especially CHNP and Kibwezi forest, to obtain forest resources such as wood fuel, building materials, thatching grass etc. This was discussed at length in the meeting and participants agreed on the need for collaborative plans between local people and government agencies so as to promote and accordingly support alternative means of livelihoods among the people who live in the CH.

One participant in the meeting suggested that if residents in Kamba villages were supported to grow miraa in their farms, encroachment into CHNP in search of miraa would decline. According to him, this would also reduce fires in CHNP since most fires in the park are associated with miraa harvesting. Participants agreed that water scarcity in both Kamba and Maasai villages has been a stumbling block to development. Participants from Kamba villages argued that provision of water in Kamba villages would promote agricultural activities in the CH, reduce poverty levels, and therefore reduce reliance on wood carvings, charcoal burning, and livestock grazing. They noted that these activities contributed to fires in the CH and also are source of conflict between the local people and government authorities.

Participants suggested several recommendations on how to incorporate the information gathered in this research into adaptive collaborative plans between KWS and the local people (Box 3).

**Box 3. Recommendations for an adaptive collaborative plan between KWS and local residents.**

- KWS and local leaders draw a plan for dissemination of research findings once the research is concluded.
- KWS and local leaders hold sensitization meetings in order to create awareness among the local people on the need to conserve the environment and thus reduce the rate of burning and tree cutting in the CH region.
- KWS carry out early burning within CHNP so as to prevent damaging fires in the late dry season.
- KWS and local leaders work on promoting agroforestry in Kamba and Maasai villages in order to increase availability of fast growing tree species and reduce reliance on native species.
These recommendations were suggested by individual participants and then passed (by acclamation) if they gained a majority of support from the participants. Recommendations that did not gain majority support among participants were not included.

Before the end of the meeting, I gave the KWS officials an opportunity to address the meeting. While representing all the KWS officials present, the warden in charge of CHNP stated that KWS was committed to a collaborative approach in the management of natural resources in the CH region. He informed the meeting that KWS as a government agency was aware that it does not have a monopoly of knowledge that is relevant for the management of the CH ecosystem and that it was open to suggestions and ideas from the local people on how to better manage fires that occur in the CH. The warden said that KWS would be keen to know the findings of the research and will be willing to implement recommendations that supported collaborative processes between KWS and local communities.

Participants were happy about the success of the meeting and expressed their willingness to learn more about adaptive collaborative management. I promised participants that I would make available to them copies of my thesis; I thanked all participants for their contributions and closed the meeting.
Chapter Six

DISCUSSION AND CONCLUSION

The goal of this research was to gain local knowledge on the role and impact of fires in Chyulu Hills (CH), Kenya and validate that knowledge towards collaborative adaptive management of natural resources between conservation authorities and communities living adjacent to Chyulu Hills National Park (CHNP). Using a participatory learning approach, I investigated the reasons why two adjacent ethnic groups, the agro-pastoral Kamba to the east and pastoral Maasai to the west use fires, the impacts of fire on their access to woody plant resources, and opportunities for adaptive collaborative planning between local residents and the Kenya Wildlife Service who manage the protected lands. My results show how dominant narratives that label fires as a cause of deforestation in rural landscapes differ with local perceptions of the Kamba and Maasai participants who regard fires as a critical component of their rural livelihood strategies. Moreover, the study demonstrates the important role of participatory methods for shared learning and collaboration in conservation research.

Fire and local livelihoods in the Chyulu Hills

Under the pretext of conservation, African states have usurped local people’s right to access and control of natural resources and landscapes through the creation of national parks and biosphere reserves (Tuxill and Nabhan 2001; Robbins 2004). In the process, local livelihood practices, including the use of fires, are characterized as destructive to the environment by state authorities in their struggle to control resources and landscapes (Eriksen 2007). Forest conservation policies in Africa are still largely uninformed about the role of anthropogenic fires in landscapes and particularly the utility of fire to local peoples and its impact on the environment (Walters 2012). These policies date back to the colonial period in Africa when indigenous use of fire was considered an ‘evil’ practice that was converting woodlands into degraded savanna grasslands. In Kenya, there is confusion among policy makers and resource managers regarding the role of fire in forest ecosystems, whether anthropogenic fires are destructive or beneficial, and if they need to be managed. In the CH, anthropogenic fires are seen
by conservation authorities as too frequent and are regarded as a threat to the biodiversity of the hills.

The findings of this study supports cultural-political ecology (CPE) research that attempts to understand the link between anthropogenic fires, local livelihoods, and ecosystem impacts in Africa from the standpoint of local residents who burn the landscape (Kull 2012; Butz 2009; and Eriksen 2007). Results from focus group discussions and transect walks with Maasai and Kamba suggest that contrary to dominant views of fire as factor of degradation, rural communities view fires as an integral part of their production systems. Their use of fire is not haphazard but intentionally done to achieve multiple goals.

The Kamba and Maasai living in the CH clearly utilize fires as a tool to promote their agro-pastoral livelihoods but they also provide evidence for its role in livelihood diversification for local security (Ellis 2009). Like most rural communities in Africa, the Kamba and Maasai perceive seasonal burning as an important practice for productive land use and for the prevention of damaging late dry season fires. Similar research findings from studies of traditional burning practices in Tanzania (Butz (2009); Madagascar (Kull 2004); and Zambia (Eriksen 2007) concur with these findings. For example, pastoralists in Engikareti, Tanzania use mosaic patterns of burning in the early dry season to help prevent large fires later in the dry season (Butz 2009). In concurrence with reasons for burning mentioned by the Kamba and Maasai, anthropogenic fires around Kasanka National Park in Zambia are directly linked to the livelihood needs of adjacent pastoral residents for new or more nutritious pastures that can fatten their livestock (Erikson 2007). Like the current study, fires are also used in Madagascar to kill pests and disease causing vectors, especially ticks, and to clear bush to improve visibility for the movement of livestock and people (Kull 2004).

The study also adds evidence that shows how fire fits into a diversity of other activities that also support the livelihood security of rural dwellers (Ellis 2009). Burning the landscape to aid hunting of small game as reported in Kamba villages is also recorded in Zambia (Eriksen 2007). The new grass that sprouts after burning attracts small game and this makes it easy for hunters to catch the animals by laying traps in areas with fresh grass. Furthermore, villagers use fires to remove the bush and thus expose the animals for easier hunting. Use of fires for crop
field preparation in rural settlements of Madagascar just before the rainy season (Kull 2004) is similar to the slash and burning that takes place in the CH landscape where at least 60 % of the population engage in small scale farming.

CPE research emphasizes the current trend toward fights over access to and control of natural resources between local and extra-local stakeholders (Kull 2002; Blaikie 1985). For a few of the residents, fire may be a reaction to take-over by the state of community managed lands. State domination of control over forest resources through implementation of rules that prohibit utilization of these resources by local people such as fire suppression policies have been met with local resistance. In the CH, just like in Madagascar (Kull 2002), accounts by local people indicate that some fires started in state managed lands by the local people are a sign of protest against authorities. In these situations, efforts to discourage burning through legal action against illegal fire setters or education awareness campaigns have failed. The result of this failure heightens tension and conflict between conservation authorities and local people. This raises into question the rationale of continuing the implementation of fire suppression policies and calls for the re-examination of these policies.

**Local perceptions of vegetation change in the Chyulu Hills**

Research findings compiled with the village participants emphasize the complex relations rural residents maintain with plant resources as they support their livelihoods. During transect walks, villagers reported a diversity of woody plant resources that are impacted by fires around their home areas. Interestingly, narratives from Kamba participants show how human settlements actually promote woody plant cover. Similar findings reported in Kissidougou, Guinea questioned the direct impact of local human activity on forest cover and consequent deforestation statistics (Fairhead and Leach 2000). In the CH, an invasive shrub *Lantana camara* was found to occur in fire disturbed open lands, but village residents value the plant as an important fodder for livestock and other local uses.

Although rural dwellers may associate vegetation changes in their landscape with proximate causes such as fires, several studies emphasize the role of extra-local forces in driving vegetation changes in rural settlements (Muriuki et al. 2007, Medley and Kalibo 2007). A careful analysis of participant’s narratives and observations of the CH landscape show that the decline of
some woody plant resources in the CH is better explained by extra-local forces. A high and growing demand for charcoal in Nairobi and Mombasa promote charcoal production in the CH and its impact on potentially spreading fires across the landscape. The reported decline of woody plant species like *Acacia tortilis*, *Acacia mellifera*, *Acacia nilotica*, *Olea europaea* and *Dalbergia melanoxylon*, which are the most common raw material for wood carvings and charcoal burning in the CH, has occurred due to increased urban markets for these products. This calls for the need to promote adaptive forest management approaches that promote dialogue and partnership building among local communities, researchers, resource managers, and policy makers.

**Adaptive collaborative management of fires in Chyulu Hills**

My findings concur with studies that support the integration of local knowledge in conservation research and planning (Mclain and Lee 1996, Holling et al, 2002, Berkes and Folke 1998, Medley and Kalibo 2007). Narratives from the Maasai and Kamba indicate that traditional resource use practices, such as collection of dry firewood and grazing of pastures, are effective measures against forest fires. In Africa, alienation of local peoples from their traditional lands to form protected areas is usually accompanied by the replacement of indigenous fire use practices with fire suppression policies. However, local views gathered from the Maasai and Kamba suggest that fires fragment the landscape thus preventing large damaging fires. These views on the role of fires in the CH seem to agree with ecological research conducted elsewhere (Laris and Wardell 2006). Participants during the meeting between local people and KWS agreed that eliminating fires in the CH is likely to lead to a decrease in the diversity and productivity of the forest. This supports ecological research that argues that landscape heterogeneity rather than homogeneity is important for biodiversity and ecosystem health (Laris and Wardell 2006). Small fires, which act as a disturbance factor, produce spatial and temporal heterogeneity in the landscape and thereby minimize the potential for large destructive fires. The view by the local people that the Chyulu ecosystem is fire dependent reflects a major contrast with the views of KWS officials who work in CHNP. Because they operate within the KWS regime of fire suppression, the officials do not see fires as playing a role in the ecology of the CH other than the reduction of forest cover.
Greater dialogue and knowledge sharing between KWS officials and the local people are important first steps toward a collaborative approach to fire management. Discussions among local people during the meeting with KWS officials indicate that local people are willing to partner with state authorities to manage fires in the CH. Fire management in the CH cannot succeed without the cooperation of the local people. Many scholars today agree that the ‘fines and fences’ and ‘command and control’ approaches to conservation are not feasible when dealing with complex socio-ecological systems (Hulme and Murphree 2001; Tuxill and Nabhan 2001; Holling et al. 2002). Confrontational and coercive interactions between conservation authorities and local residents in the CH have not worked in the past (Mosse 2003; Okello and Tome 2007). Meaningful collaboration between local people and KWS can be achieved through incentives that support the livelihoods of the local people. This may include allowing sustainable use of forest resources for subsistence and small-scale fire management. Development of alternatives to forest utilization through investment in social and economic infrastructure such as schools and water projects in the local community also have the potential of enhancing collaboration between local people and conservation authorities. Also, more effective strategies to deal with human-wildlife conflict prevalent in the CH especially addressing the frequent destruction of crops by elephants.

**Participatory research and fire management**

Recent research in natural resource management substantiate that top down approaches that ignore the knowledge of local people do not often achieve their objectives and this research further validates the importance of local knowledge in resource management (Chambers 1994; Medley and Kalibo 2007). Local people possess knowledge of natural ecosystems and plant species in which they are in contact and this knowledge can contribute to sustainable management of ecosystems. This study involved local people in focus group discussions and transect walks in order to gain local knowledge on the role of fires in the CH and to validate that knowledge toward collaborative fire management plans between local people and KWS. The participatory research approach employed provided an opportunity for local people to share and thereby enhance their knowledge of life conditions; and shared learning shows potential to empower local people and contribute to adaptive management (Chambers 1994; Medley and Kalibo 2005; Breitbart 2010). Through participation, the study ‘unpacks’ the complex role that
fires play in the livelihood condition of Kamba and Maasai resident in CH. The Kamba and Maasai demonstrated that they possess diverse knowledge on plant resources and fire management practices that can and should be included in adaptive management plans with KWS. Participatory research is also prone to production of biased data if not well designed (Cooke and Kothari 2001). This study was designed to ensure that there was equal participation by gender and across villages in the CH to minimize biases.

Conclusion

Overall, this study validates the knowledge of the Kamba and Maasai living in the CH on fires. The study compares how they utilize fires to manipulate vegetation and therefore support diverse strategies for livelihood security. Narratives gathered in Kamba and Maasai villages are in agreement with research that critiques scientific claims (German 2010). The narratives indicate that fires have important ‘positive’ ecological functions, including pest and disease control and prevention of damaging fires, and that the elimination of fire in a landscape can lead to high fuel loads and thus enhance the scale and intensity of fires. I argue that fire management problems in the CH need to be framed at a more local level and should not ignore the livelihood concerns of the Kamba and Maasai. Conservation authorities in CH should value the knowledge of the Kamba and Maasai in fire management. My findings provide strong rationale for information sharing between local people and conservation authorities and the inclusion of local people’s knowledge on fires in adaptive collaborative management plans for Chyulu Hills. I hope that this study is controversial and that it stimulates the reader to think more about the opportunities for positive interactions and less on the degradation potential of human populations that rely on natural resources for their survival.
References


Appendix 1

OFFICE FOR THE ADVANCEMENT OF
RESEARCH AND SCHOLARSHIP (OARS)
Institutional Review Board for
Human Subjects Research
103 Roehrshush Hall
Oxford, OH 45056
513-529-3600

Date: May 4, 2012

To: Mr. Peter Kamau
    Dr. Kimberly Medley

From: Dr. Sarah B. Woodruff, Co-Chair
      Institutional Review Board for Human Subjects Research

RE: Anthropogenic Fires, Local Livelihoods and Forest Resources at Chyulu Hills, Kenya

Thank you for submitting the application referenced above to the Institutional Review Board (IRB). The board has reviewed and approved your proposal through the regulatory Expedited Review procedure.

Your protocol approval number is: 00112i

Approval of this project is in effect until: May 3, 2013

If you complete your project before the date listed above, please send an email message indicating so to humansubjects@muohio.edu and we will close your file.

Regulations require periodic review of all ongoing human subjects research projects. If your project will continue beyond the approval date shown above, you will need to submit an Application for Continuing Review and status update for review before the expiration date.

Please submit your next application for continuing review by: April 3, 2013

Should you wish to change your procedures relating to the use of human subjects or personnel having access to the data, you must obtain approval from the IRB prior to instituting any changes.

On behalf of the committee and the University, I thank you for your efforts to conduct your research in compliance with the federal regulations that have been established for the protection of human subjects. Thank you for your attention to this matter, and best wishes for the success of your project.
Appendix 2

REPUBLIC OF KENYA

NATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGY

Telephone: 254-020-2213471, 2241349
254-020-310571, 2213123, 2219420
Fax: 254-020-318245, 218249
When replying please quote
secretary@ncst.go.ke

NCST/RCD/14/012/800

3rd July 2012

Peter Ngugi Kamau
Miami University
Oxford, Ohio.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on
"Anthropogenic fires, forest resources and local livelihoods in Chyulu
Hills, Kenya," I am pleased to inform you that you have been authorized
to undertake research in Kibwezi and Loitokitok Districts for a period
ending 31st August, 2012.

You are advised to report to the District Commissioners and the
District Education Officers, Kibwezi and Loitokitok Districts before
embarking on the research project.

On completion of the research, you are expected to submit two hard
copies and one soft copy in pdf of the research report/thesis to our office.

DR. M. K. RUGUTT, PhD; HSc.
DEPUTY COUNCIL SECRETARY

Copy to:

The District Commissioner
The District Education Officer
Kibwezi and Loitokitok Districts.