THE ROLE OF LOCAL INSTITUTIONS ON DEFORESTATION AND DEGRADATION IN THE KAIMOISI FOREST, WESTERN KENYA

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Abstract: The Kakamega Forest is the last remaining rainforest in Kenya and provides over 200,000 locals with important forest resources. This paper explores the role of local institutions (i.e. forest-use rules) on deforestation and degradation in the Kaimosi Forest, a smaller portion of the Kakamega Forest. Drawing from common property theory, this study examines various factors previously identified with successful management practices of common property forest resources. Additionally, this study draws from Cultural and Political Ecology (CAPE) perspectives to broaden the analysis of this people and forest relationship to include the role of household decision-making and power struggles among individual actors. The Kaimosi Forest is owned and managed by Kenyan Quaker Mission Church (QMC) that allows approximately 3,000 locals to use the forest while abiding by local institutions, or forest-use rules. Specifically, this paper looks at differing local perceptions with the QMC management, and how such rules influence forest-use and impact local livelihoods. The field methods include participant-observation techniques, 12 key-informant interviews, and 68 household surveys. The statistical methods for analyzing the household dataset include two-independent samples t-test and Pearson's correlations. The analysis compares a stratified sample of two villages surrounding the Kaimosi Forest. Variables include household level: demographics, land-use, livelihood, forest-use, and perception of local institutions. Results show that a revised management plan should be implemented by the QMC, and implemented in collaboration with local government leaders, the Kenyan Forest Service, and local residents in order to reduce pressures on forest resources. Furthermore, more forest commons studies are needed in the other parts of the Kakamega area to better understand why the smaller Kaimosi Forest fragment is undergoing the highest levels of deforestation and degradation.

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CHAPTER I

INTRODUCTION

Research Problem

The Kaimosi Forest in Western Kenya is a 1,000 acre forest plot owned by the Quaker Mission Church (QMC). The church allows locals to communally use the forest while abiding by the institutions, or forest-use rules. The forest supplies approximately 3,000 locals with deadwood for cooking, edible and medicinal plants, and a place for cultural ceremonies. However, the Kaimosi Forest, a small fragment of the larger Kakamega Forest, is also undergoing the most rapid deforestation and degradation in the region of Western Kenya (Lung and Schaab 2006).

This study compares two villages surrounding the Kaimosi Forest in terms of household demographics, land-use, livelihood, forest-use, and perception of the local institutions (forest-use rules) in relation to the recent deforestation and degradation. The two selected villages are the *perceived* least and most successful villages in terms of commons natural resource management. Drawing from Common Property Theory and Cultural and Political Ecology (CAPE) literatures, this study seeks to better understand complex people and forest dynamics.

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The research questions include:

> **1)** What are the major socio-economic and demographic factors that influence household land-use decisions and forest extraction?
>
> **2)** How are local forest institutions created, implemented, monitored, and enforced in the Kaimosi Forest?
>
> **3)** How do local perceptions among households and other actors differ regarding the institutions currently operating in the Kaimosi Forest? **3b)** How do these differences impact forest-use and local livelihoods?

These questions seek to explain how institutions (i.e. forest-use rules) impact local livelihoods and deforestation and degradation in the Kaimosi Forest. Past commons studies show that local institutions must be properly implemented in order to accomplish long-term sustainable resource management (Ostrom 1990). The remainder of this chapter discusses the importance of tropical forests and more specifically Kenyan forests. Furthermore, a discussion is provided regarding the environmental issues facing Kakamega and Kaimosi Forest and a brief history and description of the study area.

Importance of Tropical Forests

Tropical forests play an essential role in regulating, provisioning, and supporting the ecosystem and natural resources (Muller and Mburu 2009). For instance, tropical forests influence the microclimate, regulate local water cycles, and provide vegetative cover that prevents soil erosion and retains subsoil nutrients (Millennium Ecosystem Assessment 2005; Muller and Mburu 2009). The role and importance of tropical forests in sustaining the world's population is becoming more evident (Duveiller et al. 2008); however, they are suffering from rapid land-use changes (Wright 2005). Approximately 13 million hectares of forest cover is lost each year due to deforestation (FAO 2011).

Annually, tropical deforestation is responsible for approximately 2.2 Gigatons of carbon emissions, which accounts for one-fourth of all anthropogenic emissions worldwide (Fearnside and Laurance 2004). The high level of carbon emissions makes tropical deforestation a main driver of environmental change at various spatial scales (Geist and Lambin 2002). Degradation is also a main cause of global land-use and land cover change. In tropical forests, degradation accounts for 50 percent of the total deforestation rate (Murdiyarso et al. 2008).

At a global scale, deforestation and degradation causes significant biodiversity loss, affects the hydrologic balance, and global carbon cycles (Allen and Barnes 1985; Fearnside and Laurance 2004). Locally, deforestation and degradation decreases the quality of rural life, negatively affects soil and water cycles, and diminishes (e.g. fuel wood) used for household energy (FAO 2011). Although the precise measure of global deforestation and degradation has been disputed, the consequences are apparent, especially in developing countries where forest dependency is most prevalent (Allen and Barnes 1985; Grainger 2008).

Deforestation and Degradation in Africa

According to the Global Forest Resources Assessment (FRA) 2010, an estimated 675 million hectares of forest area remains in Africa, accounting for 17 percent of global forest area and 23 percent total land area in Africa (FAO 2011). The extent of forest designated for production of wood and non-wood forest products declined over the past 20 years; however, the value of wood removals increased in the region from $2.6 billion in 1990 to $2.9 billion in 2005 (FAO 2011). Since 1990, 15 million hectares of planted

forest area has been added, with the biggest portion being in North Africa (FAO 2011). It must be noted that researchers have questioned the accuracy of FAO data for tropical forest trends (Grainger 2008). Regardless, FAO data is still beneficial to show general trends.

Although deforestation rates have slightly decreased in the last decade, from 3.4 million hectares per year between 1990 and 2000 and another 3.2 million hectares per year in the subsequent decade, from 2000-2010 (FAO 2011), the rate of loss is still alarming for researchers and policy makers due to its severe local and regional effects on climate and livelihoods (Archard et al. 2002; Geist and Lambin 2002). The plausible causes of deforestation and degradation in tropical African forests are attributed to private timber logging, mining, charcoal production, fuel wood for domestic uses, urbanization, and agricultural expansion (Mather, Needle, and Fairbairn 1998; Duveiller et al. 2008; Wright 2005). The underlying driving forces are often in-migration patterns and population growth, which create a demand for cropland and forest products (Geist and Lambin 2002; Wright 2005). In eastern Africa, cropland has expanded by 200 percent from 1900 to 1990 (Goldweijk 2001). The highly populated East African region makes up approximately 11 percent of the total forest in Africa (FAO 2010). In particular, Kenya has the most diverse forest in East Africa and the most highly fragmented (Wass 1995).

Kenyan Forests

In 2010, Kenya had 3.4 million hectares of forest consisting of 4 percent of the total land area (FAO 2010). Out of the 3.4 million hectares approximately 84 percent are

indigenous forests while the other types consist of exotic plantations, privately owned forests, and mangrove forests (Pellikka, Ylhaisi, and Clark 2004). The FRA 2010 Kenya Report states that forest ownership consists of 10 thousand hectares of individual private ownership, 1.3 million hectares public ownership, and 2 million hectares of local community ownership (FAO 2010). From 1990 to 2010, an average of 13,000 hectares was deforested each year (FAO 2010). The different forest types in Kenya are lowland tropical forest in western Kenya and montane forest in the central and western highlands (Noad and Birnie 1990). Lowland forests are the most vulnerable due to agricultural expansion and current population pressures (Pellikka, Ylhaisi, and Clark 2004).

Kakamega and Kaimosi Forest, Western Kenya

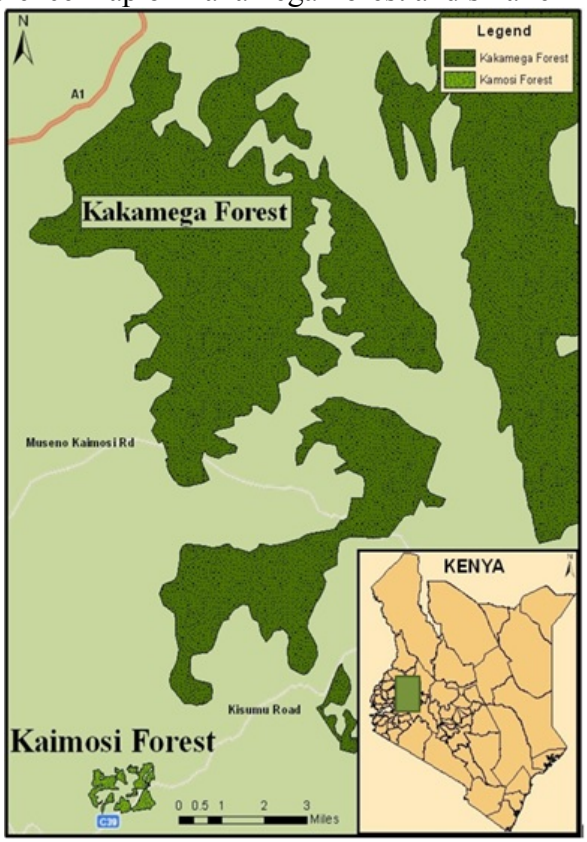
The province of Western Kenya has one of the highest rural population densities in the world with 600 people per square kilometer (km) and is currently undergoing rapid deforestation and degradation (Wass 1995; Blackett 1994; Guthiga 2008). Located in the Western Province and 75 km north of Lake Victoria (see Figure 1), the Kakamega Rainforest is the last remaining tropical rainforest in Kenya and provides its local population with forest resources (Wass 1995); over 200,000 people depend on it for their livelihoods (Kiplagat, Mburu, and Mugendi 2008). The Kakamega Rainforest is a mid-latitudinal evergreen tropical rainforest and is the eastern-most extent of the Guineo-Congolean rainforest belt that once covered the equatorial strip of Africa (Lung and Schaab 2006). The annual rainfall is approximately 2,000 millimeter (mm) with the rainy season during April to November and a dry season from December to March. The maximum daily temperature is approximately 26°C and the minimum approximately

10°C (Glenday 2006). With an altitude ranging from 1500 to 1700 meters (m), it is famous for its rare diversity of flora and fauna.

There are indigenous tree species such as Elgon teak *Olea capensis*, Red Stinkwood *Prunus africanum*, and African Satinwood *Zanthoxylum gilletti* (Noad and Birnie 1990). According to Sayer, Harcourt, and Collins (1992) the L'Hoest's monkey is endemic to the Kakamega and there are two globally threatened bird species: Turner's eremomela *Eremomela turneri,* and Chapin's flycatcher *Muscicapa lendu.* The forest contains the largest number of bird species in Kenya with approximately 254 types (Wass 1995) and there is an estimated 400 varieties of butterfly species (Marttila and Virtanen 1998). Despite the high levels of biodiversity, the forest has a long history of anthropogenic use leading to both deforestation and land degradation (Wass 1995; Lung and Schaab 2006; Bleher, Uster, and Bergsdorf 2006).

In the last decade, a significant increase in human-environment research has centered on the Kakamega Forest due to continued conflicts between forest conservation and land-use needs (Waas 1995; Lung and Schaab 2006). The natural forest cover of the Kakamega Forest in 1913 was 74,718 hectares, while only 34 percent remained in 2001 with 25,727 hectares (Mitchell, Lung, and Schaab 2006). In the last three decades, over 20 percent of the Kakamega Forest has been deforested with the majority of the deforested land being smaller forest fragments surrounding the perimeter of the main forest block (Lung and Schaab 2006). The highly dependent local population surrounding the forest is often forced to over-use the forest resources, which has led to high levels of degradation (Kassilly and Tsingalia 2009).

Figure 1. Reference map of Kakamega Forest and smaller Kaimosi Forest.



Map made by Daniel Wilson (February 2012)
Source: World Resource Institute, 2010

Several researchers have analyzed the current status of forest management conservation in the Kakamega Forest (Lung and Schaab 2006; Bleher, Uster, and Bergsdorf 2006). These studies support the conclusion that the Kaimosi Forest has the highest level of deforestation and degradation in the Kakamega Forest (Figure 1). Specifically, Lung and Schaab (2006) use Landsat time series imagery to analyze land-use and cover change (LUCC) in the Kakamega Forest from 1972 to 2001. Their findings indicate that the Kaimosi Forest in southern Kakamega shows "severe forest loss, but tiny patches of stable forest can still be made out" (Lung and Schaab 2006, 498). They classify the Kaimosi Forest fragment as being mainly near natural plus old secondary forest and find that several other forest fragments surrounding the larger

Kakamega Forest have been completely overtaken by agricultural land (Lung and Schaab 2006).

Bleher, Uster, and Bergsdorf (2006) found that of 22 selected forest areas in the Kakamega Forest region, the Kaimosi Forest has the greatest issue with illegal logging. Unlike Lung and Schaab (2006), their methods did not involve remotely sensed data, but instead measured the level of deforestation by ground truthing selected sites of the Kakamega Forest. Muller and Mburu (2009) present similar findings as Lung and Schaab (2006) regarding the level of deforestation in the Kakamega Forest. However, they focus less on social and economic factors, and instead point to population increase as the main driver of deforestation. Regardless, out of the 8,000 hectares of remaining rainforest in Western Kenya, the 150 hectare Kaimosi Forest has suffered from the highest level of anthropogenic impacts (Lung and Schaab 2006).

Although the Kaimosi Forest is currently undergoing severe levels of deforestation (Lung and Schaab 2006), it provides medicinal plants, deadwood for cooking, deters soil erosion, and plays a major role in tribal ceremonies for over 3,000 Tiriki locals. Before discussing the human-environment literature that guides this study (Chapter 2), it is necessary to provide a historical overview of the Kaimosi Forest in order to best understand the harmful environmental and social impacts caused by the recent deforestation and degradation.

Land Tenure and Encroachment in the Western Kenya Highlands

What is misery?
It's a man without land
-*Swahili song*
(Roberts 1967, 126)

The Kenya highlands are located in the Western Province, situated to the north above the Nandi Escarpment that stretches between the highlands and the Kavirondo Gulf of Lake Victoria. Before the arrival of the first British settlers in the Kenya highlands, social organization was focused on the extended family and livelihoods were earned by small scale agriculture, cattle-keeping, handicrafts, and barter (Sangree 1966). Land tenure varied according to ethnic group, type of land, and the status of individuals; however, a common feature was the tendency to permit widespread access to land as a shared commons. According to Leo (1984), traditional land tenure arrangements were neither 'individualist' nor 'communal' in the Western sense of those terms. Members of agricultural based groups acquired rights to a particular plot, but these rights did not exclude other members from access to land. Thus, the land was not necessarily held in common, but demarcated by boundaries where individuals held land while still abiding by the obligations of the clan and their family (Wagner 1949; Leo 1984).

In 1902, Western Kenya was transferred from the Uganda Protectorate to the British controlled East African Protectorate (Rasmussen 1995). In the following decades, British settlers introduced 'modern' agriculture, commerce, and industry to the region which in turn, created new wealth along with new poverty; each being contingent upon the other. For instance, wealth was based upon the exploitation of agricultural land, while poverty stemmed from loss of land and exploitation of labor upon the land (Leo

1984). One of the most important pre-colonial aspects of the tenancy in the Kenya highlands was that it required an open frontier for newly formed families. Therefore, when the Europeans claimed unrestricted rights to seize unoccupied land, it deprived the land tenure system of its most important aspect. As Leo (1984) states, "when the colonial system began to spawn landlessness, it was inflicting, from the African point of view, an unheard-of deprivation and committing an unspeakable outrage" (pg. 32). Thus the commerce, industry, and public service brought by the Europeans did not remove the land grievances felt by the locals since the exclusion of traditional land usages had "cut the heart out of their way of life" (Leo 1984, 32).

"White Highlands" and "Native Reserves"

Upon arriving in Kenya, British settlers took their pick of the fertile well-watered Kenya highlands. Until 1960, this area was called the White Highlands or 'scheduled areas' that consisted of 3 million hectares of land, which was divided into approximately 3600 farms and ranches (Odingo 1971). During this time, locals were confined to 'native reserves' with each block of land reserved for a particular ethnic group (Rasmussen 1995). People in the reserves lived a peasant life including small-scale substance and market agricultural and animal husbandry, while relying on rudimentary technology and family labor (Cone and Lipscomb 1972). The newly established boundaries soon led to overcrowding, (i.e. ~1,000 per sq mi) and eventually severe land degradation (Sangree 1966). In the reserves, colonially appointed chiefs enforced the collection of heavy taxes levied by the colonial authorities and placed strict restrictions on commerce and agriculture (Sangree 1966). For instance, restrictions included a ban on growing cash crops and measures designed to promote 'correct' agricultural practices (i.e. contour

ploughing and terracing), which often failed to achieve the desired result. The material and cultural changes (i.e. railways, roads, permanent buildings, wheeled transports, agricultural machinery, household utensils) brought by the British were slowly integrated into the Africans' way of life (Sangree 1966). New food types where replacing old ones such as maize instead of millets. Also potatoes, peas, and improved varieties of beans were introduced (Cone and Lipscomb 1972). The main ethnic group to experience these early land-use changes and the inhabitants of the Kakamega Forest region are the Luyia people.

The Luyia and Tiriki People: History, Land-Use, and Livelihood

The Luyia people belong to the subgroup of the modern day Bantu-speaking group and inhabit the southwestern area of the Western Province of Kenya in the districts of Bungoma, Busia, Vihiga, and Kakamega (Were 1967; Ehret 1998). The region is located 50 km north of Kisimu rising above the Nandi Escarpment in a lush environment approximately 5,000 ft in elevation (Sangree 1966; Were 1967). Luyia are the dominant tribe in the Western Province and the third largest in the country with approximately 6 million people (CIA 2012). The word 'Luyia' refers to the people and language and they are commonly referred to as the 'Abaluyia' meaning "people of the clan" (Were 1967). The Luyia are not a homogenous group of people, but are recognized as a separate entity from their neighbors in the Western Province, Luo speakers to the south and the highland Nilotic speakers to the east and north (Kanyoro 1983). The Luyia origin can be traced back to the western end of the African great lakes region from around 1000 BC (Ehret 1998), reaching Kenya through Uganda around 1570 – 1600 (Were 1967). By 1850,

migration was mostly complete with only minor internal movements due to drought, disease, and later British colonialism (Were 1967).

There are 18 subgroups in the Luyia tribe. The Tiriki subgroup lives in the area surrounding the Kaimosi Forest inhabiting the lush southeastern region of the Western Province in the district of Vihiga. During pre-colonial times the Tiriki tribe had an established society that supported all members of the tribe. The clan's obligations to provide for all created a form of social security in that as long as the clan had food, no member of the clan went hungry (Painter 1966). The men in the tribe were assigned a social grouping based off age (i.e. age-group system), which included certain social expectations (Sangree 1966). For instance, in the past raiding cattle was a common occurrence for the young men in the warrior age grade. The Tiriki had very extensive funerals where the community held a celebration at the home of the deceased and mourning could last to 40 days, although it is much shorter now (Were 1967; Sangree 1966).

Currently, the official Tiriki Location (i.e. smallest governmental land division) is 70 square miles. Tiriki villages generally have sporadic paths connecting small isolated homesteads where each family lives surrounded by their crops. The family consists of husband, wife, and unmarried children. Polygamy was a common practice, but is rarely practiced today (Sangree 1966). Married sons often continue to live with their parents until they have their first child. The first born son is the main heir to his father, while daughters do not inherit property. Recently, women have been allowed to inherit property in accordance with the new Kenyan constitution (Kenya 2010). The gendered division of labor is well understood within the household. To state Wagner's (1949) interview with

an elder “It is the wife’s work to sweep, to grind, to cook, to build the fire, and to clean out the cattle partition. She carries the water from the spring and gathers firewood. She brings the salt, cleans the walls of the house and the surface of the yard with cow dung, and beats the floor of the house” (pg. 41). Since men do not often contribute to household duties, they tend to have jobs as shopkeepers, mechanics, taxi drivers, farm laborers, teachers, doctors, government workers, or church leaders. Although such traditional gender roles remain, Leo (1984) states that a level of mutual respect is found within the household and community.

Although the forest is communal, all of the homesteads surrounding the Kaimosi Forest are considered private property. Agricultural fields, generally one acre or less in size, surround the homesteads. Historically, locals practiced swidden agriculture (Cone and Lipscomb 1972), however residents are not currently able to allow their fields to lie fallow (Key-Informant Interview, 2011). Slash and burn techniques are no longer used due to the high population density and diminishing forestlands. Instead residents use commercial fertilizer to grow the two major crops in the region; beans and corn. A small percent of households also grow tea and sugarcane, although both are rare in the region.

Planting and harvesting is done by manual labor without the use of machines. Both men and women participate to varying degrees in farming activities, with men performing more of the initial physical labor required for planting and sowing, and women the day to day tasks. Residents have small patio gardens near their homesteads with cabbage, kale, tomatoes, medicinal plants, and other various vegetables. Also near their homesteads, locals grow fruit trees such as banana, avocado, mango, and guava. Residents typically have a fairly limited diet and are often restricted primarily to their

crop, orchard, and garden yields for their subsistence needs. Beans and corn are also sold as cash crops to corporate food distributors and wholesalers; while the fruits and other garden vegetables are sometimes sold or traded in the local market.

In regards to animal husbandry, cows and chickens are the two most common domesticated animals, which provide dairy and eggs, and occasionally meat. For instance, it is custom to cook a chicken when a guest from a different region visits. A small percentage of households have other domesticated animals such as ducks, goats, and donkeys. Households in this area tend to have very similar land-use types, although some exceptions do exist.

Currently, there are seven villages closely surrounding the Kaimosi Forest: Cheptulu, Shipala, Bumbo, Maganda, Shamakhokho, Jivuye, and Mahanga (Key-Informant Interview, 2011). The closest market is located to the east in the village of Cheptulu. It has several supply stores, butcheries, clothing stores, and fresh vegetables and fruits being sold by the road. People wear modern clothing and all but young children and elders speak fluent English. They also speak the national language of Kenya-Kiswahili as well as their mother tongue-Ludiriji, making most in the area trilingual. The area is dominated by different denominations of Christianity including Catholic, Pentecostal, and Quaker. The main mode of public transportation is twelve passenger vans that travel along the Kisumu-Yala main road to the neighboring villages. The region has one of the highest rural population densities in the world, with 600 people per square km (Mitchell, Lung, and Schaab 2006). Due to overpopulation, a large number of men travel to major cities to find work. Sangree (1966) estimated from his 1954-56

fieldwork that over half the Tiriki adult males had left to find work in urban areas. Furthermore, all Tiriki males participate in the circumcision ceremony.

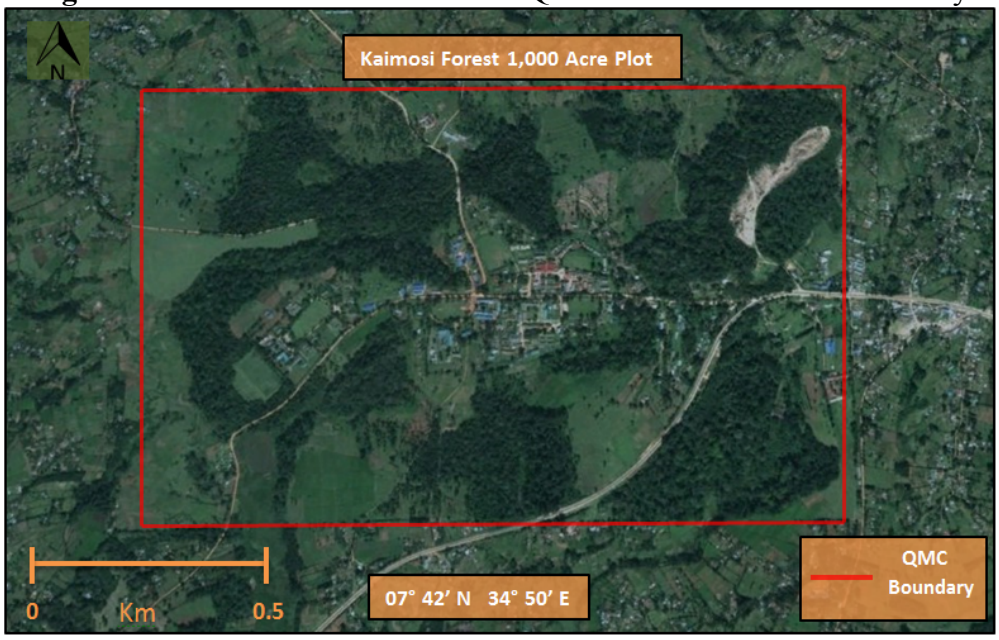
The most important Tikiri ritual is a sacred circumcision ceremony that acts as the basis for tribal identity and unity (Sangree 1966). The circumcision is performed in special ceremony sites within the sacred groves or forested areas referred to as *kavunyonje* (Kassilly and Tsingalia 2009). Following the circumcision the small group of young males spend one month isolated in the forest (Sangree 1966). Although several cultural practices and beliefs have been replaced by Christianity, the ceremony is still in practice every four to six years and is viewed as a necessity for tribal identity (Kassilly and Tsingalia 2009). The first missionaries to reach the area were American Quakers who established their mission adjacent to the Tiriki homeland and became a strong force for change in the region.

The Quaker Movement in Western Kenya

In 1902, the American Quakers Willis Hotchkiss, Arthur Chilson, and Edgar T. Hole toured the region north of Kisimu to find a suitable spot to establish a mission (Rasmussen 1995). After six weeks they chose an area known as Kaimosi because it had a small river for damming and a large hill, which offered a vantage point of the surrounding forest (Rasmussen 1996). The land was uninhabited at first, being east of the Tiriki Location and west of the Nandi Province. The literal translation of "Kaimosi" in Luyia is "a grazing field commonly held by the community for the purpose of feeding livestock" (Key-Informant Interview 2011). The British Government's decision to allow the missionaries to purchase the 1,000 acre plot was based on the hope that their presence

would help deter the fighting and cattle raiding between the Tiriki and Nandi (Sangree 1966) (see Figure 2). Soon many Tiriki started settling to the east and north of the mission to obtain help from the missionary allies. In 1905, the mission hired African guards to help protect the Tiriki cattle (Rasmussen 1995). Shortly following in 1907, the British Administration dispatched a field force against the Nandi putting an end to all major hostilities and fixing the boundaries of the Nandi. Moreover, the British recognized the eastward extension of the Tiriki boundary to the newly inhabited areas surrounding the Kaimosi Mission (Sangree 1966).

Figure 2. The Kaimosi Forest and the Quaker Mission Church Boundary



Map made by Daniel Wilson (February 2012)
Imagery Source: Google Earth Imagery, 2011

A sawmill dam was completed at Kaimosi in 1904 which supplied power for cutting the hard wood trees into boards and grinding grain into meal (Rasmussen 1996). This was to be the first of many social amenities that the church provided for the locals in the area. The American Friends Board of Missions made Kaimosi their center for all development and expansion in Western Kenya.

The political economy of colonial Kenya was premised upon the settler core of "scheduled areas" and a periphery of African "native reserves" (Gould 1989). The main function of the reserves was to provide a labor force for the urban and rural sectors of the settler economy (Leo 1984). The missionaries realized that training locals for industrial work was equally as important as spreading Christianity. The Tiriki people had several periods of high resistance towards the missionaries, but over time church membership continued to grow as the church introduced new social amenities (Rasmussen 1996). For instance, during the Kenyan famine of 1918, the Quaker Mission Church (QMC) along with the British Administration, for the first time, distributed maize meal to alleviate starvation. This in turn helped diminish early Tiriki suspicion regarding the QMC and caused maize to become the most widely used crop in the area (Sangree 1966).

Currently, there are two public primary schools and two private secondary schools (male and female), post office, hospital, teacher training college, technical college, and a hydroelectric dam all within the 1,000 acre QMC property (Rasmussen 1996). Although the QMC owns all of the land within the plot, there are several government owned and operated schools within the mission boundary. Within the past three years, there has been an attempt to start building 'Friends University, Kaimosi', a college that would be affiliated with Masinde Muliro University in the city of Kakamega, located one hour to the north of the Kaimosi Forest (Key-Informant Interview 2011). The QMC allows locals to use the forest for medicinal plant and deadwood collection (i.e. for cooking); however, the remaining forested areas are quickly diminishing (Lung and Schaab 2006).

Since the establishment of the QMC property in the early twentieth century, locals have not been allowed to live within the Kaimosi Forest. Due to the rapid population

increase, as well as the growth and establishment of the QMC lands, the average homestead size in the area is diminishing to an average of less than two acres leaving little room for the staple crops of beans and corn (Kassilly and Tsingalia 2009). The current shortage of land makes the Kaimosi Forest increasingly important for rainfall, the prevention of soil erosion, local resources, and cultural ceremonies in the area. However, recent research shows that the Kaimosi Forest is undergoing the highest rate of deforestation within the larger Kakamega Forest (Lung and Schaab 2006; Bleher, Uster, and Bergsdorf 2006). The CPR and CAPE literatures that guide this study are presented in Chapter 2 to explore the main factors influencing the role and perception of local institutions on deforestation in the Kaimosi Forest.

CHAPTER II

THEORECTICAL FRAMEWORK

Introduction

A common pool natural resource is a type of resource that benefits a group of people, but which provides diminished benefits to everyone if each individual pursues their own self-interest in the collection or use of the resource. The size or characteristics of the resource makes it costly to exclude users from obtaining benefits from its use. Thus the two defining characteristics are excludability (i.e. difficulty of controlling user access) and subtractability (i.e. each user is capable of subtracting from the welfare of other users) (Feeny 1986; Ostrom 1990). Examples include fisheries, wildlife, groundwater basins, rangeland, irrigation systems, and forests. Such resources represent an important component in the livelihoods of people throughout Africa, Asia, and Latin America (NRC 1986; Ostrom 1990). Within the past century, utilization of common pool resources has increased due to factors such as population growth, climate change, and persistent poverty (Feeny 1986; Gibson, McKean, and Ostrom 2000; Deitz et al. 2002).

For thousands of years, people dependent upon common pool resources have self-organized to create institutionalized controls for sustainably using their resource base.

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Institutions in this context are the rules that govern the collective use of the resource (Deitz et al. 2002). Examples of institutions include forest-cutting controls in Nepal, wildlife utilization regulations in the Congo Basin, and indigenous fishing regulations in Asia (Feeny 1986) The purpose of institutions are to ensure effective use of the natural resource while maintaining long-term economic viability (Ostrom 1990). In some instances institutions have not been established or have been eradicated by circumstances such as armed conflict or colonization. When institutions are not properly implemented, users have the incentive to exploit the common pool resource without concern for the negative long-term effects on other users (Ostrom et al. 1999). This undesirable result of over-exploitation is referred to as the "commons dilemma."

This chapter first reviews common property theory literature to explain and discuss the main theories surrounding the commons dilemma. The first section presents four models that are influential in shaping how researchers traditionally view common pool resource management. The second section reviews significant variables identified in commons case studies associated with successful common property regimes (CPRs). By considering each variable, this study evaluates the role and perception of local institutions on deforestation and degradation in the Kaimosi Forest, Western Kenya. The last section will show how Cultural and Political Ecology are used to gain a more comprehensive understanding of this complex people and forests relationship by focusing on the role of household decision-making and local power struggles.

The Role of Models for Analyzing Common Pool Resources

The conventional Western solution for solving the commons dilemma is to enclose the common pool resource by individually privatizing the resource (Ostrom

1990). When institutions are not established, privatization of common pool resources can be the optimal solution for the commons dilemma. However, many Western scholars have historically overlooked the role of institutions on successful resource management and suggested privatization based on the premise that rational individuals cannot mutually use the resource to ensure they reach optimal group benefits. The first three models represent this conventional theory: The Logic of Collective Action, The Tragedy of the Commons, and the Prisoner's Dilemma. Each model uses similar theoretical assumptions to formalize the commons dilemma under different circumstances to suggest privatization as the only solution (Ostrom 1998). One problem with this recommendation is that converting common property to an individual private property regime often fails to stop overuse, and in many cases may contribute to even more rapid over-use of resources (Runge 1986). In contrast, the fourth model, titled Common Property Regimes (CPRs), reevaluates the assumptions of the conventional models using empirical evidence. This model offers an alternative solution that allows communities to have local authority over the use and management of their common pool resources and has led to the development of a new theoretical framework for analyzing common pool resource management (NRC 1986; Ostrom 1990; Ostrom 1998; McKean 2000).

Model 1: The Logic of Collective Action

In "The Logic of Collective Action", Olson (1965) challenges the presumption argued in game theory that individuals in a group of any size with a common interest will work together to achieve those interests (Truman 1958). Olson (1965) uses the example of unions in the United States to show that once an individual is a member of a large group and receives group benefits, it is hard to be excluded from receiving the group

benefits. Once this occurs, individuals will have the incentive to "free ride" on the efforts of other members rather than contribute voluntarily to the provision of that good or service (Kimber 1981). Therefore, collective action is unlikely to occur in large groups without using coercion to ensure all members contribute to the common interests. One potential solution offered to help solve this dilemma is having a small-sized group where each user's contribution has a significant influence on the group's effort to achieve collective benefits. The main argument taken from Olson's work is that collective sustained benefits are not likely without the use of external coercion, monitoring, and enforcement (Ostrom 1990). Olson's (1965) argument is one of three influential models that have been used by policy-makers and state governments to justify the enclosure of all common pool resources undergoing over use and degradation (Ostrom 1990).

Model 2: The Tragedy of the Commons

In 1968, ecologist Hardin (1968) instituted a thesis that growing human populations will place increasing stress on finite natural resources, resulting in overexploitation and ruin (Burger and Gochfeld 1998). Hardin uses Lloyd's metaphor of herdsman sharing a common grazing field (Lloyd 1968). Here, each herdsman receives personal gain by adding cattle to the field, while the cost (i.e. resource degradation) is placed on the entire group. Therefore, each herdsman rationally chooses to add more cattle to his herd without limit. "Ruin is the destination toward which all men rush, each pursuing his own best interest in a society that believes in the freedom of the commons. Freedom in a commons brings ruin to all" (Hardin 1968, 162). Hardin termed this phenomenon the "Tragedy of the Commons" (Hardin 1968). One conclusion often drawn from Hardin's metaphor of individual users over-grazing a pasture is the idea that

common pool resources are also open access resources, where no requirements are established for who is allowed to use the resource (Ostrom 1990; Dietz et al. 2002). The parable of a common grazing field can also be structured as the third collective choice model: the Prisoner's Dilemma (Dawes 1973; Ostrom 1990).

Model 3: The Prisoner's Dilemma

The Prisoner's Dilemma (PD) game creates a paradox where an individual's rational strategy leads to irrational group outcomes (Dawes 1973). Suppose the players in a game are two suspects being separately interrogated about a crime they jointly committed. The suspects are not allowed to communicate. Hence, if each "co-operates" and does not confess, both will likely receive a short prison sentence, but if each defects and confesses they will receive a medium sentence. However, if one suspect stays silent and the other confesses; the first will receive a long sentence while the confessor receives a much shorter sentence. The PD game suggests that each suspect has a rationally ranked list of preferred options: (1) the other suspect stays silent, while they confess (2) both suspects stay silent (3) both suspects confess (4) one suspect stays silent while the other suspect confesses (Ostrom 1990; Deitz et al. 2002). Since it is impossible to know what the other will decide, the rational choice is for each suspect to confess to ensure that they will not receive the worst outcome of a long sentence. This shows that pursuing individual benefits logically lead the prisoners to betray the other and defect (i.e. confess), even though they would both be better off if they cooperated (i.e. not-confess) (Wade 1987). This paradox challenges the notion that rational human beings can achieve rational collective benefits (Ostrom 1990). Consequently, social scientists refer to this

paradox as the "commons dilemma" because of its relation to Hardin's "Tragedy" metaphor (Godwin and Shepard 1979).

Tragedy of the Commons Models and Resulting Policy Outcomes

Policy-makers, state-governments, and scholars have used these three conventional models to justify two standard policy recommendations; resources should be converted to private property or centralized governments should seize control of common pool resources (Ostrom 1990). For instance, Smith (1981) uses Hardin's (1968) "open to all" perspective to justify the need for privatization of common resources (Hardin 1968, 1244). As Smith remarks; "Hardin's treatment of the tragedy of the commons suggest that the only way to avoid the tragedy of the commons in natural resources and wildlife is to end the common property system by creating a system of private property rights" (1981, 467). Moreover, this view has led to a strategy called "fortress conservation" where human settlement and activity are removed from vulnerable environments undergoing severe degradation (Siurua 2006). These policy recommendations are often ineffective because the models use theoretical assumptions that do not necessarily apply to over-use issues related to common pool resources. These three models have all concluded that the commons dilemma exists because the individuals are stuck in a setting where they generate negative externalities toward one another, which in turn creates the free rider problem. The free rider problem is the expected result because all three models have analyzed simple common-pool resource systems and behavioral models that do not always apply to real world scenarios. A critique of these assumptions is provided before discussing the fourth model, Common

Property Regimes (CPRs), where common users self-organize to achieve close to optimal results when exploiting their resources (Ostrom 1990).

Guiding Assumptions used in Conventional Commons Models

The conventional theory is based off the assumption that all common pool resources are open access; however with "common property," resources are used and owned by a specific group of users (Ostrom 1990). When access is limited, the group is able to communicate and agree on how to best use their resource to ensure long term sustainability. Furthermore, the conventional theory assumes commons users do not communicate and are unrestrained by appropriation rules; these conditions fit unorganized, large groups of actors appropriating from an international commons, for instance (Ostrom 1998). However, most common pool resources are within a region or area where a small number of actors are better able to communicate, agree on their appropriation levels and sanctioning systems, and even find means to enforce these strategies themselves (Ostrom 1998; Dietz et al. 2002). The theoretical role of communication in non-cooperative game theory views words as "frail constraints" (Ostrom 1998, 427). Thus, the conventional theory has treated the ability to communicate as insignificant to change group behavior. Lastly, the conventional theory assumes that individuals can choose only once before the payoffs are received (Ostrom 1998). Yet, commons users are not prisoners. They can communicate and change their constraints over time to reach the optimal collective benefit.

The modified assumptions of commons users test the generalizability of the conventional model. Results show that in small, well specified environments where communication is possible, users are willing to pay the cost involved in creating,

monitoring, and enforcing proper resource use for overcoming the free-rider problem (Ostrom 1998; Gibson, McKean, and Ostrom 2000). Therefore the conventional theory is not adequate for explaining behavior in such settings where users overcome the commons dilemma (Ostrom 1998). Consequently, an alternative model is needed.

Model 4: Common Property Regimes

The fourth model for understanding and solving common pool resource issues was developed by Ostrom (1998) as the "Self-Governance of Common-Pool Resources," now referred to as Common Property Regimes (CPRs). The role of CPRs is to implement, monitor, and enforce local rules or *institutions* for using the resource. In a CPR arrangement, a particular set of people share the rights to a resource. Therefore, contrary to open access or public property, CPRs should be considered shared private property whereby a specific set of people have access to use the commons resource while abiding by the local institutions, or rules in use (Wade 1987; Gibson, McKean, and Ostrom 2000; Ostrom 2005). Without the role of institutions, the free rider problem suggests that individual privatization is the favorable solution to properly conserve and sustain natural resources (Dietz et al. 2002). On the contrary, CPRs use institutions to control resource use creating a managed commons, which is distinct from Hardin's (1968) free for all idea of the commons. CPRs have created sustainable human-environment relationships for thousands of years and therefore should be thought of as a positive alternative to individually owned private property (Ostrom 1990).

Unlike individually owned private property, members of a CPR receive benefits and rights to use and govern their resources (Ostrom 1990). In the "Drama of the Commons," Dietz et al. (2002) argue that CPRs perform better than private property

when the economic output of the resource is slow, the resource is spatially spread out, and the cost of enforcing private property rights is high. Individual privatization removes the chance for commons users to receive long-term benefits from the resource (Rocheleau and Edmunds 1997; Gibson, McKean, and Ostrom 2000). Therefore, the rational choice of privatization is to start pursuing maximum-harvesting strategies for economic returns rather than the traditional sustainable harvesting strategies (Ostrom and Nagendra 2006). For example, Agrawal (2000) shows in his case study on forest management in India, whenever privatization has occurred, it has damaged the complex ecology by fragmenting the land, caused locals to exacerbate deforestation and land degradation because of lost ownership, and led to lack of stewardship. Another issue with private property is that analysts rarely discuss *how* to establish private rights for common pool resources. Private property rights cannot be easily established with non-stationary resources such as water and fisheries (Clark 1980; Ostrom 1990). In addition, privatization solutions suggest parceling land-based resources into sections, which can disturb natural spatial patterns within the ecosystem and therefore increase resource degradation (Gibson, McKean, and Ostrom 2000).

CPRs offer an alternative solution that can prevent the negative social and environmental effects of privatization and maintain a balance between resource exploitation and conservation; however, local institutions must be properly established and governed in order to reach this balance. The following section discusses the development of a framework for analyzing local institutions associated with common pool resources.

Developing a Common Property Framework for People and Forests

During the mid-1980s researchers began synthesizing their empirical-based transnational common property research to develop a new analytical framework consisting of the optimal institutional arrangements for different types of CPRs. In 1985, the National Academy of Sciences' "Panel on Common Property Resource Management" was a major step in the development of a broader theory of institutional arrangements related to successful CPRs (Ostrom 1990). The most significant aspect of this particular research panel was commissioning multiple field researchers to write papers using the same analytical framework developed by Oakerson (1986). Although there had been hundreds of common property case studies published before this time, there had never been syntheses between multiple researchers at this scale (Dietz et al. 2002). A synthesis at this scale was necessary because of the different variations of CPRs, which depends on the type of resource, number of users, and the type of institutions in place (Ostrom 1990). The new comprehensive theory attempts to explain whether and under what conditions sustainable resource management will occur, rather than simply predicting the demise of all resources held in common (NRC 1986). Since variations in the type of natural resource affect the type of institutions required for successful conservation, the commons framework presented in the next section is designed for analyzing common property forests with the intentions of creating a sustainable (win-win) people and forests relationship.

Researchers argue that recognizing the role and appropriateness of local institutions is crucial for understanding a CPRs influence on deforestation (Ostrom 1990; Oakerson 1992; McKean 2000; Dietz et al. 2002). For a CPR to be successful, several

attributes regarding local institutions are necessary (see Ostrom 1990; Gibson, McKean, and Ostrom 2000). Although other frameworks include differing institutional attributes, the specific attributes included in this analysis are replicated from Vadjunec's (2010) research in the Chico Mendes Extractive Reserve, Acre, Brazil (see also McKean 2000). These include perceived fairness with rule enforcement and punishment for rule breaking, user participation in the rule making, clearly defined boundary lines, clearly defined membership requirements, monitoring forest-use, shared vision among users, and saliency (dependency on the resource).

Enforcement and Punishment of Local Institutions (Forest-Use Rules)

The appropriate level of enforcement is vital to the success of a CPR (McKean 2000). For example, Banana and Gombya-Ssembajjwe (2000) compare different levels of enforcement in five Ugandan forests and conclude that the best forest conditions exist when the level of enforcement is well understood and perceived as fair by the local forest users. Rules must also be designed in a way that allows local guards to easily enforce the rules (McKean 2000). A quantifiable rule concerning how much a resource may be exploited can be difficult to measure; such as how many kilograms of medicinal plant are being extracted. One possible solution is to design a rule that restricts the use of different types of equipment in the common property area (e.g. no machetes allowed within the forest boundary) or limit collection by seasons (Gibson, McKean, and Ostrom 2000). Punishment for rule breakers must be perceived as fair in order to increase the probability of users abiding by the rules (Ostrom 2005). A common suggestion to make forest rules perceived as fair is to make fines for first offenses low and increase with each subsequent

offense (Ostrom 1990; McKean 1992). Community participation in determining the punishment's severity is also suggested for optimal results (McKean 2000).

User Participation in the Rule Making

Members should be able to give input into rule making and the governing process (Ostrom 1990; Oakerson 1992; McKean 2000). When user input is allowed, it is more likely that the rules will be perceived as fair. In addition, when locals are involved in the decisions regarding forest-use rules, they are more likely to help monitor others more so than when an authority (e.g. forest guard) solely enforces the rules (Ostrom and Nagendra 2006).

Boundary Lines

Resource users should have a clear definition of forest boundary lines (Gibson, McKean, and Ostrom. 2000). Clearly defined and demarcated boundary lines allow the caretakers to effectively guard the resource from outside invaders, helping sustain a shared private property. Clearly defined boundary lines also prevent the resource from being divided into parcels, which makes it more cost effective to guard the resource and allows the resource to remain productive (Gibson, McKean, and Ostrom 2000). Privatizers often suggest dividing forest ecosystems into environmentally inappropriate parcels, which has led to much undesirable deforestation and land degradation throughout the world (Ostrom 1990; McKean 2000). Moreover, preventing division is especially important with forest ecosystems because fragmentation may disrupt the essential spatial dimensions required for forest species to interact (McKean 2000).

Membership

CPRs consist of a defined number of users who are allowed to use the common pool resources (McKean 2000). Specific requirements for membership are essential for CPRs because it makes the resource private instead of public and prevents outsiders from exploiting the resource (Oakerson 1992). The requirements for membership must be well defined in order to prevent the resource from becoming open access, and thus creating a commons dilemma.

Monitoring Forest-Use

Monitoring levels of extraction is important for long-term sustainability of forest resources (McKean 2000; Ostrom and Nagendra 2006). Ostrom and Nagendra (2006) argue that monitoring ecological systems helps understand the past and present conditions of the resource, make future predictions, and form a consensus between the residents and authorities on the optimal institutional arrangement for resource sustainability.

Shared Vision

Social capital is defined as a "resource of reciprocity and trust which can be drawn upon by households in the composition of sustainable livelihoods" (Cleaver 2001, 28). Social capital variables such as having a shared vision among users is seen as necessary for ensuring effective collective action towards managing common pool resources (Ostrom 1990; Narayan 1997). Research shows that users should have a shared vision of the forest and awareness of the consequences of their actions towards the environment and community (Gibson, McKean, and Ostrom 2000). A shared vision is created when the perceived allocation of resources provides an equal amount of benefit to

all members (Dietz et al. 2002). In "Making the Commons Work," Oakerson (1992) defines this attribute as "jointness," where one person's use does not subtract from the use of other members (pg. 43). A shared vision and perceived equal allocation of resources is essential for CPRs to successfully operate because it increases the chance of reciprocity between users (Rawes 1971; Ostrom 1990; Gibson, McKean, and Ostrom 2000). Community cohesion, however, is not always influential enough on its own to achieve successful collective action (Ostrom 1990). For instance, Gibson and Koontz (1998) find in their case study on two CPRs in Southern Indiana, shared values within the community does not necessarily translate into successful outcomes. Therefore, institutions should be established to translate the community's values into rules that members follow.

Saliency

One important requirement for successful resource management is saliency (Ostrom 1990; McKean 2000). Saliency occurs when an individual is directly dependent on the resource for their livelihood (Turner, Gibson, and Dodds 2007). Saliency ensures that all members have a direct interest in the sustainability of the resource and will therefore act in favor of long-term conservation (Gibson, McKean, and Ostrom 2000). Although Hardin's (1968) metaphor does not distinguish between common resources where the users are salient or not, Kimber (1983) considers Hardin's logic to be most likely true when users are not directly dependent on the resource for survival. Following this logic, Wade (1987) states that when survival is at stake, the "rational" commons users must restrain from resource exploitation at some point. Furthermore, Vadjunec (2010) finds that saliency can contribute to creating community cohesion by forming a

singular identity among commons users. Turner and colleagues (2007) argue that saliency and a perceived scarcity of the resource are both equally important requirements for having a successful CPR with restrictive rules concerning resource use.

Empirical evidence shows that when institutional attributes are properly implemented, CPRs can create a socially and environmentally just balance that can be highly sustainable (Gibson, McKean, and Ostrom 2000; Vadjunec 2010). CPRs also provide people with access to valuable resources instead of merely restricting them; as a result, they can increase the quality of livelihoods for a larger group of people. This study uses the CPR framework (described above) to explore the main factors influencing the role and perception of local institutions on deforestation in the Kaimosi Forest. As noted by Gibson and Becker (2000), each CPR is unique in regards to social, environmental, and institutional factors and what works for one CPR, may not work in another.

Cultural and Political Ecology

Cultural and Political Ecology (CAPE) offers an additional and valuable approach for understanding the role and perception of institutions on deforestation and degradation in the Kaimosi Forest. CAPE broadens the focus to include the role of individual actors in commons resource management by focusing on the role of household decision-making (i.e. Cultural Ecology) and local power struggles (i.e. Political Ecology). The specific CAPE approaches used in this study will be discussed before explaining how they enhance the CPR framework presented above.

Cultural Ecology

The study of cultural ecology (CE) emerged in anthropology and geography with a broad focus on the relationship between culture and the environment, often focusing on cultural adaptation to local ecologies and environmental change (Steward 1955; Sutton and Anderson 2010). The interdisciplinary nature of CE enables a synthesis between theories and approaches from different specialized subfields and is therefore the most appropriate field to inform human-environment policy (Sutton and Anderson 2010). CE research evaluates the social and environmental effects of policy change and helps predict future outcomes concerning a wide range of applied issues. This research has yielded insight for policy reform on issues such as alleviation of water shortages in Africa (White, Bradley, and White 1972), adaptation to drought (Westcoat 1991), and local knowledge-based farming practices (Doolittle 1984; Netting 1993).

CE generally addresses issues on the micro-spatial scale (i.e. household level) in non-western settings and typically involves extensive field research. Moreover, CE studies often focus on a particular social group (e.g. peasant or native) for an extended period of time in the field. Much CE research focuses on local-level settings (i.e. village or household) in order to best understand resource-use behaviors. This research design has proven very helpful in understanding people-forest interactions in the humid tropics. According to Zimmerer (2004, 795), CE's most important contribution is the capacity to focus the "research design on selective combination of the key socio-economic and environmental dimensions that are embodied in the diverse logics and decision-making of forest-using households." Analyzing intra-household adaptation and decision-making allows the researcher to understand the choices and consequences of such choices (e.g.

farming practices and forest plant extraction) on natural resource management. These choices engender important livelihood and environmental consequences that must be understood before interpreting the impact of local policies and institutions (Smit and Wandel 2006). Although CE perspectives cover a wide range of human-environment aspects, this study focuses on household decision-making in regards to land-use and forest-use. A few early CE studies recognized the effects of power and political economy in the lives of rural people, which eventually led to a new approach called Political Ecology (Blaikie and Brookfield 1987).

Political Ecology

In the mid-1980s, geographers Blaikie and Brookfield (1987) popularized the term Political Ecology (PE) by combining "the concerns of ecology and a broadly defined political economy"(pg. 17). Representing an explicit alternative to "apolitical" ecology, PE contextually approaches issues by "identifying the broader systems rather than blaming proximate and local forces", and "viewing ecological systems as power-laden rather than politically inert" (Robbins 2004, 5). Political ecologists query the relationship between livelihood, politics, and nature (Robbins 2004). PE studies that include multiple scales (micro, macro) of analysis offer a broadened dimension of human-environment interactions by showing the inter-connectedness and influence of political and economic forces. Topical issues include land degradation, deforestation, desertification, conservation, institutions and governance, ecological impacts of economic development, and equality and environmental trade-offs (Turner and Robbins 2008).

The main premise behind PE research is that environmental change and ecological degradation are the product of political processes and unequal power dynamics (Robbins 2004). This premise is formed by three connected assumptions: (1) "the costs and benefits associated with environmental change are for the most part distributed among actors unequally," (2) this unequal distribution of environmental costs "reinforces existing social and economic inequalities" and, in turn, (3) "also has political implications in terms of the altered power of actors in relation to other actors" (Bryant and Bailey 1997, 28-29).

The types of actors involved in environmental change and conflict in developing countries include states, multilateral institutions, businesses, environmental NGOs and grassroots actors (e.g. poor farmers, shifting cultivators, and pastoralists). Political ecologists view the concept of power "in relation to the ability of an actor to control their own interaction with the environment and the interaction of other actors with the environment" (Bryant and Bailey 1997, 39). PE research tends to reveal that environmental change signifies winners and losers (i.e. wealth creation for some and impoverishment for others), and reveals the differential power and conflict that produces social and environmental outcomes (Robbins 2004). Power struggles and conflict among actors lead to degradation of natural resources that often have the most detrimental impact on marginalized and powerless groups.

Employing Common Property Theory and CAPE as Complementary Approaches

The institutional variables presented in the previous section have been applied to numerous commons case studies and have proven reliable for analyzing local institutions; however, the framework does not explicitly account for the effects of political forces on

livelihoods and conflict between individual actors within CPRs (Dietz et al. 2002). Robbins (2004) argues, although common property theory is "one of the first and most essential contributions to a contemporary political ecology…practical action is limited to internal 'rule crafting' " (pg. 43-45). He is suggesting that a more adequate theory should comprise of multiple scales of power and diverse players acting within the commons (Robbins 2004). Therefore, environmental issues cannot be understood in isolation from the political and livelihood context within which CPR they are created (Bryant and Bailey 1997; Robbins 2004).

Furthermore, the CPR framework described above is typically applied at the community level using rapid assessment techniques (IFRI 2007). CE provides a complementary approach for highlighting the complexities within communities by focusing on the household level to best understand local resource-use behaviors. In addition, CE approaches are essential for understanding temporal dimensions of CPRs such as the role of household decision-making and adaptation techniques. Taken together, CAPE highlights the role of household decision-making and adaptation while also including the role of power struggles and conflict among players acting within the commons. Overall, the community scale approach of CPR studies combined with the micro and macro scale approaches of CAPE add robustness to this analysis. Here, CAPE approaches broaden the focus beyond traditional CPR case studies in order to produce a comprehensive interpretation of the environmental issues facing this people and forests relationship.

Conclusion

This chapter began with an outline of three conventional models that were used to form a theory of environmental degradation of common pool resources. According to the models' assumptions, the inevitable result was failure and degradation whereby rational individuals seek personal benefit while placing the cost on the group (i.e. the free rider problem). The fourth model presented empirical evidence collected from commons researchers which concluded that if conditions allow for community negotiation, iterative observation of outcomes, and proper structure of institutions, environmental degradation is not the inevitable result of collectivity (Ostrom 1990; Dietz et al. 2002; Robbins 2004). Researchers then began to focus on the role of local institutions for understanding a CPRs influence on resource management. Moreover, this focus led to the identification of significant attributes associated with successful CPRs (Ostrom 1990; McKean 2000; Dietz et al. 2002).

CAPE approaches offer a human-environment perspective that can complement other existing frameworks, such as common property theory, by expanding the understanding of environmental change in the context of an integrated understanding of human-environmental interactions (Bryant and Bailey 1997). CE approaches help highlight the role of the household, while PE highlights environmental degradation as a result of power struggles and conflict. CAPE complements the CPR research design by enabling the analysis to explore the relationship between household patterns, local actors, and the CPR institutional dimensions. As the methods chapter will show, the data collection techniques were designed to integrate all three approaches. Therefore, this study seeks to better understand the role of (1) significant attributes for successful CPRs,

(2) household decisions regarding land-use and natural resource use, and (3) local power struggles among individual actors.

CHAPTER III

METHODOLOGY

Introduction

A mixed methods approach was used in this study to best interpret the role and perception of local institutions on deforestation and degradation in the Kaimosi Forest, Western Kenya. Traditionally, human-environment research that explores institutional dimensions of CPRs typically focuses on the community level (Ostrom 1990, Robbins 2004). With the addition of a CAPE lens, this research analysis is broadened to include household differences in land-use, livelihood, and forest-use within two villages surrounding the Kaimosi Forest. Household surveys and key-informant interviews were conducted within two villages in order to explore relationships between people and forest dynamics. The types of variables collected in this study are replicated from Vadjunec's (2010) framework for analyzing a CPR in Acre, Brazil. Before explaining the methodologies, it is necessary to discuss the research questions that form the basis of this study:

> **1)** What are the major socio-economic and demographic factors that influence household land-use decisions and forest extraction?
>
> **2)** How are local forest institutions created, implemented, monitored, and enforced in the Kaimosi Forest?

3) How do local perceptions among households and other actors differ regarding the institutions currently operating in the Kaimosi Forest? **3b)** How do these differences impact forest-use and local livelihoods?

Answers to these questions will help explain how the relationship between people and forests impacts livelihoods and deforestation and degradation in the Kaimosi Forest. More specifically, by focusing on the role and perception of local institutions and land-use, I seek to gain insight into the main social and institutional factors that influence deforestation and degradation. Below are the various components of the research methodologies (Table 1).

Table 1. Research Components: Primary Data Collection and Exploratory Data Analysis

Questions	Methodologies	Summary of Intentions
	Research Permit and Field Assistants	Received full approval of research from Kenyan Government and hired two field assistants.
1, 2 and 3	Participant Observation	Gained local knowledge regarding local land-uses, forest-extraction types, and cultural practices associated with the surrounding forest.
2 and 3	Key-informant Interviews (n=12)	(a) Received information regarding local institutions and land-use. (b) Determined two opposing villages undergoing the least and most deforestation and degradation.
1, 2 and 3	Household Surveys (n= 64)	Collected data regarding socio-economic (livelihood), demographic, land-use, forest-use, and the role and perception of institutions.
1 and 3b	Statistical and Qualitative Synthesis	(a) Explored the relationship between household demographics, land-use livelihoods, and forest-use. (b) Interpreted the role of local institutions on deforestation and degradation in the Kaimosi Forest.

The mixed methods approach used in this study is presented in two stages consisting of primary data collection and exploratory data analysis. The first section explains the data collection carried out over a ten-week period from June to August 2011. The field methods consist of participant-observation, key-informant interviews (n=12), and household surveys (n=68). Since this study involves human subjects living near the

Kaimosi Forest, approval was first obtained from the Institutional Review Board in May 2011 (see Appendix A). The next section includes the steps for constructing the database and indices as well as the statistics used in exploring the quantitative primary data. The qualitative data collected from field notes and open-ended survey questions will assist in contextualizing and interpreting the quantitative results. The last section shows how these methods are designed and triangulated to produce a comprehensive interpretation of the environmental issues facing the Kaimosi Forest and local residents.

Stage 1: Fieldwork in the Kaimosi Forest, Western Kenya

Research Permit, Field Assistants, and Consideration of Human Subjects

Before the fieldwork began, the research permit was acquired from the National Research Council of Science and Technology headquarters in Nairobi, Kenya (see Appendix B). In order to meet the requirements of the permit, an affiliation was established with Masinde Muliro University in Kakamega, Kenya. After receiving the permit, two research assistants were hired to assist in the completion of the household surveys. The assistants were undergraduate students at Moi University in Eldoret, Kenya. Prior to starting any fieldwork, a day was set aside to train the assistants about the purpose and intentions of the field techniques. The research assistants were fluent in English, Kiswahili (i.e. the national language of Kenya), and Luyia (i.e. the local regional language). Having trilingual field assistants allowed for the data collection to be completed without language barriers.

Working with human subjects in a different culture required an extra focus on preventing ethical dilemmas. The assistants were trained to describe to the participants

the ethical considerations that were taken to protect human subjects in this study. To ensure that minimal risks were placed upon the participants, full confidentially and/or anonymity was required. It was clearly explained that names would not be recorded and their responses would be kept safe throughout the research process. Before the survey or interview began, participants were told that they did not have to answer any questions they felt were inappropriate and could stop at any time. The first two weeks of participant-observation techniques ensured that cultural norms were understood before conducting any formal interviews or surveys. The next section discusses how the participant-observation techniques were used in the field.

Participant-Observation

Participant-observation is a method in which a field researcher takes part in daily activities, rituals, and interactions of a group of people as a means of learning the aspects of their everyday lives and culture (Dewalt and Dewalt 2011). There are not necessarily formal steps to follow when using this method; however, there are common suggestions to ensure the technique is completed in an ethical and productive manner. For instance, it is equally important to focus on participating (learning through experience) as well as observing (learning by seeing) (Laurier 2003). Participant-observation can help view certain types of social and environmental phenomena that are often too complex for methodologies used for detecting general trends. It allows the researcher to obtain a degree of the particular know-how of activities, appropriate conduct, and common knowledge of the place and people (Livingston 1987; Dewalt and Dewalt 2011). In addition, participant-observation complements other methodologies by allowing the researcher to build a bottom-up qualitative description of an area.

The first two weeks out of ten total weeks in the field consisted exclusively of participant-observation. Prior to conducting any other forms of research, it was essential to build the necessary social capital by creating a partnership with local actors. My intentions were to establish my presence as a researcher and a temporary member of the community. As an outsider, participating in local activities such as collecting forest plants, harvesting crops, and attending church helped create a relationship with locals to ensure that my presence in the village was understood (Laurier 2003). More specifically, it was an opportunity to better understand local household land-uses as well as the types of NTFPs extracted, species collected, and cultural practices associated with the surrounding forest. Participating in these activities also allowed locals to ask me questions pertaining to my intentions as a student and a researcher.

Participating in such activities as harvesting crops and collecting medicinal forest plants allowed the field note commentary to include *why* decisions were made and *how* tasks were completed. Laurier (2003) notes that an important aspect of transcribing observations is when and where the notes are taken. Therefore, consideration was taken in sensitive settings and field notes were often transcribed after the activity was completed. The field note commentary is drawn from to triangulate the qualitative and quantitative data during the discussion of the results in chapter 5. The next section explains the design and completion of the key-informant interviews.

Key-Informant Interviews

On June 6th, 2011 Masinde Muliro University hosted the International Conference on Tropical Forest Resources. This provided an excellent opportunity to enhance my

knowledge regarding the environmental issues facing the Kakamega Forest and interview scholars having expertise in the field of study and region. Starting during the third week, 12 key-informant semi-structured interviews were conducted with local actors including, chiefs, education officials, Quaker Mission Church leaders, and Kenyan Forest Service officials. Each interview took approximately one hour to complete. I was present during all the interviews along with one research assistant. All of the key-informants spoke English, which allowed me to lead all of the interviews. A geographically stratified snowballing technique was used as the sampling method to capture major actors relevant to the management of the Kaimosi Forest. This method was determined to be the best technique to obtain the target number of interviews from a wide range of informants. Both fixed and open-ended questions were used in the interviews. The questions focused on the following types of information (see Appendix D for Key-Informant Interviews):

- Major environmental issues in the Kaimosi Forest (e.g. deforestation, degradation, water, soil, over-use of forest resources) and major land-use/land-tenure issues
- Community conflicts regarding: selling property, hunting, timber extraction, NGOs, forest-use rules, water, and soil erosion
- Main institutions responsible for monitoring, enforcing, and punishing forest-use rules, level of local participation in rule making, and issues with rule-breaking
- Perceptions regarding the village with the least and most amount of environmental issues (deforestation and degradation) and the least and most organized village surrounding the Kaimosi Forest

The key-informant sampling started with the highest-ranking government official in the region and continued outward to more localized chiefs, church leaders, and Kenyan Forest Service officials. The snowballing technique was used by asking each key-informant for additional contacts to high-ranking leaders in the area. Two objectives were completed during the 12 semi-structured interviews. The first objective was to gain

insight on, land-use, forest-use, local institutions, and environmental pressures in the Kaimosi Forest and surrounding areas. The second objective was to determine the official's perception regarding villages undergoing the least and most deforestation and degradation pertaining to CPR management of the Kaimosi Forest. This information was used to determine two villages (i.e. sampling frames) for the household surveys. The *perceived* least and most successful villages in terms of commons natural resource management were selected to carry out a quantitative comparison of the two villages in regards to household demographics, land-use, livelihood, forest-use, and perception of institutional dimensions. Due to time constraints, the household surveys began directly after the two villages had been selected.

Household Surveys

The household interviews were designed to have clear and effective questions to ensure non-bias and relevant data collection (Longhurst 2003). The CPR framework and CAPE perspectives presented in Chapter 2 theoretically guided the design of the surveys. Fixed and open-ended questions were used to acquire the proper data types. Fixed questions were used to collect demographic/household characteristics and land-use/forest-use patterns. These questions provided responses that could be quantified and explored with inferential statistics to reveal significant trends. Fixed responses also included the Likert scale to show the range of differing perceptions and opinions among participants. For instance, ordinal responses such as "(1) disagree strongly, (2) disagree somewhat, (3) agree in general, or (4) agree strongly" provided quantifiable fixed data. The open-ended questions offered detailed insights regarding differences in local decision-making, perceptions, opinions, and experiences. These questions allowed

participants to craft their own responses in order to best represent their true viewpoints. Thus, the qualitative data gathered from these open-ended questions supplemented the quantitative data with contextual understandings of the local circumstances. Since it is essential that questions be simple, clear, and easy to understand; a pre-test was conducted in the field to reveal flaws in the survey design.

Information collected from the key-informant interviews were used to select two villages for a stratified comparison household demographics, land-use, livelihood, forest-use, and perception of institutional dimensions. Once the villages were selected, 34 household surveys were conducted in each village (n = 68). A sample size of at least 30 surveys per village was necessary to reach a balance between time constraints, while at the same time satisfying the minimal requirements needed for the inferential statistical analysis. Random sampling was used within the two villages to allow for the best representation of the two villages. Each household survey took approximately one hour to complete. Most surveys were conducted in the late morning or midafternoon when residents were most likely to be home. Out of courtesy, surveys were not conducted on weekends.

Preferably the male and female head of household, or, minimally the self-identified head of household was interviewed. It was a common occurrence to walk with the homeowner to see their livestock and farm while the survey was completed. The participants were told that they did not have to answer any questions they deemed sensitive or inappropriate. Furthermore, my intentions as a student and researcher were fully explained before questions were asked. Oral consent was required from all participants before any questions were asked (see Appendix E). Although I was always

present during the surveys, the variation among participants regarding English-speaking skills determined how involved I was in asking the questions. Some household surveys were completed entirely in Luyia and Kiswahili. I understood enough Kiswahili for casual conversions and translating simple information (e.g. numbers or animal types); however, to aid in the execution of the survey, my field assistants often charged with asking the majority of survey questions in Kiswahili. A brief meeting was held after completing each survey to validate that all translations were transcribed accurately. The questions explored the following types of information (See Appendix E for household surveys):

- Socio-economic and demographic data (age, gender, education level, number of years of residency, and number of children)
- Land-use and livelihood data (type of crops, animals, garden plants, dependency on the forest, non-timber forest products (NTFPs), household assets, mode of transportation, and distance to market)
- Perceptions regarding institutions, resource management, resource scarcity, and environmental awareness

The next section explains how the field data were organized and explored after returning from the field.

Stage 2: Data Set Variables and Statistical Methods

Independent Variables

This section provides the specific questions and descriptive statistical methods used in exploring the independent variables. The categories are guided by the CPR and CAPE literatures and more specifically Vadjunec's (2010) analytical framework (see also Ostrom 1990; Gibson, McKean, and Ostrom 2000). The village means are compared in order to explore differences in household demographics, land-use, livelihood, forest-use

and perception of institutional dimensions. The household survey cross-sectional data set consists of the following categories: household demographics, land-use, forest-use, and institutional dimensions.

Demographic Variables

The first category consists of basic household demographic data such as total number of residents, total number of females and males, and length of residency. In addition, these data were included in the statistical analysis (i.e. correlations) to explore trends in demographic attributes (e.g. family size and number of males per household) with land-use patterns such as amount of crop production and animal husbandry.

Land-Use Variables

One of the main intentions of this study is to explore the relationship between land-use types and the perception of local institutions for using forest resources. Consequently, extensive land-use data were collected during the household surveys. Variables include property size (acres), type and quantity of crop production, and type and quantity of domesticated animals. Land-use patterns were gleaned to better understand how socio-economic and demographic factors affected land-use decision within villages surrounding the forest. The results chapter will discuss significant correlations regarding the relationship between household demographics, land-use, livelihood, and forest-use patterns.

Livelihood Variables

Livelihood variables were collected with the intentions of creating a livelihood index for each household surveyed. The livelihood index measures the level of financial well-being of the household. Income levels for each household are difficult to acquire due to the high levels informal economic transactions within the communities. Therefore, the livelihood index was used to represent the income level of each household (Lindenberg 2002). Replicating from Vadjunec (2010), household assets and housing type were identified as the best indicators of livelihood in the region. The index was created by assigning points for certain types of significant household assets: TV, icebox, sofa, table, stove, electric, motorbike, car, and type of house structure: roof type, house type, fence, water source type. From these 12 variables, a livelihood index was created to measure household wealth and economic well-being.

Forest-Use Variables

The variables for analyzing local forest-use include frequency of collecting medicinal forest plants, domesticating forest plants, collecting deadwood, and purchasing deadwood from the market. Following the framework presented in Chapter 2, a measure of household forest saliency was designed. The saliency index measures the level of forest extraction (i.e. forest dependency) for each household surveyed. Plant-use and deadwood collection were identified as the ideal measurement of forest dependency because they account for the most common types of forest extraction. The ten most commonly used plants by local residents were identified during key-informant interviews and household surveys. Deadwood collection was characterized by frequency of

collection (i.e. daily, weekly, or monthly). Medicinal plant collection was measured by frequency of collection in the past year. Overall, the variables used represent the most common type of human use in the Kaimosi Forest. Therefore, the indicators used in this index provide a base measurement of forest saliency at the household level.

Role and Perception of Local Institutions

The household surveys contained a section with questions that acquired information regarding the individual's knowledge and experience with local institutions (i.e. the specific rules for using the Kaimosi Forest resources). Participants were asked whether they knew the rule, if they felt it was being properly monitored, and if they had heard of the rule being broken. In addition, participants were asked their range of agreement with each rule (see Appendix E for survey). This approach was useful for understanding the local perception and impacts of the forest-use rules currently operating within the Kaimosi Forest.

The second group of institutional variables consisted of the selected attributes identified as significant to successful CPRs (Ostrom 1990; Gibson, McKean, and Ostrom 2000; Vadjunec 2010). Participants were asked if they had a clear understanding of the forest boundaries, if they had issues with outsiders invading the boundaries, if they thought the rules were being monitored, if there was a defined membership for using the Kaimosi Forest, if they had any involvement in the rule making process, and the level of unity they felt existed within the their community. The data obtained from these questions allowed the analysis to provide insight regarding the role of various institutional dimensions within both communities surrounding the Kaimosi Forest.

Statistical Methods

The quantitative household data were explored with statistical techniques in order to determine significant similarities and differences in two villages (i.e. Village A and B) surrounding the Kaimosi Forest. The comparative analysis is based on Village A undergoing high levels and Village B undergoing low levels of deforestation and degradation. Each question in the household survey represented an independent variable. Accordingly, a codebook was created to define the relationship between the question and abbreviated variable name used in Microsoft Excel. The household survey data were then organized into a cross-sectional data set using Microsoft Excel. Lastly, the data set was transferred to the program SPSS in order to calculate the statistics.

Table 2. Summary Statistics for Analyzing the Household Survey Data (n=68)

Questions	Methodologies	Intentions
2, 3 & 3b	Two-means sample t-test of household survey data	Explored differences and similarities between two villages for all household variables
1, 3 & 3b	Pearson's correlation coefficient of household survey data	Measured strength of the linear relationship between household variables

The first step was analyzing histograms and normal Q-Q plots to visually explore the distribution, variance, and normality of each variable. Next, the mean and standard deviation for all the household variables were calculated for Village A (n= 34) and Village B (n =34). An independent samples t-test was used to determine which variables had a significant difference in equality at the 90% confidence level (Table 2). These calculations focused on the household-level to determined significant differences in village means. The next statistic calculated was the Pearson's product-moment correlations coefficient, which measured the direction and strength of the linear

relationship between two variables (Table 2). For this calculation, both village samples were combined to explore the relationships between variables for the entire population surveyed.

Using both the independent samples t-test and the Person's correlation allowed the analysis to show significant (and non-significant) similarities and differences between the two villages in regards to household demographics, land-use, livelihood, forest-use, and the perception of the institutional dimensions. Variables that had a non-significant p-value also added to the results by showing similarities between villages.

Quantitative and Qualitative Synthesis

Qualitative data collected from participant-observation activities, key-informant interviews, household surveys, and field notes is used to further interpret and contextualize the quantitative results. The intentions of Chapter 4 are to first present and explain the statistical results and then triangulate the results with the supplementary qualitative findings.

Conclusion

This chapter has described the data collection, dataset organization, and statistical methodologies employed in this study. A mixed methods approach was used to gain a comprehensive understanding of the role of institutions on deforestation and degradation in the two selected villages surrounding the Kaimosi Forest. The methodologies were designed to collect data that corresponded with both CPR and CAPE perspectives. These perspectives guide the quantitative analysis of differences in household demographics,

land-use, livelihood, forest-use, and perception of institutional dimensions. The qualitative discussion will help interpret the quantitative results.

CHAPTER IV

RESULTS AND DISCUSSION

Introduction

This chapter draws from quantitative and qualitative data to explore the statistical results discovered in the household dataset as well as provide a discussion of the results. The first section explores differences in demographics, land-use, livelihood, and forest-use in the two selected villages surrounding the Kaimosi Forest. Authorities perceive village A as undergoing higher rates of deforestation and degradation compared with Village B. The second section explores the role and perception of local institutions operating in the two villages surrounding the Kaimosi Forest. The institutions (i.e. forest-use rules) for using the Kaimosi Forest are officially implemented, monitored, and enforced by both the Quaker Mission Church (QMC) and the Kenyan Forest Service (KFS). This section interprets the institutional dimensions of this CPR to better understand the factors causing the high levels of deforestation and degradation in Village A. The discussion will expand on the main results and discuss how this CPR relates to the common property literature presented in Chapter 2.

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Section 1: Household Demography, Land-Use, Livelihood, and Forest-Use Characteristics

Village Comparison of Household Demographic Averages

Table 3. Demographic Summary Statistics from Household (HH) Surveys: Two Independent Samples t-test: Mean and *(S.D.)*

HH Demographic Variables	VILLAGE A (n=34) High Deforestation and Degradation	VILLAGE B (n=34) Low Deforestation and Degradation	Mean Total (n=68)
Total Residents per HH	5.71 *(2.79)*	6.68 *(3.08)*	6.20 *(2.95)*
Total Males per HH*	2.65 *(1.51)*	3.62 *(2.23)*	3.14 *(1.87)*
Total Females per HH	3.06 *(1.89)*	3.06 *(1.79)*	3.06 *(1.84)*
Percent Male living in HH	0.46 *(0.22)*	0.54 *(0.17)*	0.50 *(0.20)*

Statistically significant at *0.05 level, **0.10 level

Household demographic data is included in this analysis to provide a basic understanding of how demographic differences influence village-level patterns in land-use, livelihood, and forest-use (Table 3). The data reveals that the total amount of males living within the household is significantly higher in Village B (3.62) than Village A (2.65, p = .040). Although not significant, Village B has on average one additional resident per household (6.68) than Village A (5.71). The next subsection presents the household averages regarding land-use and livelihoods in the two villages (Table 4).

Village Comparison of Household Land-Use and Livelihood Averages

Table 4. Land-Use and Livelihood Summary Statistics from Household (HH) Surveys: Two Independent Samples t-test: Mean and *(S.D.)*

HH Land-Use and Livelihood Variables	VILLAGE A (n=34) High Deforestation and Degradation	VILLAGE B (n=34) Low Deforestation and Degradation	Mean Total (n=68)
HH property size (acres)**	1.19 *(0.93)*	1.69 *(1.37)*	1.44 *(1.15)*
HH crop size (acres)	1.05 *(0.91)*	1.48 *(1.27)*	1.26 *(1.09)*
HH agro-forest size (acres)	0.06 *(0.13)*	0.12 *(0.19)*	0.09 *(0.16)*
Crops and Animals			
Total HH corn production (kgs)*	70.24 *(80.66)*	136.76 *(158.36)*	102.20 *(119.51)*
Total HH bean production (kgs)	18.83 *(31.32)*	24.58 *(23.90)*	21.75 *(27.61)*
Percent of HHs that own chickens	0.62 *(0.47)*	0.77 *(0.29)*	0.69 *(0.38)*
Average number of chickens per HH	5.70 *(6.82)*	5.79 *(7.08)*	5.75 *(6.95)*
Percent of HHs that own cows	0.67 *(0.49)*	0.91 *(0.43)*	0.79 *(0.46)*
Average number of cows per HH	1.29 *(1.40)*	1.38 *(1.18)*	1.33 *(1.29)*
Livelihood			
Livelihood Index (1-19)*	7.53 *(1.62)*	8.97 *(1.61)*	8.25 *(1.62)*

Statistically significant at *0.05 level, **0.10 level

The results reveal several significant differences between villages regarding household averages for land-use characteristics and livelihood (Table 4). Results show a significantly larger average property size for residents in Village B (1.69 acres), who have less perceived deforestation and degradation, compared with Village A (1.19 acres, $p = .090$). [1] Moreover, there is a significantly larger average amount of household corn production in Village B (136.76 kgs) compared with Village A (70.24 kgs, $p = .040$). The

1. In this study acres are used since it is the most commonly used local unit of measurement regarding property size.

results also indicate that household livelihood is significantly higher in Village B (8.97) than Village A (7.53, p =.000).

Thus, the results reveal that Village B households have on average significantly more access to land, higher corn production, and a higher livelihood. Key-informants and residents suggested several reasons for the differences between the two villages. According to a key-informant, a high-ranking member of Village B is a relative of a high-ranking member of the QMC. Consequently, Village B is the only village (out of the seven villages surrounding the forest) that receives piped water from the Kaimosi Forest. Residents from Village A explained that the piped water is why Village B is able to have more productive crops. Another reason, Village A residents suggested is that Village A's geographic location on top of a large hill allows the wind to more easily damage their corn fields. Residents in Village A regularly talked about the significant damage caused by the wind. As one resident explained "people spend a lot of time and effort planting the cornfields and then lose their entire crop overnight" (Anonymous Interview 2011).

Although not significant, in general, a higher percentage of residents have more cows and chickens in Village B (83.80%) than Village A (64.30%). Cows and chickens are the two most common domesticated animals in the region with both villages raising livestock. A small amount (<10) of households have other animals such as goats, ducks, and donkeys.

The vast majority of household property in both villages consists of agricultural fields. Accordingly, although not significantly different between villages, households in both villages have on average a very small amount of agro-forest on their homestead with (0.06 acres) in Village A and (0.10 acres) in Village B. Most agro-forest consists of a

small amount (< 20) of blue gum trees (*eucalyptus globulus)*. Residents explained that blue gum trees are fast growing and therefore a good source of fuel for cooking. Other residents stated that they plant blue gum trees to sell to the Kenyan Government for use as electric poles.

The results show that Village B has a significantly higher average number of males per household (Table 3) and a higher average property size (Table 4). Since Village A averages a third of an acre per household resident, the results indicate that Village A households may be more likely to place a higher amount of stress on their land. Consequently, Village A residents often stated that the access to fertile land is the most pressing issue in the area. As one household interviewee commented "there is an issue with quality and quantity and the need for fertilizer makes the cost of crop production much higher" (Anonymous Interview 2011). Another head of household explained how in the past they could allow certain areas of their land to lie fallow, but it is no longer possible due to the increase in the local population. The greater access to land allows Village B households to have significantly higher crop yields and higher livelihoods. The next sub-section presents the results regarding the difference in household forest-use averages between villages.

Village Comparison of Household Forest-Use Averages

Table 5. 10 Most Common Plants Collected from the Kaimosi Forest

Scientific Name	Common Name	Use
Harungana madagascariensis	Mulondomusala	Medicinal
Ficus lutea	Alukhava	Medicinal
Croton macrostachyus	Musutsu	Medicinal
Unidentified	Shikhutu	Medicinal
Zanthoxyllum gillettii	Shikhuma	Medicinal
Triepisium madagascariensis	Tsimbalakaya	Edible
Synsepalum cerasiferum	Tsikhulumuru	Edible
Unidentified	Saga	Edible
Turraua holstii	Shirietso	Edible
Basella alba	Indelema	Edible

(Maundu, Ngugi, and Kabuye 1999)

During the household surveys, residents identified the 10 most commonly collected plants in the Kaimosi Forest (Table 5). This data helps provide an understanding of how and why locals utilize forest plants as well as aids in the creation of the saliency index (Table 8). The saliency index measures the level of forest dependency on forest resources. Since hunting and cutting trees are never permitted, the best measurement is the frequency of forest plant collection.

Over 40 plants were identified during the household surveys; however, most residents said it was rare for locals to collect plants other than the ten primary plants identified above (Table 5). For instance, a medicine woman in Village A identified numerous medicinal plants that can be found in the Kaimosi Forest, but were only used for rare occasions (e.g. uncommon illness or extreme drought).

Table 6. Forest-Use Summary Statistics from Household (HH) Surveys: Two Independent Samples t-test: Mean and *(S.D.)*

HH Forest-Use Variables	VILLAGE A (n=34) High Deforestation and Degradation	VILLAGE B (n=34) Low Deforestation and Degradation	Mean Total (n=68)
Percent of HHs that collect deadwood from the forest**	0.65 *(0.49)*	0.44 *(0.50)*	0.54 *(0.49)*
Percent of HHs that purchase deadwood from the forest**	0.18 *(0.39)*	0.38 *(0.49)*	0.29 *(0.44)*
HH average number of 10 most common forest plants collected	5.35/10 *(0.16)*	4.23/10 *(0.18)*	4.79 *(0.17)*

Statistically significant at *0.05 level, **0.10 level

The results reveal differences between villages regarding household forest-use and plant collection (Table 6). A significantly higher percentage of households collect deadwood from the forest in Village A (64.71%) compared with Village B (44.12%, p = .029). Consequently, a significantly higher percentage of households in Village B (38.24%) purchase deadwood from the local market compared with Village A (17.65%, p =.031). Common species of deadwood include Elgon Teak *(Olea capensis)*, Red Stinkwood *(Prunus africanum)*, White Stinkwood *(Celtis africana)*, African Satinwood *(Zanthoxylum gilletti),* and White Mahogany *(Khaya anthotheca)*. These results show that deadwood is a vital resource in the region regardless of whether it is collected or purchased. When residents were asked what is the best thing about the Kaimosi Forest (see Appendix E for household survey), a common response was that it provided deadwood. As one local explained "The wind can be bad because it destroys our cornfields, but we also like it because it knocks down a lot of branches. Without the wood from the forest, I would not be able to cook for my family" (Anonymous Interview 2011). Furthermore, residents explained that deadwood is increasingly over-harvested.

Table 7. Household (HH) Correlations of Livelihood, Forest Saliency, and Land-Use Characteristics: Pearson's Correlation Coefficient (n=68)

	Livelihood Index	Forest Saliency Index	HH Total Property Size (acres)	Total Residents per HH	Corn Production per HH	Num. of Cows per HH
Livelihood Index						
Forest Saliency Index	-.077					
HH Total Property Size (acres)	.097	-.257*				
Total Residents per HH	.094	.180	-.010			
Crop Production per HH	.277*	-.263**	.524**	.120		
Num. of Cows per HH	.402*	.251	.117	.398*	.163	
Num. of Chickens per HH	.281*	-.153	-.027	-.043	.049	.048

Statistically significant at the *0.05 level, **0.10 level

Pearson's correlation tests the relationships between the household land-use, forest-use, and livelihood variables. The results show that residents with a higher livelihood have significantly higher crop production (.263, p= .030), number of cows (.402, p= .001), and number of chickens (.281, p=.020) per household (Table 7). These positive correlations are likely because within these two communities, higher crop production and animal husbandry significantly increase the livelihood of the residents. For instance, heads of households with multiple cows stated that they are able to sell milk to the surrounding households who do not have cows. One resident explained that the selling price is very low but it still helps support them financially, because they can sell it every day. Results reveal that households with more residents tend to have more cows per household (.398, p= .001) (Table 7). This shows that households with higher livelihoods and number of residents have the financial ability to invest in more crop production and animal husbandry.

Households with higher forest saliency have a significantly lower property size (-2.57, p= .040) and crop production (-.263, p= 0.28) (Table 7). Results indicate that having greater access to land and higher crop production allows the households to not be as dependent on forest resources. Several residents stated that collecting plants and deadwood is not easy due to the over-use. Therefore, residents prefer to buy medicinal plants (or similar medicines) and deadwood from the market. The correlation shows that households that have higher crop production and livelihoods are more likely to choose to purchase forest resources from the market. Accordingly, although not significant, results show that households with higher livelihoods are on average less dependent on forest resources (Table 7).

Overall the results reveal the household-level differences between villages in regards to land-use, forest-use, and livelihood. Results reveal that residents with higher livelihoods are more likely to have higher crop production and more cows and chickens per household (Table 7). Furthermore, residents with higher forest saliency are more likely to have a smaller property size and lower crop production (Table 7). The following section discusses the CPR variables regarding the institutions (i.e. forest-use rules) established by the QMC for using the Kaimosi Forest.

Section 2: CPR Variables: Forest-Use Rules and Institutional Characteristics

Next, the statistical and qualitative results from the household surveys concerning the institutional dimensions operating in the Kaimosi Forest are explored. All local residents are allowed to collect edible and medicinal plants and deadwood from the forest while abiding by the local institutions (i.e. forest-use rules). The QMC controls the Kaimosi Forest land tenure; however, the Kenyan Forest Act of 2005 gives the KFS full authority over the management and use of the forest. Regardless of this fact, KFS officials do not often monitor or enforce these rules; rather the QMC hires local forest guards to patrol inside the Kaimosi Forest boundaries. Therefore, the forest-use rules are implemented by the QMC (see Table 8). The QMC is also the main authority that is in charge of monitoring, enforcing, and punishing locals who commit rule infractions. The next subsection presents the differences in household averages between the two villages regarding local knowledge and perception of the forest-use rules (table 8). Furthermore, the differences between villages regarding the CPR institutions operating within the two villages are explored (see Appendix E for household surveys) (Table 9).

Village Comparison of Household Knowledge and Perception of Forest-Use Rules

Table 8. Forest-Use Rules: Summary Statistics from Household (HH) Surveys: Two Independent Samples t-test: Mean

6 Rules for Using the Kaimosi Forest	VILLAGEA(n=34) High Deforestation and Degradation	VILLAGE B (n=34) Low Deforestation and Degradation	Mean Total (n=68)
(1) Collection of all plants and deadwood is allowed.			
Percent HHs who knew this rule:	0.85	0.82	0.84
Level of HH agreement with rule (1-4):	3.72	3.72	3.72
(2) Tree bark removal is prohibited.			
Percent HHs who knew this rule**:	0.82	0.91	0.87
Level of HH agreement with rule (1-4):	3.89	3.84	3.86
Percent HHs heard or seen rule broken:	0.54	0.69	0.62
Percent HHs perceive rule as being monitored*:	0.60	0.84	0.74
(3) Permit required for tree cutting.			
Percent HHs who knew this rule:	0.97	0.97	0.97
Level of HH agreement with rule (1-4):	3.78	3.90	3.84
Percent HHs heard or seen rule broken**:	0.97	0.85	0.91
Percent HHs perceive rule as being monitored*:	0.87	1.00	0.94
(4) Absolutely no hunting in forest.			
Percent HHs who knew this rule:	0.85	0.82	0.83
Level of HH agreement with rule (1-4):	3.89	3.69	3.78
Percent HHs heard or seen rule broken:	0.65	0.56	0.60
Percent HHs perceive rule as being monitored**:	0.76	0.55	0.63
(5) No charcoal burning in forest.			
Percent HHs who knew this rule:	0.94	0.97	0.95
Level of HH agreement with rule (1-4)**:	3.76	4.00	3.88
Percent HHs heard or seen rule broken:	0.78	0.64	0.71
Percent HHs perceive rule as being monitored:	0.90	0.85	0.88
(6) No mining in forest.			
Percent HHs who knew this rule:	0.68	0.59	0.63
Level of HH agreement with rule (1-4)**:	3.50	4.00	3.73
Percent HHs heard or seen rule broken*:	0.50	0.21	0.34
Percent HHs perceive rule as being monitored **:	0.81	0.56	0.67

Statistically significant at *0.05 level, **0.10 level

(1) Disagree Strongly (2) Disagree Somewhat (3) Agree in General (4) Agree Strongly

Knowledge of the Rules

Knowledge of the rules is vital to the success of a CPR because it ensures that locals have a clear understanding of how they are allowed to use forest resources (Gibson, McKean, and Ostrom 2000). Results reveal differences between forest-use rules across villages (Table 8). Rule 2, prohibiting tree bark removal, is the only rule with a

statistically significant difference between village means (Village A: 82.35%, Village B: 91.18%, p =.032). Although there is not a significant difference between villages regarding the other rules prohibiting (rule 2) tree bark removal, (rule 3) cutting trees, (rule 4) hunting, (rule 5) charcoal burning, and (rule 6) mining, the results indicate that the majority of residents from both villages are aware of the rules (> 60%). However, a small percent of residents are not aware of all the rules for using the forest. In some instances, the residents were hearing about the rules for the first time during the household surveys. During the key-informant interviews it became very clear that there are issues with the rules. For instance, Chiefs, KFS officials, and the QMC all gave contradicting definitions of the rules. Some even responded that locals are not allowed to use forest resources or to enter the forest boundaries.

Level of Agreement with the Rules

In general, residents must agree with the rules in order for commons resource management to be successful (Ostrom 1990). The results show that the level of agreement regarding rule 5, no charcoal burning in the forest, is significantly higher in Village B (4.00) "agree strongly" compared with Village A (3.76, p = .104). The level of agreement is also significantly higher for Rule 6, banning mining in the forest in Village B (4.00) "agree strongly" compared with Village A (3.50, p = .060). The results regarding level of agreement with each rule indicates that the majority of households "agree in general" with the rules (i.e. average of all responses were higher than 3) (see Table 8). Furthermore, residents from both villages did not express a strong opinion about disagreeing with any of the rules.

Rule Infractions

To successfully manage CPR resources, residents, in general, must perceive that their fellow community members are also following the rules, in order to avoid a free-rider scenario (Ostrom 1990). In addition, a high level of rule infractions indicates issues with the rules in relation to successful commons natural resource management. Asking questions about rule infractions is a sensitive subject for residents due to the often severe punishment for rule infractions. Residents stated that punishment for less severe rule infractions, (rule 3) such as removing bark from a tree, would usually be a warning from the forest guards. They explained that it is the guard's decision whether or not to turn the person into the police, where punishment can vary from fines to prison time. A key-informant stated that being caught cutting an indigenous tree in the Kaimosi Forest is punishable with up to three years in prison. Households were asked if they had seen or heard of the rule being broken within the last year. Results show that rule infractions are a common occurrence in both villages with the majority of households reporting rule infractions (>50%) (Table 8). A significantly higher percent of residents have heard of Rule 3, cutting trees without a permit, being broken in Village A (96.88%) compared with Village B (84.85%, $p=0.97$). Cutting trees without a permit is also the most common rule infraction ($\mu=90.76\%$). Furthermore, a significantly higher number of residents have heard Rule 6, no mining in the forest, being broken in Village A (50.0%) compared with Village B (21.43%, $p = .002$).

Several residents from both villages mentioned that some residents could "pay off" forest guards for rule infractions. The only statistical evidence of this was a significant positive correlation between livelihood and perceived fairness of rule

enforcement (r = .281, p = .024). As one resident cleverly stated, “around here you are guilty until proven rich” (Anonymous Interview 2011). Another resident explained that they have seen people arrested for cutting trees, and then seen them walking around the village the next day.

Monitoring of the Rules

Another important attribute regarding the rules is that the residents perceive them as being monitored (Table 8). Rule 2 prohibiting tree bark removal is perceived as being monitored significantly more in Village B (84.38 %) than Village A (60.00%, p= .039). The results show a similar pattern with Rule 3, permit required for cutting trees, where a significantly higher amount of resident in Village B (100%) believe the rule is monitored compared with (87.10%, p= .033) in Village A. Thus, the results reveal that residents from Village A perceive the rules regarding the trees (i.e. bark removal and cutting) to be less monitored than Village B. On the contrary, a significantly higher percent of residents perceive Rule 4, banning hunting in the forest, as being monitored in Village A (76.00%) compared with Village B (54.55%, p= .095). Furthermore, the results reveal that a significantly higher percent of residents perceive Rule 6, banning mining in the forest, as being monitored in Village A (80.95%) compared with Village B (55.56%, p= .066).

Most households know that the QMC hires guards to watch over the forest; however, residents also feel that the guards do not monitor each rule consistently. Residents explained that the reason Rule 3 (permit for cutting trees) is perceived as being more strictly monitored than Rule 4 (no hunting in the forest) is because the QMC received no financial gain for protecting the animals, yet they have a high financial

investment in protecting the trees because of their potential monetary value. That is, locals believe that the QMC is cutting and selling the trees and therefore instruct the guards to strictly monitor the trees to prevent locals from cutting them.

A large percentage of residents repeated that hunting is allowed due to the lack of monitoring. The only mammals that still live in the Kaimosi Forest are the black and white colobus monkeys *(colobus guereza)* and the red-tailed monkeys (*Cercopithecus ascanius)*. Residents perceive monkeys to be a nuisance because they eat corn from the fields that surround the forest. A key-informant mentioned that the KFS recently caught and transported several monkeys to a larger area of the Kakamega Forest due to the lack of monitoring and thus high levels of illegal hunting. Next, the results concerning the institutional dimensions operating in the Kaimosi Forest are presented.

Village Comparison of Household Averages Regarding the CPR Institutions

The variables regarding the CPR institutions include *level of agreement with rule enforcement, adding forest-use rules, participation in rule making, level of perception with rules in relation to forest conservation, clearly defined forest boundary, membership requirements, invasion issues*, and *shared vision in conserving the environment* (Table 9). Each variable represents an institutional characteristic associated with successful common property regimes that enable a sustainable people and forests relationship (McKean 2000; Vadjunec 2010). These variables are analyzed to better understand complex people and forests dynamics and provide recommendations for lowering the levels of deforestation and degradation in the Kaimosi Forest.

Table 9. CPR Institutions: Summary Statistics from Household (HH) Surveys: Two Independent Samples t-test: Mean and *(S.D.)*

Institutional Characteristics	VILLAGE A (n=34) High Deforestation and Degradation	VILLAGE B (n=34) Low Deforestation and Degradation	Mean Total (n=68)
Overall HH agreement with how the rules are enforced (1-4):	2.40 *(1.33)*	2.85 (1.37)	2.64 *(1.35)*
HH belief that new rules should be added (1-4):*	2.15 *(1.09)*	1.37 *(1.00)*	1.77 *(1.05)*
Percent HH participation in rule making process:	0.18 *(0.39)*	0.12 *(0.33)*	0.15 *(0.36)*
Percent of HHs that perceive forest-use rules are conserving the forest:*	0.48 *(0.51)*	0.84 *(0.37)*	0.67 *(0.44)*
Percent HHs who believe there is a clearly defined forest boundary:	0.88 *(0.33)*	0.91 *(0.29)*	0.90 *(0.31)*
Percent HHs who believe there are membership requirements to use forest:*	0.00 *(0.00)*	0.12 *(0.33)*	0.06 *(0.17)*
Percent HHs who have had issues with HH property invasion within the last year:	0.88 *(0.33)*	0.94 *(0.24)*	0.91 *(0.29)*
Percent of HH Invasion from: People	0.72 *(0.50)*	0.73 *(0.50)*	0.73 *(0.50)*
Animals	0.39 *(0.39)*	0.53 *(0.41)*	0.46 *(0.40)*
Both	0.24 *(0.43)*	0.32 *(0.47)*	0.28 *(0.45)*
Belief that village has a shared vision in conserving the environment (1-4):	3.24 *(1.12)*	2.91 *(1.35)*	3.07 *(1.24)*
Saliency Index (1-13):*	7.26 *(4.71)*	5.18 *(2.61)*	6.22 *(3.71)*

(1) Disagree Strongly (2) Disagree Somewhat (3) Agree in General (4) Agree Strongly
Statistically significant at *0.05 level, **0.10 level

Level of Agreement with Rule Enforcement

A common characteristic associated with successful CPRs is that residents agree with how the rules are enforced (Ostrom 1990). Although not significant, results show that residents in Village B (2.85) "agree in general" with the enforcement of the rules slightly more so than Village A (2.40) (Table 9). Although the results indicate that the average in both villages (μ=2.63) was "agree in general," several residents told stories of

how the QMC guards have mistreated or threatened them. Furthermore, the residents commonly stated that the guards are under-paid and have a reputation for accepting bribery for rule infractions. Another issue stressed during the household surveys is that residents who want to break the rules can easily do so by predicting the movement of the forest guards. That is, the residents can determine when the guards are off-duty or patrolling another area of the forest. Several Village A residents explained that the biggest disagreement they have with rule enforcement is how Village B residents could pay-off forest guards for rule infractions.

Adding Forest-Use Rules

The variable regarding adding forest-use rules sought to determine if residents felt there was a significant forest-use rule that should be added. Results indicate that residents in Village A (2.15) have a significantly higher level of agreement that new rules should be added compared with Village B (1.37, $p = .004$) (Table 9). However, the overall average between villages "disagree somewhat" that new rules should be added ($\mu=1.77$). This shows that although there is a significantly different range of opinions present, in general, residents do not believe that adding new rules is necessarily the solution for reducing deforestation and degradation.

Participation in Rule Making

Local input is recommended to ensure locals agree with the rules and have a clear role in the creation of the rules. Although not significant, a slightly higher percent of residents in Village A (18.34%) feel they actually participated in the rule making process compared with Village B (12.56%) (Table 9). In fact, the majority of residents from both villages have never heard of local residents being included in the rule making process

(μ=14.93%). Furthermore, none of the key-informants have heard of resident input being considered when creating the forest-use rules.

Level of Perception with Rules in Relation to Forest Conservation

A characteristic of successful CPRs is that locals perceive the rules as conserving forest resources. A significantly higher average of residents believe the current forest-use rules are conserving the forest in Village B (84.38%) than Village A (48.27%, p= .002) (Table 9). A common response by Village A residents was that it is not the rules that are causing the high levels of deforestation, but rather the QMC leadership. Residents stressed that the KFS should not allow the QMC to enforce and monitor their own forest-use rules with the lack of supervision. A resident explained that the recent clearing of forested land in the Kaimosi Forest for cornfields is a perfect example of how freely the QMC operates. A key-informant explained that a high-ranking government official is friends with QMC officials and therefore instructs the KFS to allow the QMC to cut indigenous trees in the Kaimosi Forest. A household interviewee stated, "the KFS officials identify first as Quakers and secondly as forest guards, and that was why they allow the QMC to operate without KFS supervision" (Anonymous Interview, 2011). Throughout the fieldwork, it became clear that the conflict between locals and the QMC was exasperating environmental issues; when the word "deforestation" was mentioned, locals always blamed the QMC leadership of being corrupt before ever mentioning the forest-use rules.

For instance, the majority of residents took time to explain the extensive amount of deforestation that they have seen in their lifetime. One resident explained "when you were in the forest several decades ago it took a long time for the rain to reach the ground,

now there are so few trees all the rain quickly falls down" (Anonymous Interview 2011). This response highlights the significant canopy loss that is occurring throughout the forest. Others residents believe that the QMC is intentionally cutting trees selectively for timber harvest throughout the entire forest. They believe this gives the appearance from outside the forest boundaries that the forest cover is still intact, which explains why the canopy has evenly spread openings throughout the entire forest.

Clearly Defined Forest Boundary

Although not significant, a slightly higher percent of residents in Village B (91.83%) believe that there is a clearly defined forest boundary compared with Village A (88.26%) (Table 9). Overall, the results indicate that the majority of residents from both villages feel that the forest boundary is clearly defined (μ=89.71%). Reflective posts surround the entire Kaimosi Forest boundary and therefore demarcated boundaries are not an issue in either village. Residents explained that the church primarily placed new markers in response to recent encroachment by residents living along the forest perimeter. Although they both acknowledge encroachment to be a growing issue, both villages believe there is a clear forest boundary.

Membership Requirements

The attributes for maintaining a successful CPR include having a defined membership for using forest resources. Although not significant, in general more residents in Village B (12.23%) believe there is a formal membership requirement for using the forest compared with Village A (0.00%). According to the key-informant interviews, the QMC does not impose any formal membership requirements for using the Kaimosi Forest. Accordingly, very few residents from either village believe that there are

formal membership requirements (μ=6.06%). However, throughout the interview process, informal membership rules emerged from discussions regarding deadwood and medicinal plant collection. For instance, several interviewees discussed how they would occasionally question people they did not recognize within the forest boundaries. Residents do not perceive the lack of membership requirements to be a reason for the high levels of deforestation and degradation. One resident explained that only locals who live within walking distance use the Kaimosi Forest. Several residents suggested that there are too many people that are allowed to use the forest. They did not think establishing a membership requirement would help, but rather suggested banning all locals from using the forest.

Invasion Issues

Although not significant, Village B (52.94%) experiences higher levels of household invasion with animals compared with Village A (32.39 %). Red-tailed and black and white colobus monkeys are a major issue for residents during the harvest season. A resident from Village B explained that since Village B has more forest cover near their village, they have a larger population of monkeys living near their households, which increases their likelihood of invasion. A similar percentage of residents from both villages have had issues with invasion by people within the last year with (72.31%) in Village A and (73.67%) in Village B. Locals explained that common invasions by people include minor events such as children stealing fruit or vegetables from their crops, or more serious crimes such as stealing cows from their home. Overall, issues with invasion are a major concern for local residents. However, residents stated that issues with household theft does not hinder the feeling of a strong community because locals

understand that serious invasion incidents such as stealing cattle are committed by people from distant villages.

Shared Vision in Conserving the Environment

A characteristic of successful CPRs is that residents have the perception that users have a shared vision in conserving the environment (Gibson, McKean, and Ostrom 2000). The perception of residents having a shared vision is important in maintaining a successful CPR. Although not significant, the results show that the majority of households in both Village A (3.24) and Village B (2.91) "agree in general" that their communities have a shared vision in conserving the environment (Table 9). Residents often responded to this question by suggesting that the severe environmental issues are not due to a lack of shared vision within the communities, but rather the QMC leadership is the one to blame for the high levels of deforestation and degradation. Another common response is that the youth do not understand the importance of environmental conservation. Most head of households feel that the older residents have a better understanding of the significance of the deforestation and degradation. Residents expressed concern regarding fellow residents who have over-planted blue gum trees near the streams without concern for neighbors downstream. Residents understand that blue gum trees consume a large amount of water, which significantly alters the water flow for neighbors downstream. Overall, results show that regardless of difference in age, there is a strong presence of community cohesion in both villages regarding the importance of conserving the environment.

Forest Saliency

A key characteristic for successful commons resources management is that users have a direct saliency on forest resources (McKean 2000). Results show that households from both villages moderately depend on the forest for resources such as deadwood collection (forest saliency $\mu = 6.22$). However, Village A residents (7.26) are significantly more salient on forest resources (plant and deadwood collection) compared with Village B (5.18, $p = .027$) (Table 9).

The following discussion gives explains the significant differences between the two villages regarding household demographics, land-use, livelihood, and forest-use. In addition, the results regarding the institutional dimensions of this CPR are compared and contrasted with relevant common property literature.

Section 3: Discussion

The first section of results regarding household demographics, land-use, livelihood, and forest-use reveals several statistically significant differences between the two villages. Village B has a significantly higher number of males per household. One possible reason for this difference is that Village A males may be more likely to leave their home to search for work in urban areas. Regardless of the reason, having more males per household helps explain why Village B residents have a significantly higher crop production, livelihood, and lower forest dependency. This relationship is seen elsewhere in the tropics since more males are available to help in crop production at the household-level (Caldas et al. 2007). The households in Village B also have a better opportunity at having a higher livelihood by having more employed male family members, which are more likely to have higher status jobs. Furthermore, residents in

Village A commonly repeated that Village B residents are able to have higher crop yields because they are the only village to receive piped water from the Kaimosi Forest.

Since residents in Village B have a higher average livelihood, there is a significantly higher percent of residents who purchase deadwood and medicines in the market rather than collecting from the forest. The significantly lower livelihood average in Village A also helps explain why Village A has a significantly higher percentage of residents who collect deadwood from the forest. An important detail is that the majority of deadwood sold in the market is collected from the Kaimosi Forest. Therefore, even though Village B may be locally undergoing less deforestation and degradation, residents are still contributing to the overall deforestation and degradation by using the deadwood collected by others from the forest.

The results reveal that this CPR has several strengths and weaknesses for maintaining a successful people and forests relationship. Drawing from the theoretical framework for creating and maintaining a successful CPR (Chapter 2), the institutional characteristics that are strong in both villages include a high level of local knowledge and agreement with the rules, resident "agree in general" with rule enforcement, have clearly defined boundary lines, and a perceived shared vision among villages in conserving the environment. The main significant positive difference between villages is that Village A residents have a significantly higher average forest saliency.

The results indicate that a positive characteristic of this CPR is a high level of local agreement with the rules. There are several possible reasons for why Village B residents have a higher average level of agreement with the rules. First, a lower average number of Village B residents who have heard of rule infractions within the last year.

Village B also has a lower forest dependency, which means on average Village B residents have low forest dependency and thus less interaction with forest guards. The higher agreement level in Village B could also indicate that the rules are better suited for residents who have more access to land. Power dynamics, revealed through the qualitative interviews, may also played a role in the differences between villages since Village B residents received piped water from the Kaimosi Forest, they were more likely to believe that the QMC leadership (and rules) are doing a better job compared with Village A residents.

A local hearing about the rules for the first time during the household surveys explains why some rules have a higher percent of people agreeing with the rule than actually knowing the rule. Residents overall agree with the rules; however, making sure locals understand the rules is the first step for allowing this CPR to be more successful. This indicates that communication of the rules is more of an issue than the actual rules themselves.

Another positive characteristic is clearly defined boundary lines. Ostrom (1990) states that locals need to have a clear understanding of the spatial boundaries of the resource (e.g. commons forest). Residents understand when they enter the forest; however, there is still an issue with locals extending their homesteads into the forest boundaries. Furthermore, community cohesion is strong in both villages. Residents commonly spoke of the high level of reciprocity that exists within the villages.

The CPR framework presented in Chapter 3 suggests that in order for a CPR to be successful (i.e. sustainable), members must have a direct saliency (i.e. dependency) on forest resources (Gibson, McKean, and Ostrom 2000). The results show a relationship

that is somewhat contrary to what the CPR literature suggests. Although both Villages use the forest to varying degrees, the village that has more forest dependency (Village A) also is known to have greater issues regarding commons management in terms of greater deforestation and degradation. One possible reason for this divergence from previous CPR case-studies is that Village B residents have more access to land. Having more access to land less means they are more likely not to be forced to over-use forest resources.

Households with greater access to land have a greater potential to grow larger crops. Since crop production significantly raises the livelihood of households, the households with the largest crop productions are also the least salient on the forest. Thus, residents in Village B have a larger average property size and a lower average forest saliency.

In addition, Village A residents having a lower average property size reduces their average household crop production and therefore forces residents to be more dependent on forest resources. Therefore, the higher saliency in Village A may explain, in part, the higher levels of deforestation and degradation. This finding has major implications to the success of this CPR. Overall, Village B residents feel that the QMC institutions are properly implemented, monitored, and enforced. Since Village B residents have more access to land and are not forced to depend as heavily on forest resources, a more successful and sustainable relationship is maintained between the locals and the QMC.

Deficient characteristics in this CPR include issues with monitoring and enforcing the rules, frequency of rules infractions, local participation in the rule making process, formal membership requirements for using the forest, and local perception that rules are

conserving the forest. In regards to the deficient characteristics, the main significant difference is that Village B residents perceive the forest-use rules to be conserving the forest and believe there are membership requirements for using the forest.

The results indicate that a major issue in effective CPR management is the negative perception of how the forest guards monitor the rules. Locals can break the forest-use rules when the guards are on the other side of the forest boundaries or off-duty (e.g. middle of the night). McKean (2000) states that rules must be designed so guards can easily monitor and enforce the rules. Therefore, a recommendation could be to hire more guards or adjust the rules to allow the guards to more easily monitor and enforce the forest-use rules. Numerous locals stated that they are regularly mistreated or threated by the forest guards. This relates with Banana and Gombya-Ssembajjew (2000) study, where they found that perceived fairness of the rules was a major component in conserving forest resources.

According to CPR theory, a low level of local knowledge regarding the rules indicates a major issue in CPR management (Ostrom 1990). This issue is connected with the lack of local participation in the rule-making process. The QMC should organize community meetings to discuss the rules and listen to the opinions of the locals to solve both of these issues. This would likely raise the resident's level of agreement with the rules. Hundreds of locals use the Kaimosi Forest on a daily basis for plant and deadwood collection. It is therefore very important for locals to have a lucid understanding of the rules and to be able to participate in the rule making process. The reason that more residents in Village B believe there are a formal membership requirements could be from

the fact that they do not commonly enter the forest boundaries and therefore assume membership is a requirement.

Local perception that rules are conserving the forest is significantly higher in Village B. This result is logical given that village B is undergoing less deforestation and degradation and therefore perceives the rules as successfully conserving the forest. On the contrary, Village A is undergoing more deforestation and degradation causing residents to believe the rules are not working. Although Village A residents significantly agree more that rules should be added compared with Village B; both villages overall disagree that new rules are the solution to lowering the levels of deforestation and degradation. This shows that the main issue is more likely the lack of communication between the QMC and locals regarding the rules.

In early 2011, locals began to voice their opinion regarding the rapid deforestation caused by the QMC. A sanctioned protest was held in the Kaimosi Forest in January 2011. The locals received permission from the government to conduct the protest; however, several locals were still arrested during the event. Following on Feb 6th, 2011, the local government organized a public community meeting (*baraza*) to discuss the deforestation. Government and KFS officials spoke to a large crowd about how the QMC was using the Kaimosi Forest. Through informal conversions with locals, most felt that the leaders who spoke did not acknowledge the issue of deforestation, but rather talked about how the important the QMC was to the local economy. Yet, locals understand that the Kaimosi Forest is an important resource and culturally sensitive area for the Tiriki people.

An estimated 3,000 locals depend on Kaimosi Forest resources for deadwood and plant collection. Furthermore, the circumcision ceremony is still seen as a necessity for tribal identity. The ceremony requires the young boys to spend one month isolated in the forest. Locals fear that they will soon not have a forested area large enough to privately conduct the ceremony. Therefore, the locals view the forest as equally important for cultural resources. As one resident stated, "when I looked at the forest it use to make me happy, but now I become sad because I know that it is suffering" (Anonymous Interview 2011) The cultural and livelihood importance of the Kaimosi Forest, along with the increasing deforestation and degradation reported by residents and key-informants, reveals that successful management of this CPR is important more so than ever for local communities.

Conclusion

The first section of this analysis compared two villages surrounding the Kaimosi Forest in terms of household demographics, land-use, livelihood, and forest-use. The comparison of the villages is based off of local authorities who claim that Village A is undergoing high levels of deforestation and degradation, while Village B is undergoing relatively lower levels. Results indicate that Village B has significantly higher number of men per household, property size, corn production, and livelihoods. A significantly higher amount of residents in Village A are more likely to collect plants and deadwood from the forest compared with Village B. Accordingly, a significantly higher amount of residents in Village B are more likely to purchase deadwood in the market.

This study reveals an interesting relationship between forest saliency and deforestation and degradation issues. Since Village B residents have on average more

access to land and higher livelihoods, they tend to be less dependent on forest resources. Since Village A residents are more dependent on forest resources, they appear to have more issues with over-using forest resources causing higher levels of deforestation and degradation. Overall, issues of poverty and differential land access may explain why Village A residents are failing to conserve forest resources.

The results show that power dynamics between individual actors plays a significant role in local perceptions regarding the efficiency of QMC forest management. Village B residents receive piped water due to a connection between the QMC leadership and Village B leadership. CPR management is more successful in Village B since, on average, they have significantly greater access to land. Regardless of the differences between villages, overall there is not a very positive relationship between the QMC and local residents. Numerous residents from both villages believe poor QMC leadership is the reason for the recent deforestation and degradation, thus showing the importance of appropriate governance when managing the commons.

Overall, results indicate that this CPR has several weak characteristics. There are significant issues regarding communicating, monitoring and enforcing the rules, local participation in the rule making process, and formal membership requirements for using the forest. These deficiencies cause a high frequency in rule infractions and a low local perception that rules are conserving the forest. Therefore, in order for this CPR to be more successful, adjustments include collaborating with locals on how rules should be better monitored and enforced, as well as establishing a formal membership requirement for using the Kaimosi Forest. This analysis shows that one village (Village B) has less interaction with the forest due to a higher average livelihood and more access to land.

Therefore, the QMC church and KFS service should also acknowledge the role of poverty and access to land when making adjustments to the management plans in order to ensure both environmental and social justice. The next chapter will summarize the intentions and main findings of this study, discuss the scope and limitations, and provide suggestions for additional research.

CHAPTER V

CONCLUSION

Common Property Regimes (CPRs) have successfully managed the collective use of natural resources for thousands of years. Within the past several centuries, CPRs have been replaced by converting natural resources into private property. This conversion was justified to reduce the over-exploitation of common property resources; however, empirical evidence shows that CPRs can create a just balance between user exploitation and natural resource conservation when local institutions (i.e. rules for using the resource) are properly established (Ostrom 1990). Drawing from common property theory and cultural and political ecology (CAPE), the intentions of this study were to analyze the role of local institutions on deforestation and degradation in the Kaimosi Forest, Western Kenya. This case study contributed to common property theory by applying a tested theoretical framework for analyzing common property regimes (Gibson, McKean, and Ostrom 2000; Vadjunec 2010) on a unique people and forests relationship. The findings of this study will help future researchers better understand how local institutions, household decision-making, and power struggles among local actors influence natural resource conservation of forests in developing counties. The Kaimosi Forest, a small forest fragment of the larger Kakamega Forest (see Figure 1), is

undergoing the highest rates of deforestation in the region (Lung and Schaab 2006; Bleher, Uster, and Bergsdorf 2006). The Quaker Mission Church (QMC), who owns and manages the Kaimosi Forest, allows approximately 3,000 locals to use the forest while abiding by the local institutions (i.e. forest-use rules). The Kaimosi Forest was therefore an ideal study area to apply Vadjunec's (2010) framework for analyzing the institutional dimensions of a common property regime (CPR) in regards to successful natural resource conservation. In addition to analyzing the role of significant attributes for successful CPRs, supplementary CAPE perspectives were included to broaden the research to include household decision-making regarding land-use and forest-use and local power struggles among individual actors. In order to incorporate these research elements, fieldwork was carried out in the summer of 2011.

The field methods included participant-observation activities, key-informant interviews (n=12), and household surveys (n=68). The sampling frame included two villages surrounding the Kaimosi Forest in order to conduct a stratified comparison. The two villages were selected based off the perception of the key-informants. The first village was perceived as undergoing the least deforestation and degradation in the area, while the second was perceived as undergoing the most. The household data set was quantitatively explored using two statistical methods: independent samples t-test and Pearson's correlations. The comparative analysis focused on differences in household demographics, land-use, livelihood, forest-use, and the role and perception of local institutions. Qualitative data gleaned from open-ended survey questions, participant-observation activities, and field notes was used to contextualize the quantitative results. Chapter 1 provided a historical overview of the area to gain an understanding of the local

people, issues with land tenure, and the cultural significant of the forest. Furthermore, Chapter 1 reviewed recent human-environment research conducted in the area to show that the Kaimosi Forest was undergoing the highest level of deforestation in the area. The selected theoretical frameworks (Chapter 2), methodologies (Chapter 3), and results (Chapter 4) sought to provide a comprehensive understanding of this people and forests relationship. The household demographic and land-use results revealed that Village B households had, on average, significantly more males per household, more access to land, higher corn production, and a higher livelihood.

In addition, the results of this study gave insight regarding the strengths and weaknesses of this CPR. Institutional characteristics that were strong characteristics included a high level of local knowledge and agreement with the rules, residents "agree in general" with rule enforcement, clearly defined boundaries lines, and a perceived shared vision among villages in conserving the environment. Deficient characteristics in this CPR included issues with monitoring and enforcing the rules and frequency with rules infractions, local participation in the rule making process, formal membership requirements for using the forest and local perception. The main differences between villages were that Village B had a significantly lower forest saliency and a significantly higher percent of residents that perceived the forest-use rules were conserving the forest.

The household level analysis showed that increased deforestation did not raise the average livelihood (since Village B had less deforestation and a higher livelihood). The results showed that since Village A residents had on average less access to land they also had more forest saliency on the forest. The higher saliency forced Village A residents to

over-use forest resources, which caused higher perceived levels of deforestation and degradation.

The qualitative data obtained during the fieldwork helped highlight the role of individual actors (i.e. QMC leadership, government officials, and KFS officials). Several actors from the QMC and KFS leadership played a role in allowing the Kaimosi Forest and surrounding villages to undergo such high levels of deforestation and degradation. Residents commonly repeated that the high levels of deforestation were caused by the QMC leadership cutting and selling the trees. Furthermore, key-informants and local residents explained that the KFS officials knew about the illegal removal of indigenous trees but intentionally allowed the QMC to operate without supervision.

The results showed that a revised management plan is needed from the QMC that incorporates the opinions and needs of the local community. Furthermore, the results indicated that the QMC has the responsibility to create more specific, organized, and sustainable institutions for using the Kaimosi Forest in collaboration with the KFS and local leaders. Furthermore, the QMC should be more aware that households with lower livelihoods indicators and property size tend to be more salient on forest resources, which may ultimately lead to a higher level of deforestation and degradation. Communication between the QMC and locals needs to be improved to ensure all residents have a lucid understanding of the forest-use rules. A possible solution could be listing the rules on signs surrounding the forest. The QMC must take in to consideration the dependency locals have on forest resources before the QMC leadership choses to deforest anymore of the remaining forest.

Scope and Limitations

The intentions of this study were to contribute to common property theory by analyzing a unique people and forests relationship in Western Kenya. The scope of this analysis was broadened to include CAPE perspectives by including household decision-making and the role of power struggles among individual actors. The sampling size represented a relatively small population (n=68) of residents living in two villages out of the total seven surrounding the Kaimosi Forest. The sampling technique was opportunist rather than completely random. Consequently, the results of this analysis possess limitations for representing the entire population living near the forest.

A possible limitation in the research design was also that the indicator for Village A undergoing higher levels of deforestation and degradation was based off the perception and expert opinion of the key-informants. However, the key informants unanimously stated that Village A was undergoing the most deforestation and degradation and Village B was undergoing the least. Furthermore, key-informants held important roles as local authorities in the region. Additionally, my experience in the field corroborated their stratum. Regardless, a biophysical and/or remote sensing analysis would have been beneficial in selecting the two sampling sites.

Another limitation was the small amount of time (ten weeks) living in the area. Ten weeks was a sufficient amount of time to conduct the proposed amount of key-informant interviews and household surveys; however, it would have been beneficial to live in the area for a longer period of time. I had originally proposed to hold a community meeting prior to beginning the household surveys. Due to lack of funding and the extremely high population density in the area, I decided to not hold the meetings within

the villages. Instead, I made a strong effort in the market area to meet people and explain my intentions as a student and human-environment researcher.

Hiring two research assistants that were trilingual college students was a major key to my success in the field. They helped explain cultural norms and traditions that prevented me from making mistakes while interacting with locals. Some examples included always shaking hands when meeting a person and yelling "hodi!" when approaching a homestead.

A major obstacle during the surveys was explaining the necessity of the required information. A common issue was explaining how land-use questions, such as the number of domesticated animals on the homestead, related to studying deforestation and degradation. Consequently, a major limitation in analyzing the data was the issue of missing data. Throughout out the surveys, I continued to become more skilled and comfortable with asking questions. However, the first several surveys had a relatively large amount of missing data. The missing data significantly altered the analysis of this research by inhibiting the originally proposed binary logic regression analysis. My research assistants had a comprehensive understanding of the research intentions and therefore became experts at articulating to the participants why we were asking such detailed questions. Overall, the surveys were the most challenging and yet rewarding task completed in the field. With these valuable lessons, experiences, and insight in mind, I am excited for the opportunity to continue my career as a "muddy boots" geographer.

Future Directions for Additional Research

Future research could consist of expanding the sample size to include more villages surrounding the forest. This would allow the study to more adequately analyze

the issues with deforestation and degradation in relation with local land-use, livelihood, and forest-use. In addition, randomizing the samples in each village would allow for a more robust comparison between villages. The Kaimosi Forest is a small fragment of the Kakamega Forest and is undergoing the highest level of deforestation in the area. Therefore, conducting a study using a similar theoretical framework on another area of the Kakamega Forest would be very beneficial for comparing the institutional dimensions with a more successful CPR. Additional research could also include a remote sensing analysis on the Kaimosi Forest in order to help researchers and local government leaders properly monitor the levels of deforestation and degradation. Furthermore, more studies should be conducted regarding the role of the Kenyan Forest Service and the Kenyan Forest Act of 2005 in relation to the deforestation occurring across the country.

REFERENCES

Agrawal, A. 2000. Small is beautiful, but is larger better? Forest-Management Institutions in the Kumaon Himalaya, India. In *People and forest: Communities, institutions, and governance*, ed. C. C. Gibson, M. A. McKean, E. Ostrom, 57-85. Cambridge: MIT Press.

Agrawal, A. and C.C. Gibson. 1999. Enchantment and disenchantment: the role of community in natural resource conservation. *World Development* 27 (4): 629-649.

Allen, J. C., and D. F. Barnes. 1985. The causes of deforestation in developing countries. *Annals of the Association of American Geographers*, 75 (2): 163-184.

Archard, F., H. D. Eva, H. Stibg, P. Mayaux, J. Gallego, T. Richards, J.P. Malingreau. 2002. Determination of deforestation rates of the world's humid tropical forests. *Science* 9: 999-1002.

Banana, A. Y., and W. Gombya-Ssembajjwe. 2000. "Successful forest management: The importance of security of tenure and rule enforcement in Ugandan Forests." In *People and forest: Communities, institutions, and governance*, ed. C. C. Gibson, M. A. McKean, E. Ostrom, 87-98. Cambridge: MIT Press.

Blackett, H. L. 1994. Forest Inventory Report No. 3. Kakamega. *Forest Department/KIFCON, Nairobi Kenya.*

Blaikie P. and H.C. Brookfield. 1987. *Land Degradation and Society*. London: Metheun.

Bleher, B., D. Uster, and T. Bergsdorf. 2006. Assessment of threat status and management effectiveness in Kakamega Forest, Kenya. *Biodiversity and Conservation* 15: 1159- 1177.

Bryant, R. L. and S. Bailey. 1997. *Third World Political Ecology*. London: Routledge.

Burger, J. and M. Gochfeld. 1998. The tragedy of the commons 30 years later. Environment: *Science and Policy for Sustainable Development* 40 (10): 4-13.

Butzer K. W. 1980. Civilizations: organisms or systems? *Am. Sci*. 68: 517-523.

Butzer, K.W. 1989. "Cultural ecology." In *Geography in America*, ed. G.L. Gaile and C. Willmott, 192-208. Columbus, Ohio: Merrill.

Caldas, M, R. Walker, E. Arima, S. Perz, S. Aldrich, C. Simmons. 2007. Theorizing land cover and land use change: the peasant economy of Amazonian deforestation. *Ann. Assoc. Am. Geogr.* 97 (1): 86-110.

CIA. 2012 (U.S. Central Intelligence Agency). The World Factbook. https://www.cia.gov/cia/publications/factbook/index.html (accessed October 14, 2012).

Clark, C. W. 1980. Restricted access to common property fishery resources: A game-theoretic analysis. In *Dynamic Optimization and Mathematical Economics*, ed. P.T. Liu, 117-32. New York: Plenum Press.

Cleaver, F. 2001. Institutional bricolage, conflict and cooperation in Usangu, Tanzania. *IDS Bulletin* 32 (4): 26-35.

Clifford, N. J., and G. Valentine. 2003. *Key methods in geography.* London: SAGE Publications

Cone, L. W. and J. F. Lipscomb. 1972. *The history of Kenya agriculture*. Nairobi: University Press of Africa.

Dawes, R.M. 1973. The commons dilemma game: An n-person mixed-motive game with a dominating strategy for defection. *ORI Research Bulletin* 13:1-12.

Dewalt, K.M. and B.R. Dewalt. 2011. *Participant-observation: A guide for fieldworkers.* 2nd edition. United Kingdom: Altamira Press.

Dietz, T., N. Dolsak, E. Ostrom, and P.S. Stern. 2002. "The drama of the commons." In *The drama of the commons.* ed. E. Ostrom, T. Dietz, N. Dolsak, P. C. Stern, S. Stovich, and E. U. Weber, 3 – 35. Washington, DC: National Academy Press.

Doolittle, W.E. 1984. Agricultural change as an incremental process. *Ann. Assoc. Am. Geogr.* 74 (1): 124-137.

Duveiller, G. P. Defourny, B. Desclee, and P. Mayaux. 2008. Deforestation in Central Africa: Estimates at regional, national and landscape levels by advanced processing of systematically-distributed Landsat extracts. *Remote Sensing of Environment* 112: 1968-1981.

Ehret, Christopher. 1998. *An African Classical Age: Eastern & Southern Africa in World History, 1000 B.C. to A.D. 400.* Oxford: James Curry.

FAO. 1998. Guidelines for the management of tropical forests. *Forestry Department, Corporate Document Repository* 135: 1-307.

FAO. 2010. Global forest resources assessment 2010, country report, Kenya. *Forestry Department*, *United Nations Food and Agricultural Organization* 107: 1-47.

FAO. 2011. "The state of forest resources- a regional analysis." In "State of the worlds forest 2011". *Forestry Department, United Nations Food and Agricultural Organization.*

Fearnside, P. M., and W. F. Laurance. 2004. Tropical Deforestation and Greenhouse-Gas Emissions. *Ecological Applications* 14 (4): 982-986.

Feeny, D. H. 1986. "Conference on common property resource management: An introduction." In *Proceedings of the conference on common property resource management, National Research Council*, 7-11. Washington, DC: National Academy Press.

Forsyth, T. 2003. *Critical political ecology*. Routledge: New York.

Geist, H. J., and E.F. Lambin. 2002. Proximate causes and underlying driving forces of tropical deforestation. *BioScience* 52 (2): 143-150.

Gibson, C.C. and T. Koontz. 1998. When "community" is not enough: Institutions and values in community-based forest management in Southern Indiana. *Human Ecology* 26 (4): 621-647.

Gibson, C. C., M. A. McKean, and E. Ostrom. 2000. *People and forests: Communities, institutions, and governance.* Cambridge: The MIT Press.

Gibson, C. C, and C. D. Becker. 2000. "A lack of institutional demand: Why a strong local community in Western Ecuador fails to protect its forest." In *People and forest: Communities, institutions, and governance*, ed. C. C. Gibson, M. A. McKean, E. Ostrom, 27-55. Cambridge: MIT Press.

Glenday, J. 2006. Carbon storage and emissions offset potential in an East African tropical rainforest. *Forest Ecology and Management* 235: 72-83.

Godwin, K. and B.W. Shepard. 1979. Forcing Squares, Triangles and Ellipses into a Circular Paradigm: The use of commons dilemma in examining the allocation of common resources. *The Western Political Quarterly* 32 (3): 265-277.

Goldewijk, K. 2001. Estimating global land use change over the past 300 years: the HYDE database. *Global Biogeochem. Cycles* 15: 417-433.

Gonzalez, R. 2001. *Zapotec science: Farming and food in the Northern Sierra of Oaxaca*. Austin: University of Texas Press.

Gould, W.T.S. 1989. Technical Education and Migration in Tiriki, Western Kenya, 1902-1987. *African Affairs* 88 (351): 253-271.

Grainger, A. 2008. Difficulties in tracking the long-term global trend in tropical forest area. *Proceedings of the National Academy of Sciences* 105 (2): 818-823.

Guthiga, P. M., 2008. Understanding local communities' perception of existing forest management regimes of a Kenyan rainforest. *International Journal of Social Forestry* 1(2): 145-166.

Hardin, G. 1968. Tragedy of the commons. *Science* 162 (3859): 1234-1248.

Hedrick, K. 2007. Our Way of Life: Identity, Landscape, and Conflict. Ph.D. dissertation, University of California, Riverside.

IFRI. 2007. Field Manual, Version 14. *International Forestry Resources and Institutions Research Program.*

Kanyoro, R. A.. 1983. *Unity in Diversity: A linguistic survey of the Abaluyia in Western Kenya.* Vienna: AfroPublications.

Kassilly, F. N., and H. M. Tsingalia. 2009. Persistence and loss of cultural Values of Tiriki Scared Groves in Hamisi District, Kenya: Implications for management. *Journal of Human Ecology* 27(2): 137-141.

Kenya. 2010. The constitution of Kenya. *National Legislative Bodies*.

Kimber, R. 1981. Collective Action and the fallacy of the liberal fallacy. *World Politics*, 33 (2): 178-196.

Kimber, R. 1983. *The tragedy of the commons reappraised*. Department of Politics, University of Keele.

Kiplagat, A. K., J. Mburu, and D. N. Mugendi. 2008. Consumption of non-timber forest products (NTFPs) in Kakamega forest, Western Kenya: accessibility, role and value to resident rural household. Paper presented at IASC Biennial International Conference, Cheltenham, England. July 14-19.

Kirsch, S. 2006. *Reverse Anthropology: Indigenous analysis of social and environmental relations in New Guinea*. Stanford, CA: Stanford University Press.

Laurier, E. 2003. "Participant observation." In *Key methods in geography*, ed. N. J. Clifford and G. Valentine, 133-148. London: SAGE Publications Ltd.

Leo, C. 1984. *Land and Class in Kenya.* Toronto: University of Toronto Press.

Lindenberg, M. 2002. Measuring Household Livelihood Security at the Family and Community Level in the Developing World. *World Development.* 30 (2): 301-318.

Livingston, E. 1987. *Making sense of Ethnomethodology.* London: Routledge and Kegan Paul.

Lloyd, W.F. 1968. "Population, Value, Poor-laws, and Rent." In *Reprints of Economic Classics*. New York: Kelly.

Lochner, K., I. Kawachi, and B. P. Kennedy. 1999. Social capital: a guide to its measurement. *Health and Place* 5: 259-270.

Longhurst, R. 2003. "Semi-structured interviews and focus groups." In *Key methods in geography*, ed. N. J. Clifford and G. Valentine, 117-132. London: SAGE Publications Ltd.

Lung, T., and G. Schaab. 2006. Assessing fragmentation and disturbance of west Kenyan rainforests by means of remotely sensed time series data and landscape metrics. *African Journal Ecology* 44: 491-506.

Millennium Ecosystem Assessment. 2005. *Ecosystems and Human Well-being: Synthesis*. Island Press, Washington, DC.

Mather, A. S., C. L. Needle, and J. Fairbairn. 1998. The human drivers of global land cover change: the case of forests. *Hydrological processes* 12: 1983-1994

Marttila, O. and P. Virtanen. 1998. *Kilimanjarolta Serengetiin. Afrikan suuri luonto*. WSOY, Porvoo.

Maundu, P.M., G.W. Ngugi, and C.H.S. Kabuye. 1999. *Traditional food plants of Kenya.* Kenya Resource Centre for Indigenous Knowledge, National Museums of Kenya.

McCay, B. 1998. *Oyster wars and the public trust: Property law, and ecology in New Jersey History.* Tucson: University of Arizona Press.

McKean, M. A. 1992. "Success on the Commons: A comparative examination of institutions for common property resource management." *Journal of Theoretical Politics* 4(3): 247-281.

_____2000. "Common property: what is it, what is it good for, and what makes it work?" In *People and forest: Communities, institutions, and governance*, ed. C. C. Gibson, M. A. McKean, E. Ostrom, 27-55. Cambridge: MIT Press.

Mitchell, N., T. Lung, and G. Schaab. 2006. "Tracing significant losses and limited gains in forest cover for the Kakamega-Nandi complex in western Kenya across 90 years by use of satellite imagery, aerial photography and maps." In *Proceedings of the ISPRS (TC7) Mid-Term Symposium ''Remote Sensing: From Pixels to Processes*'' (Eds N. Kerle and A. K. Skidmore) 8-11 May 2006, ITC Enschede, the Netherlands.

Moran, E. F., and E. Ostrom, 2005. *Seeing the Forest and the Trees*. Cambridge: MIT Press.

Muller, D., and J. Mburu. 2009. Forecasting hotspots of forest clearing in Kakamega Forest, Western Kenya. *Forest Ecology and Management* 257: 968-999.

Murdiyarso, D., M. Skutsch, M. Guariguata, M. Kanninen, C. Luttrell, P. Verweij, and O. Stella. 2008. Measuring and monitoring forest degradation for REDD: Implications for country circumstances. www.cifor.cgiar.org

National Research Council. 1986. *Proceedings of the conference on common property resource management.* National Academy Press, Washington, D.C.

Narayan, D. 1997. Voices of the poor: Poverty and social capital in Tanzania. *Environmentally and socially sustainable development studies and monograph series*. Washington: The World Bank.

Netting R. M. 1993. *Smallholders, householders: Farm, families, and the ecology of intensive, sustainable agriculture.* Stanford, CA: Stanford Univ. Press.

Neumann, R.P. 2009. Political ecology: Theorizing scale. *Progress in Human Geography* 33 (3): 398-406.

Noad, T. and A. Birnie. 1990. *Trees of Kenya*. General Printers Ltd., Nairobi.

Oakerson, R. A. 1986. A model for the analysis of common property problems. In *Proceedings of the Conference on Common Property Resource Management*, *National Research Council*, 13-30. Washington, D.C.: National Academy Press.

Oakerson, R. A. 1992. "Analyzing the commons: A framework." In *Making the commons work: Theory, practice, and policy,* ed. D. W. Bromley, 41-62. San Francisco: ICS Press.

Odingo, R.S. 1971. *The Kenya Highlands: Land use and agricultural development.* Nairobi: East African Publishing House.

Olson, M. 1965. *The logic of collective action: Public goods and the theory of groups*. Cambridge: Harvard University Press.

Ostrom, E. 1986. “Issues of definition and theory: Some conclusions and hypotheses.” In *Proceedings of the conference on common property resource management, National Research Council*, 7-11. Washington, DC: National Academy Press.

_____1990. *Governing the commons: The evolution of institutions for collective action.* Cambridge: New York: Cambridge University Press.

_____ 1998. “Self-governance of common pool resources.” In *The new palgrave dictionary of economics and law*, 424-433. New York: Stockton Press.

_____2005. *Understanding institutional diversity*. Princeton N.J.: Princeton University Press.

Ostrom, E., J. Burger, C. B. Field, R.B. Norgaard, and D. Policansky. 1999. Revisiting the commons: Local lessons, global challenges. *Science* 284: 278-282.

Ostrom, E., and H. Nagendra. 2006. “Insights on linking forests, trees, and people from the air, on the ground, and in the laboratory.” *Proceedings, National Academy of Sciences*, U.S.A. 103 (51): 19224-19231.

Painter, L. K. 1966. *The hill of vision: The story of the Quaker Movement in East Africa 1902-1965.* Kaimosi, Kenya: East Africa Yearly Meeting of Friends.

Pellikka, P., J. Ylhaisi, and B. Clark. 2004. Taita Hills and Kenya, seminar, reports and journal of a field excursion to Kenya. *Expedition reports of the Department of Geography*, *University of Helsinki* 40: 8-13.

Rangan, H., and C.A. Kull. 2009. What makes ecology ‘political’?: Rethinking ‘scale’ in political ecology. *Progress in Human Geography* 33(1): 28-45.

Rasmussen, A.M.B. 1995. A history of the Quaker movement in Africa. London: I.B. Tauris & Co Ltd.

Rawes, J. 1971. *A theory of justice.* Cambridge: Harvard University Press.

Rice, S. 2003. “Sampling in geography.” In *Key methods in geography*, ed. N. J. Clifford and G. Valentine, 223-248. London: SAGE Publications Ltd.

Robbins, P. 2004. *Political ecology.* Malden, MA: Blackwell Publishing.

Roberts, J.S. 1967. *A land full of people: Life in Kenya today*. New York: Frederick A. Praeger, Inc.

Rocheleau, D., and D. Edmunds. 1997. Women, men and tress: Gender, power and property in forest and agrarian landscapes. *World Development* 25 (8): 1351-1371.

Runge, F. C. 1986. “Common property and collective action in economic development.” In *Proceedings of the conference on common property resource management, National Research Council*, 7-11. Washington, DC: National Academy Press.

Runge, F. C. 1992. “Common property and collective action in economic development.” In *Making the commons work: Theory, practice, and policy,* ed. D. W. Bromley, 17-40. San Francisco: ICS Press.

Sangree, W. H. 1962. “The social functions of beer drinking in Bantu Tiriki.” In *Society, Culture, and Drinking Patterns,* ed. D. J. Pittman and C. R. Snyder, 6-21. New York; John Wiley and Sons.

_____1966. *Age, prayer, and politics in Tiriki, Kenya*. London: Oxford University Press.

Sayer, A.J. and C.S. Harcourt and N. M. Collins. 1992. *The conservation atlas of tropical forests. Africa*. Macmillan Publishers Ltd., United Kingdom.

Siurua, H. 2006. Nature above people: Rolston and “Fortress” conservation in the South. *Ethics and Environment* 11(1): 71-96.

Smit, B. and J. Wandel. 2006. Adaptation, adaptive capacity and vulnerability. *Global Environmental Change* 16: 282-292.

Smith, R. J. 1981. Resolving the tragedy of the commons by creating private property rights in wildlife. *Cato Journal*. 1(2): 439-468.

Steward J. 1955. *The Theory of Cultural Change*. Urbana: Univ. Ill Press.

Stott, P. and S. Sullivan. 2000. *Political ecology: Science, myth and power*. London, Arnold.

Sutton, M. Q. and E. N. Anderson. 2010. *Introduction to cultural ecology*. New York: Altamira press.

Turner BL II. 1997. Spirals, bridges, and tunnels: engaging human-environment perspectives in geography? *Ecumene* 4: 196-217.

_____ 2003. Contested identities: human-environment geography and disciplinary implications in a restructuring academy. *Ann. Assoc. Am. Geogr.* 92: 52-74.

Turner, B.L. II. and P. Robbins. 2008. Land change science and political ecology: Similarities, differences, and implications for sustainability science. *Annu. Rev. Environ. Resour* 33: 295-316.

Turner, P., C. C. Gibson, and D. Dodds. 2007. Explaining community-level forest outcomes: salience, scarcity, and rules in Eastern Guatemala. *Conservation and Society* 5 (3): 361-381.

Truman, D. B. 1958. *The governmental process*. New York: Knopf.

Vadjunec, J. M. 2010. Extracting a livelihood: Institutional and social dimensions of deforestation in the Chico Mendes Extractive Reserve, Acre, Brazil. *Journal of Latin American Geography* 10 (1): 149-172.

Wade, R. 1987. The management of common property resources: collective action as an alternative to privatization or state regulation. *Cambridge Journal of Economics* 11: 95-106.

Wagner, G. 1949. *The Bantu of North Kavirondo*. London: Oxford University Press.

Wass, P. 1995. *Kenya's indigenous forest: Status, management and conservation*. Gland: International Union for Conservation of Nature (IUCN)

Were, G. S. 1967. *A history of the Abaluyia of Western Kenya c. 1500-1930*. Nairobi: East African Publishing House.

West, P. 2006. Conservation is our government now: The politics of ecology in Papua New Guinea. Durham, NC: Duke University Press.

Westcoat J.L. 1991. Managing the Indus river basin in light of climate change: four conceptual approaches. *Glob. Environ. Change Hum. Policy Dimers.* 1: 381-395.

White G.F., Bradley D.J., White A.U. 1972. *Drawers of water: Domestic water use in East Africa*. Chicago IL: Univ. Chicago Press.

Wolf E. 1972. Ownership and political ecology. *Anthropol Q.* 45: 201-205.

World Resource Institute. 2013. http://www.wri.org/publications/data-sets.

Wright, S. J. 2005. Tropical forests in a changing environment. *Trends in Ecology and Evolution* 20(10): 553-560.

Zimmerer, K.S. 2004. Cultural ecology: placing households in human-environment studies: the cases of tropical forest transitions and agrobiodiversity change. *Progress in Human Geography* 28(6): 795-806

APPENDICES

Appendix A: Institutional Review Board Approval Letter

Oklahoma State University Institutional Review Board

Date:	Friday, May 13, 2011
IRB Application No	AS1158
Proposal Title:	The Role of Local Institutions on Deforestation in Kaimosi Forest, Kenya
Reviewed and Processed as:	Exempt

Status Recommended by Reviewer(s): Approved Protocol Expires: 5/12/2012

Principal Investigator(s):

Daniel E. Wilson
405 N. Husband
Stillwater, OK 74075

Jacqueline Vadjunec
324 Murray Hall
Stillwater, OK 74078

The IRB application referenced above has been approved. It is the judgment of the reviewers that the rights and welfare of individuals who may be asked to participate in this study will be respected, and that the research will be conducted in a manner consistent with the IRB requirements as outlined in section 45 CFR 46.

☒ The final versions of any printed recruitment, consent and assent documents bearing the IRB approval stamp are attached to this letter. These are the versions that must be used during the study.

As Principal Investigator, it is your responsibility to do the following:

1. Conduct this study exactly as it has been approved. Any modifications to the research protocol must be submitted with the appropriate signatures for IRB approval.
2. Submit a request for continuation if the study extends beyond the approval period of one calendar year. This continuation must receive IRB review and approval before the research can continue.
3. Report any adverse events to the IRB Chair promptly. Adverse events are those which are unanticipated and impact the subjects during the course of this research; and
4. Notify the IRB office in writing when your research project is complete.

Please note that approved protocols are subject to monitoring by the IRB and that the IRB office has the authority to inspect research records associated with this protocol at any time. If you have questions about the IRB procedures or need any assistance from the Board, please contact Beth McTernan in 219 Cordell North (phone: 405-744-5700, beth.mcternan@okstate.edu).

Sincerely,

Shelia M. Kennison

Shelia Kennison, Chair
Institutional Review Board

Appendix B: Research Permit

PAGE 2

THIS IS TO CERTIFY THAT:

Prof./Dr./Mr./Mrs./Miss. PROF. DANIEL WILSON

of (Address) OKLAHOMA STATE UNIVERSITY, USA.

has been permitted to conduct research in .....Location,

HAMISI .....District,

WESTERN .....Province,

on the topic. 'THE ROLE OF LOCAL INSTITUTIONS ON DEFORESTATION IN THE KAIMOSI FOREST, KENYA.

for a period ending. 31ST DECEMBER ,2011

PAGE 3

Research Permit No. NCST/RRI/12/1/ES-011/22

Date of issue. 8/6/11

Fee received. KSHS. 29,750

Applicant's Signature

Secretary National Council for Science and Technology

Appendix C: Research Authorization

REPUBLIC OF KENYA

NATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGY

Telegrams: "SCIENCETECH", Nairobi
Telephone: 254-020-241349, 2213102
254-020-310571, 2213123,
Fax: 254-020-2213215, 318245, 318249
When replying please quote

P.O. Box 30623-00100
NAIROBI-KENYA
Website: www.ncst.go.ke

Our Ref: **NCST/RRI/12/1/ES-011/22/4**

Date: **8th June, 2011**

Prof. Daniel Everett Wilson
Oklahoma State University
USA

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on **"The role of local institutions on deforestation in the Kaimosi Forest, Kenya"** I am pleased to inform you that you have been authorized to undertake research in **Hamisi District** for a period ending ***31st December, 2011.***

You are advised to report to the District Commissioner & the District Education Officer, Hamisi District & the District Forest Officer before embarking on the research project.

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

P. N. NYAKUNDI
FOR: SECRETARY/CEO

Copy to:

The District Commissioner
Hamisi District

The District Education Officer
Hamisi District

Appendix D: Key Informant Interviews

Survey # _____Interviewer:_____ Date: _____

Position/Title of the Interviewee _____Location: _____

ENVIRONMENT

What are the major environmental issues in the Kaimosi Forest (deforestation, water, soil, overuse of forest resources)?

_____

_____

_____

_____

_____

LAND-USE

What are the major land-use or land tenure issues in the Kaimosi Forest area? _____

_____

_____

_____

_____

In your opinion, have any Kaimosi Forest communities had conflicts with any of the following issues in the last 5 years:

Conflict Type	Yes/No	
Land /Title	Y N	
Selling Property	Y N	
Hunting	Y N	
Timber Extraction	Y N	
NGO	Y N	
Other Communities	Y N	
Forest Use Rules	Y N	
Water	Y N	
Soil Erosion	Y N	

FOREST MANAGEMENT RULES

What are the main community organizations in the Kaimosi Forest Area? _____

_____

_____

_____

_____

What are the main institutions responsible for monitoring/enforcing/ and punishment of forest use rules in the Kaimosi Forest (QMC, traditional leaders)? _____

_____

_____

_____

_____

_____

In your opinion, are there certain membership requirements for using the Kaimosi Forest? Yes No If yes, what is the eligibility for membership? _____

_____

_____

Do locals participate in the rule making process? Yes No Explain: _____

_____

_____

_____

How are the rules of forest use monitored in the Kaimosi Forest? _____

_____

_____

_____

What are the most common forest use rules that are broken in the area? _____

_____

_____

_____

In general what is the punishment for breaking forest use rules? _____

_____

_____

_____

Do you agree or disagree that new rules should be added? (1-4)*___ Explain?
_____

_____

_____

_____

*(1) No, disagree strongly (2) No, disagree somewhat (3) Yes, agree in general (4) Yes, agree strongly

Village with the <u>most</u> amount of environment problems (Deforestation and Degradation)

1._____ 2. _____

3._____

Village with the <u>least</u> amount of environmental problems (Deforestation and Degradation)

1._____ 2. _____

3._____

Most organized village in the Kaimosi Area?

1._____2. _____

3._____

Least organized village in the Kaimosi Area?

1._____2. _____

3._____

Appendix E: Household Surveys

Survey # _____Interviewer:_____ Date: _____

Village name: _____ Location: _____

GENERAL INFORMATION:

Permanent Residents	**Age**	**Education Level**	**Permanent Resident**	**Age**	**Education Level**
Mother					
Father					

* Education Level: (P) Primary (S) Secondary (C) College
* Resident: Son, Daughter, Cousin, Aunt, Uncle, Nephew, Niece, Friend or Other.

Are you a full time resident? Yes No If no, please indicate, where/when: _____

_____

How long have you been a resident? _____

EDUCATION:

Name of the school(s) your family attends? _____

_____

Distance to school: _____ Travel time to school: _____

MOBILITY:

Mode of Transportation	**Rarely**	**Less Often**	**Often**	**Most Often**
Walk				
Bicycle				
Motor Bike				
Private Car				
Public (busi, matatu)				
Other:				

Distance to nearest hospital/clinic: _____Travel time to nearest hospital/clinic: _____

Distance to nearest market: _____Travel time to nearest market: _____

Distance to forest: _____Travel time to forest: _____

LAND-USE:

Total Acres Owned: _____ Total Acres Rented: _____

Land-Use	**Acres**	**Crops**	**Produce (kg)**	**Consume (kg)**	**Sell (kg)**	**Price**
Pasture		Beans				
Agriculture		Maize				
Perennials		Cowpeas				
Primary Forest		Bananas				
Secondary Forest		Chi/Tea				
		Coffee				
		Sugarcane				

Animals	**Number Owned**	**Number Rented**	**Number Consumed**	**Number Sold**	**Price**
Chickens			Every 3 Months:	Every 3 Months:	
Goats			Yearly:	Yearly:	
Cattle			Yearly:	Yearly:	
Pigs			Yearly:	Yearly:	
Sheep			Yearly:	Yearly:	

Animal Products	**Consumer**	**Sold**	**Price**
Eggs	Per month:	Per month:	
Milk	Per month:	Per month:	
Cattle hide	Yearly:	Yearly:	
Sheep skin	Yearly:	Yearly:	

What types of garden plants do you have? Cabbage_____Pumpkins_____Kales ____

Other:_____

_____

_____

Other
Employment:_____

_____

FOREST USE

Extractive Forest Products (Fruits, Nuts, Medicinal Plants)	**Frequency of Extraction***	**Quantity per Month**	**Do you sell this product?**	**Quantity Sold per Month**	**Price**
Honey			Y N		
			Y N		
			Y N		
			Y N		
			Y N		
			Y N		
			Y N		
			Y N		
			Y N		
			Y N		
			Y N		
			Y N		

* Frequency of Extraction: (D) Daily (W) Weekly (BW) Biweekly (M) Monthly
(L) Longer than Monthly

Do you feel that non-timber forest products have **decreased, increased, or stayed the same** in the last 10 years? _____

If decreased, what types _____

_____

_____

_____

_____

HOUSEHOLD ASSESTS

Stove type: Gas Wood Other: _____

Water source: Stream Well Other: _____

Roof type: Iron Sheets Tiles Grass Other: _____

Electric type: Solar Generator Hydro Other: ___

Floor type: _____

Assets	Yes/No	Quantity
House Phone	Y N	
Cell Phone	Y N	
Television	Y N	
Radio	Y N	
Ice Box	Y N	
Vehicle	Y N	
Couch (Sofa)	Y N	
Chainsaw	Y N	
Table	Y N	
Fence	Y N	
Water Filter	Y N	

COMMUNITY ORGANIZATION

What local organizations are you involved with?

Community Organization	Years as a member	Frequency of meetings per year	Currently Active (Last Vote) Yes/No	Satisfaction Level*
(1) Quaker Mission Church				
(2)				
(3)				
(4)				
(5)				
(6)				

*Satisfaction Level: (1) Strongly Unsatisfied (2) Unsatisfied (3) Satisfied (4) Strongly Satisfied

Reasons for not being satisfied/Comments about organizations?_____

(1)_____

(2)_____

(3)_____

(4)_____

(5)_____

FOREST MANAGEMENT RULES

Overall, do you agree with the forest use rule?

(1) No, disagree strongly (2) No, disagree somewhat (3) Yes, agree in general (4) Yes, agree strongly

Why or why not? _____

_____

_____

Forest Use Rules	**Do you know this rule? (Y/N)**	**Do you agree with rule? (1-4)***	**In your opinion, do you think this rule is being monitored? (Y/N)**	**Have you heard of someone in the community that has broken this rule (in the last year)? (Y/N)**	**What happens when someone breaks this rule?**
(1)					
(2)					
(3)					
(4)					

(5)					
(6)					
(7)					
(8)					

*(1) No, disagree strongly (2) No, disagree somewhat (3) Yes, agree in general (4) Yes, agree strongly

In your opinion, do you feel that there is a clearly defined boundary for the Kaimosi Forest? Yes No_____

In your opinion, do you agree or disagree with how the rules are being enforced?

(1) No, disagree strongly (2) No, disagree somewhat (3) Yes, agree in general (4) Yes, agree strongly

Why or why not: _____

_____

Are there certain membership requirements for forest use? Yes No If yes, please explain _____

_____

Do you feel the membership requirements are fair? Yes No Please explain _____

_____

_____

Have you or anyone in the community experienced any issues with invasion? Yes No

If yes, please explain:_____

_____

Do/Did you have any participation in the rule making process? Yes No If yes, please explain: _____

_____

In your opinion, what rules do feel need to be changed? _____

_____

_____

Do you agree or disagree that new rules should be added? (1-4)*___ Explain? _____

_____

_____

_____

*(1)No, disagree strongly (2)No, disagree somewhat (3)Yes, agree in general (4)Yes, agree strongly

Do you feel that the forest use rules are preserving the forest? Yes No Why or why not? _____

_____

In your opinion, what is the biggest environmental issue facing this community (water, soil erosion, deforestation, other)?_____

_____

_____

_____

In your opinion, what is the best thing about the Kaimosi Forest? _____

_____

_____

VITA

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Candidate for the Degree of

Master of Science

Thesis: THE ROLE OF LOCAL INSTITUTIONS ON DEFORESTATION AND DEGRADATION IN THE KAIMOSI FOREST, WESTERN KENYA

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