Environmental Education for Forest Resources Management in Loliondo Area,

Northern Tanzania

A Dissertation

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Dedication

This dissertation is dedicated to my parents and siblings. Their love and support have always been the backbone for my persistence in longing for greater achievements.

Abstract

In this dissertation, I analyze the impact of three environmental education strategies implemented in rural northern Tanzania focused on forest-related knowledge. In Chapter Five, I assess the impact of two strategies—face-to-face group discussion and mobile phone texting—on knowledge. I also compare the effectiveness of the two strategies in terms of change in knowledge among participants and cost-effectiveness. I find a positive association between environmental education and knowledge, but only for the face-to-face group discussion strategy. In Chapter Six, I assess the impact of using a photo-map (a high-resolution map made from satellite imagery) on knowledge about forest health status. Increasingly, satellite images are being used for knowledge transfer and land use planning as they facilitate visual learning. While survey data show no evidence of increased knowledge, qualitative data suggest that knowledge increased among participants. To understand the actual health status of the forest, I analyzed satellite imagery and determined how the forest's land use land cover changed between 2003 and 2014. I compared land cover results with participants' knowledge about health status. Results suggest that people's answers to the question about forest health status were politicized; participants ensured that their answers aligned with community's conservation obligations. In Chapter Seven, I assess factors that influence engagement in environmentally friendly behaviors and found that, as in previous studies, both knowledge and sense of personal responsibility are strong determinants of engagement among people in Loliondo.

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1. Introduction

"Binadamu na mifugo watakufa"; meaning*, "Both human beings and livestock will die."* A local person expresses why he would feel sad if the forest he depends on disappears, but is that enough to act to protect it?

Environmental education can sometimes change people's behaviors, but can it do so in rural Tanzania where people use forests for both cooking fuel and economic livelihood? Moreover, do text messages provide an effective mechanism for knowledge transfer? These and related questions are addressed in this dissertation.

Environmental education has in many cases resulted in increased knowledge (Bizerril et al., 2011; Kuhar, Bettinger, Lehnhardt, Tracy, & Cox, 2010; Strong, 1998; Uzun & Keles, 2012; Zsóka, Szerényi, Széchy, & Kocsis, 2013) and in environmental-related attitudes (Zsóka et al., 2013), both of which are critical prerequisites for engagement in environmentally friendly behaviors (Bamberg, & Möser, 2007; Hines, Hungerford, & Tomera, 1987; Hungerford, & Volk, 1990). While environmental education has been linked to high participation in behaviors that aim to preserve the environment (Asch & Shore, 1975; Bizerril et al., 2011; Uzun & Keles, 2012), this has not been the case in all circumstances. In this dissertation, I assess whether environmental education can lead to increased knowledge and participation in environmentally friendly behaviors (EFBs) in rural Tanzania where people rely on forest products for both cooking fuel and economic livelihood.

The other question to be addressed in this dissertation is whether text messages can provide an effective mechanism for knowledge transfer. Short message service

(SMS) is a relatively simple technology for sending and receiving messages on mobile phones or any other device and is generally inexpensive compared to phone voice calling. Sending text messages to thousands of people can cost almost nothing compared to voice calling (Dickinger, Haghirian, Murphy, & Scharl, 2004). Due to its potential in improving service delivery, especially in developing nations where infrastructure remains a challenge, application of SMS has recently received massive attention by scholars from various fields. While research on this topic is relatively new, health-related and other fields have shown promising results when used in awareness provision (Lund et al., 2012; L'Engle et al., 2013; Mahmud, Rodriguez, & Nesbit, 2010).

1.1. Background of the study

This study was triggered by the 2009 drought which hit most parts of Northern Tanzania, leading to large numbers of livestock losses. Some livestock owners from dry areas lost over half of their herds (SFTZ, 2010). While conducting research in the Arusha region for Savannas Forever Tanzania (SFTZ),[1] I personally witnessed vast numbers of livestock carcasses on the ground. During interviews, oftentimes respondents cried whenever they were asked questions about livestock ownership, because the memories of the losses were still fresh in their minds. During these devastating moments, many pastoralists in drier parts of Tanzania sought pasture in areas with intact forests as these are the few places that still had green pasture in Northern Tanzania. Livestock herders in forested areas benefited from living near forests; losses in these areas were much lower

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1 SFTZ is a non-profit research organization I worked for at the time. The research happened around the months of October and November of 2009.

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compared to drier parts. It was soon after the drought that village leaders in Loliondo

division, northern Tanzania, sought support from Frankfurt Zoological Society (FZS)[2] to

help fund conservation activities in their area to help protect the remaining forests. This

request made experts from FZS speculate that communities in Loliondo area became

more willing to take actions to protect the local forests after witnessing the ecological

values the forests provided during the 2009 drought.

These interesting observations raised many serious questions for FZS, including

"Does access to information on environmental damage lead to improvement in

management of forest resources by communities?" Their interest in answering these

questions and in an effort to help conserve critical forests in the area propelled them to

seek funds to support implementation of research projects in the Serengeti Ecosystem. In

2011, FZS applied for research funds from the European Union (EU) to support several

graduate students conducting inter-related studies in the Serengeti (Tanzania) and North

Luangwa (Zambia) ecosystems, under the umbrella project called Conservation Research

for East Africa's Threatened Ecosystems (CREATE). My study, which focused on the

role of access to environmental information on natural resources management, was thus

one of the five major studies coordinated and funded through FZS. With financial and in-

kind support from FZS, I implemented and evaluated an environmental education project

in eight villages of Loliondo division of Northern Tanzania to broadly address

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2 FZS is an international conservation organization based in Frankfurt in Germany; it operates in various parts of
  Tanzania.

CREATE's research goals.[3] The environmental education project aimed at disseminating information about the values of forests, behaviors that contribute to forest degradation and their solutions, negative impacts of deforestation, and actions and behaviors that would help sustain the forests, with the expectation that increased environmental knowledge would lead to better management of local forests.

The study villages are located near an important local forest called Enguserosambu Community Forest (ECF). ECF is a "sensitive area" as defined by the Tanzanian Forest Act of 2002, because it preserves water and generates rivers that run through important ecosystems: Serengeti National Park, Ngorongoro Conservation Area, Lake Natron, and others. ECF is also a major source of wood for local people for both construction and fuel energy, and serves as grazing land during the dry season when pasturage becomes scarce. Like many other forests in Tanzania, however, ECF is under threat of depletion largely due to anthropogenic pressure.

1.2. Purpose and significance of the study

Forest degradation is among the most important threats to biodiversity and people's wellbeing and to the livelihoods of rural people worldwide. Most forests around the world are facing intense anthropogenic pressure (DeFries, Hansen, Newton, & Hansen., 2005; Ellis et al., 2013; Food and Agriculture Organization [FAO], 2016; Lambin, Geist, & Lepers, 2003; Lambin & Strahler, 1994) despite the many use and

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3 Improve understanding of the links between poverty, human health, disaster management, and environmental sustainability while actively informing local and international decision making and policy development in two key African ecosystems.

none-use values supplied by natural ecosystems. While natural factors contribute to this degradation, human behaviors have been widely reported to contribute more to this problem (Denevan, 1992; Bray et al., 2008; FAO, 2010). Tropical forests, especially those found in developing nations, are currently most vulnerable to human threats partly because most forests are found near communities whose livelihoods depend directly on these natural forests (Basnet,1992; Hines & Eckman, 1993), and oftentimes there are no alternative sources of forest products. Moreover, due to economic vulnerability of people and poor infrastructure in rural areas of the tropics, they cannot afford to carry out forest management activities such as patrols or tree planting projects. Those who volunteer to guard forests tend to be easily lured by monetary bribes. A study conducted in Tanzania by Campbell et al. (2007), for example, show how people who volunteer to guard the forest end up taking bribes because they are not paid for the work they do; instead, they depend on fines paid by people caught engaging in illegal forest activities. Other scholars, including Mol (2011) argue that Africa's environmental degradation has been worsened by the dependency on natural resources by new ascending economies, such as China, which import forest products in massive quantities for industrial purposes.

　　　While research shows that frequently people clear forests to meet their livelihood needs (Nielsen, 2011), at other times deforestation happens due to other causes. Some traditions and religious practices force people to continue engaging in unsustainable practices because that is their custom. For example, sometimes people deliberately burn forests for purposes of scaring animals (Pradhan, Dar, Maqbool Rather, Panwar, & Pala, 2012), harvesting honey (Eriksen, 2007; Kamau, & Medley, 2014; Zilihona, Shangali,

Mabula, & Hamisy, 1998), or simply for excitement. Also, forests have sometimes been set on fire due to land-related conflicts between local people and the government or the company (Dennis et al., 2005; Byron & Shepherd, 1998; Hamilton, Cunningham, Byarugaba, & Kayanja, 2000). Moreover, lack of knowledge about consequences of some traditional practices—such as complete debarking of trees to extract natural medicines – have contributed to the disappearance of various tree species. As demonstrated by Delvaux, Sinsin, and Van Damme (2010), excessive debarking weakens and eventually kills trees. While it can be argued that most local people who live near forests often have deep understandings of some aspects of forest use and management (Berkes, 2012; IFAD, 2012; Stevens, 1997) from both their experiences and local histories, these understandings are sometimes inadequate to deal with rising environmental challenges.

More knowledge in various aspects of environmental issues may empower local communities to sustainably manage forest resources in their proximity and consequently sustain both economic and ecological benefits provided by forests. In this study, provision of environmental education was thus meant to help local people integrate new environmental information into their knowledge with the expectation that they would be able to deal with environmental problems more effectively. They would thus improve management of forests within their proximity. I applied social learning theory to guide me through the implementation and evaluation of the study.

Many scholars advocate for environmental education because it is perceived as a valuable tool for improving people's' comprehension of environmental issues, and

because it is highly associated with positive attitudes and behaviors of people toward their environment (Clayton & Myers, 2009, 2015; Cutter-Mackenzie & Smith, 2003; Heimlich & Ardoin, 2008). As illustrated by Chao (2012) and Hsu (2004) and Karami & Larijani (2015), environmental education has demonstrated positive impacts on some environmentally friendly behaviors, including recycling and care for nature. Like many others, however, Schultz (2002) argues that environmental information alone tends to motivate behavior change only when a lack of such information acts as the only barrier to behavior change. Furthermore, Heimlich and Ardoin (2008) point out that while environmental education is associated with positive impacts on people's behaviors toward the environment, its impacts cannot be generalized. Additionally, factors predicting engagement in environmentally friendly behaviors do not seem to be consistent among studies (Chao, 2012). This study acknowledges the complexity of engagement in environmentally friendly behaviors, and points out how some of these factors might have affected the results.

While studies on the role of environmental education on people's environmental knowledge, attitudes, and practices (KAP) have been conducted in the past, most of them measured environmental constructs applicable to industrialized contexts. Most constructs used in modeling the impacts of environmental education cannot be applied in developing countries in the same way, especially in rural areas. Concepts such as recycling, energy use, or water use behaviors cannot be operationalized in the Loliondo area because such behaviors are rarely practiced in rural parts of developing nations. In Loliondo area, it is

not understood how environmental education influences people's' knowledge, attitudes, and practices related to forest use and management.

Second, various strategies are employed to implement environmental education, including formal (through schools) and informal (e.g., through community projects) means (Clayton & Myers, 2009, 2015). The use of mobile phones as an environmental education tool has been reported only minimally, and none of them used a simple text messaging strategy. The purpose of my research was to elucidate the role of environmental education on natural resources use and management in the context of Loliondo by comparing KAP values before and after the environmental education project. Implementing two strategies (group discussions and mobile phone texting) is aimed at identifying a strategy that would be more effective at influencing knowledge, attitudes, and practices as well as being cost-effective in the Loliondo area. Identification of efficient and cost-effective environmental education strategies is key to ensuring that more populations have access to environmental information, especially in countries such as Tanzania, where few if any financial and human resources are allocated for purposes of managing forests on non-protected lands. Furthermore, the identification of contextual factors that influence engagement in forest-related environmentally friendly behaviors among Loliondo people is essential for maximizing limited resources for environmental education strategies.

1.3. Context of the study

The context described here largely includes information about the Ngorongoro District as a whole rather than information only specific to Ngorongoro villages that were included in the study. This was necessary as previous studies have broadly studied the District rather than specific villages. The study area comprised eight villages; seven are part of the Loliondo Division while one is part of the Sale Division of the Ngorongoro District located in the northern part of Tanzania. The Loliondo and Sale Divisions[4] are among the three divisions that make up Ngorongoro District; the third one is Ngorongoro. The villages are also part of the three wards (out of 20) that make up Ngorongoro District: Orgosorok, Enguserosambu, and Sale. The area is part of the Loliondo Game Controlled Area (LGCA),[5] a wildlife protected area that contains village lands. LGCA also comprises hunting blocks adjacent to the Serengeti National Park; tourist hunting such as sport-hunting takes place in these areas (The United Republic of Tanzania [URT], 1991). LGCA lies to the east of Serengeti National Park and north of the Ngorongoro Conservation Area (see Figure 1.1). The area can be accessed from Arusha City through seasonal roads, either through Mto wa Mbu village, Karatu District, Ngorongoro Conservation Area, and Serengeti plains, or through Selela and Engaruka villages, Lake

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4 Administrative boundaries of Tanzania are divided into regions, which are further divided into districts, ("Wilaya"). A district is made up of divisions (Tarafa), which are further divided into wards ("Kata"). The wards are finally subdivided into villages ("Vijiji"), and villages into sub-villages ("Vitongoji").

5 According to the 2009 Wildlife Conservation Act of Tanzania, a Game Controlled Area" is one of the conservation areas declared under section 15 of the act. Under this act, hunting of wildlife is restricted in a GCA under section 19. Also, under this section, grazing of livestock is prohibited. As stated in sub-section 21, "Any person shall not, save with the written permission of the Director previously sought and obtained, graze any livestock in any game controlled area." Under sub-section 20, other activities such as mining and crop cultivation are also restricted; under sub-section 29, the President can modify restrictions imposed on GCAs.

Natron, then Sale District. Since the Divisions are within a GCA, natural resources

utilization within its boundaries are subject to regulations stipulated in the wildlife-

related policies.

All eight villages are adjacent to a local forest called Enguserosambu Community

Forest (ECF), officially known as Loliondo II Forest Catchment Reserve; four of them

claim ownership of the forest (Personal communication with the various stakeholders in

the study area). Evidence from forest ownership certification, however, show that the

management rights belong to all adjacent villages (see certificate of ownership attached

in Appendix A).[6]

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6 The four villages that claim to own land management rights of ECF do not want to share these rights with other adjacent
  villages.

Figure 1.1. Location of study area (Loliondo) in relation to important ecosystems
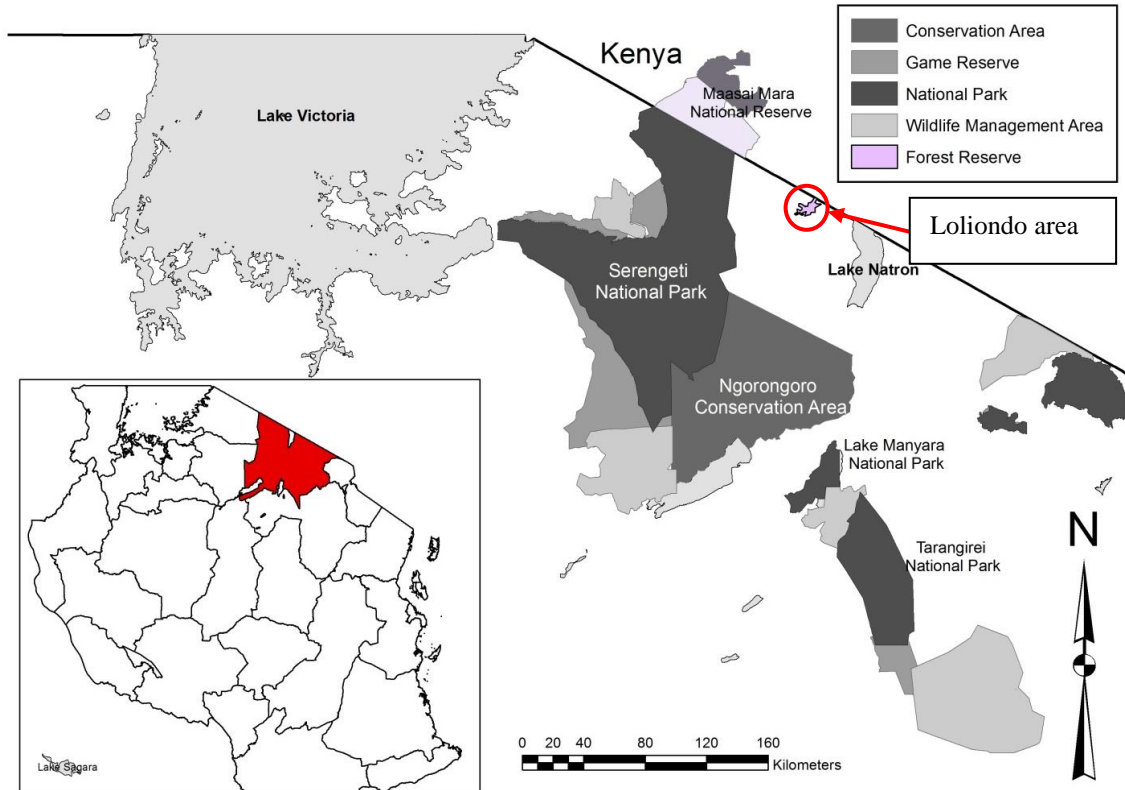
1.3.1. Infrastructure and means of communication in Loliondo

All three divisions and its villages have poor road networks and all the roads are seasonal. The district headquarters has access to electricity supplied by a large generator, but only a small population is connected to this source. Most villages have limited wireless networks; some areas are more widely covered than others, especially those in business centers. Loliondo and Sakala villages were the only villages that were widely covered by wireless mobile network; all other villages had specific locations in the village where network could be accessed. The villages also had limited access to mobile phones, radio and television. Throughout the study area, information sources are largely

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limited to oral means—through face-to-face informal conversations or formal village assemblies. However, a few households in the district headquarters may have access to written booklets, brochures, posters, radio programs, and newspapers. Based on informal conversations with village leaders during my preliminary study conducted in the summer of 2012, radio signals for a few radio stations were accessible only from about 7:00 p.m. to 8:00 a.m., making it hard even for people who have radios to listen to news. While households in some villages own more mobile phones compared to others, less than 50% of households own one or more mobile phones, and only a small percentage of households in one village has access to electricity. In most households, mobile phones are largely owned by male household heads (see Chapter Five). Nevertheless, people in the study area reported access to information via mobile phone; this may be due to the fact people share mobile phones. Also, a few who receive information via mobile can always share the information with their friends or relatives. Access to information in the eight villages is thus largely by word of mouth and village meetings.

Understanding various means of communication and types of infrastructure available in the study area was essential for determining the feasible ways of communicating environmental information to local people in Loliondo. The methods that were used were those identified as feasible and the most-effective communication means.

1.3.2. Climate and vegetation

Ngorongoro District lies in a semi-arid land where droughts are common. Loliondo receives limited rainfall periods; the short rain period is between November and

December and the longer rainfall period is between March and July. Annual rainfall

ranges between 500 mm and 1,400 mm (Tumaini, 2009).[7] Kivelia (2007) cites a

difference in rainfall amounts between the areas in the lowlands and that of the highlands;

the lowlands receive much lower rains (below 600 mm) while the highlands receive more

rains (between 1,200 and 1,500 mm per annum). Records show that while rainfall

patterns have been more variable in the recent years, East Africa as a whole has been

receiving more rain over the last century (IPCC, 2001, as cited in Tumaini, 2009). With

climate change, drier parts are projected to be drier while wet areas are projected to be

wetter in the future (as cited in Tumaini, 2009). In other words, drier areas such as

Loliondo are expected to experience more drought seasons in the future.

The impact of climate change is already evident in Loliondo; in the past, several

perennial rivers flowed in the area, but now most of them have dried up and only a few

remain (Ojalammi, 2006; Sirima, 2015; Informal conversations with village leaders and

local people, Summer, 2013). Continued forest degradation may lead to further climate

change.

Loliondo has diverse vegetation composition. Documented forest types include

montane forests, broad-leaved woodland/tall grassland; broad-leaved trees include

Terminalia, Combretum and Erythrinu spp. Other vegetation includes short grassland and

Acacia/Commiphora woodlands (NLUPC, 1993, as cited in Ojalammi, 2006; Watson,

Graham, & Parker, 1969). The vegetation distribution may be due to the wide range of

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7 For 2013, 2014, and 2015, the reported average rainfalls in Arusha region were 485.9 mm, 1,188.5 mm, 701.8 mm
    respectively, as cited in the 2015 Tanzania in Figures.

soil types and varying rain patterns, as well as a wide range of altitudes in the area.

Watson et al. (1969) suggest that extreme grazing of Maasai livestock—in combination

with rainfall patterns, altitude, soils, and drainage patterns—have contributed to a

diversity of vegetation types in Loliondo and Ngorongoro divisions. Watson et al. (1969)

also note that some areas, such as Loita hills, are above 2,135 m (7,000 ft) and they

support highland forests. In several flat areas or valleys and gentle slopes,

Themeda/Pennisetum grassland predominates (Watson et al., 1969). There are also

thickets found mostly on steeper slopes and hilltops. In lower rainfall areas, grassland

dominates; the species that dominate are *Sporobolus spp*. and *Cynodon dactylon*, which

are shorter than the *Themeda/Pennisetum.*

Unfortunately, most vegetation in the Loliondo area is at risk of being degraded

due to extensive droughts which have led to heavy reliance of pastoral Maasai on the few

natural forests that exist in the area. These include the Enguerosambu Community Forest

(also officially known as Loliondo II forest Catchment Reserve). Personal observations

revealed that the woodlands in Loliondo are heavily affected by intensive grazing in

which many understory plants and tree branches were trampled by livestock herds.

Watson et al. (1969) report signs of woodland deterioration when they surveyed the area

in the 1960s. Overall, forest cover appears to have declined over the past decades due to

illegal logging for timber, charcoal burning, agricultural extensions, and overgrazing.

Watson et al. (1969) also point to wild fires as a possible factor that might have led to a

decline in forest cover in the 1960s. During my field work, some local people reported

that some use fire to harvest honey; these fires have contributed to wildfires. No serious wildfires seem to have occurred during my survey period.

1.3.3. Demographic characteristics

The major ethnic group found in the Loliondo[8] area is the Maasai which comprises about 75% of my sample. The rest of the sample includes 14% Sonjo and 11% other tribes (Author's survey data). Maasai people are also a major ethnic group in the Ngorongoro District as a whole. Tribes in the other category include Chagga, Nyiramba, Nyaturu, Barabaig, and others. These minority ethnic groups largely occupy business centers or town centers such as the district headquarters. Most families from the minority tribes either immigrated to the area in search of paid labor or trade opportunities. Out of eight study villages, one of them (Loliondo village) was largely occupied by minority tribes while another (Sakala village) had a combination of Maasai and non-Maasai populations found mostly near the town center. The other five villages are predominantly occupied by the Maasai; only one is occupied by the Sonjo.

As in other regions in Tanzania, the population of the Ngorongoro District has been increasing dramatically, from 127,137 in 2002 to 174,278 in 2012[9]—a growth rate of about 37.1% between 2002 and 2012 or an annual rate growth rate of 3.7%. Similar growth rates have been observed in the Loliondo and the Sale divisions where the study

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8 In the Ngorongoro District as a whole, the major ethnic group is Maasai.

9 The 2002 population is estimated from the IPUMS International data (Minnesota Population Center. Integrated Public Use Microdata Series, International: Version 6.5 [dataset]. Minneapolis: University of Minnesota, 2017. http://doi.org/10.18128/D020.V6.5.) I use reported figures from the Tanzania Bureau of Statistics for the 2012 population.

was conducted. The 2012 national census of Tanzania also shows that the gender composition in the Ngorongoro District was 47.4% male and 52.6% female which is similar to the gender composition in the Loliondo sample (see Chapter Five).

With respect to literacy, pastoral Maasai are among the most non-literate population in Tanzania; in my sample, only about 48% of adults have either attended or completed at least primary school education. Also, data show that many fewer women have completed any level of education compared to men (i.e., women are thus less literate compared to men). SFTZ (2010) observed similar education attainment levels in Monduli and Longido Districts which are both predominantly inhabited by the pastoral Maasai. Low educational attainment and illiteracy levels can be attributed to various factors, including the semi-nomadic nature of the pastoral Maasai populations (Gimbo, Mujawamariya, & Saunders, 2015) which their livelihood strategies require. Due to their large herds of livestock, young boys start undertaking grazing responsibilities as young as six years (Talle, 1988). By the time they reach the age of 14, they enter puberty which is also the warrior (*Moron*) stage. Warriors are responsible for defending the Maasai territories (including pasture land) and herding livestock; thus, their chances of attending or continuing attending school are diminished. Sometimes young men and their parents migrate temporarily to grazing areas which tend to be several kilometers[10] away from their permanent homesteads.[11] In Loliondo, for example, some homestead[12] (*boma* or

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10 Talle (1988) has reported as many as 30-50 km away from the Maasai's permanent homesteads to the temporally camps called enkang' oo nkishu.

11 Sometimes one family (for example, a household with the oldest wife) may be left behind to take care of assets on their permanent homestead while part of the family might migrate to a place with more pasture.

enkang) members may migrate to other parts of the region—such as near the Serengeti Plains—where they graze their livestock during the rainy season. Unlike Maasai men, Maasai girls are still married off at very young ages soon after circumcision (Gimbo et al., 2015; Talle, 1988; Personal observations).

While there have been various government efforts to ensure that every school-age child is enrolled in school, there has been high resistance from the pastoral Maasai, in part because they want to maintain their culture (Gimbo et al., 2015). Enrollment of Maasai children in school may mean a shortage of young males to herd their large herds of cattle and is seen as an abandonment of their culture (Sirima, 2015). Nevertheless, more school-age children across Tanzania were enrolled in 2012 when compared to previous years (URT, 2015).

1.3.4. Culture of the pastoral Maa-speaking people

In this section, I briefly describe the group of Maa-speaking people in this study, as well as Maasai cultural practices (specifically the *age-set* organization) in relation to natural resources use and management. While the study area is also inhabited by other tribes such as the Sonjo and several other minority groups, their proportions are very small compared to the Maasai population; in my sample there was 75% Maasai and only 25% other tribes combined. Also, in Ngorongoro District, the dominant ethnic group is Maasai. The cultural practices that I focus on include the Maasai's *age-set* organization,

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12 A Boma or Enkang is a group of houses that belong to a number of families. Families are usually of the same clan.

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the polygamous nature of the Maasai families, their livelihood strategies and how their economic activities have changed over the past decade.

Present day pastoral Maa-speaking ethnic groups inhabit most parts of the savanna plains of the Great Rift Valley on both the Tanzanian and Kenyan sides. They inhabit lowlands of the Great Rift Valley in East Africa. According to Ojalammi (2006), "The Maasai lands stretch today from the Kenyan Loita-Mara plains in the south-west across the Serengeti to the Crater Highlands and toward the southern plains of Tanzania" (p. 6). Based on Ojalammi's account (2006), when the Nilotes[13] moved from Upper Egypt to the South, some of them came and settled in the Serengeti plains. According to Talle (1988), however, it appears that the origin of the Maasai is not known, although they settled in the lowlands of West Lake Turkana, possibly on the South of Sudan and Ethiopia. They gradually moved southward, and by the Seventeenth Century, they had occupied the Ngorongoro Crater and the Serengeti Plains in Northern Tanzania. Talle (1988) also suggests that it is possible that the original Maa-speaking people moved in waves in search of food and water. Some of them might have consolidated into powerful groups such as the pastoral Maasai while others might have branched off as autonomous ethnic groups and became absorbed into more powerful groups. Talle (1988) also adds

13 The Nilotes are thought to be non-Bantu-speaking people and are divided into three major groups; the River Nilotes, the Highland Nilotes, and the Plains Nilotes. The Plains Nilotes are believed to be the Maa-speaking group (Talle, 1988). Greenberg (1963) provides more details on which tribes make up each of the three Nilotes groups. Talle also notes that the Maa-speaking people are further divided into several distinct ethnic groups, including the Samburu, the Njemps, and the Ndorobo (Okiek) groups found in Kenya. Other Maa-speaking groups are the Arusha and the Parakuyo found in Tanzania. "Only the Maasai, Samburu and Parakuyo can be designated as pastoralists, in the sense that livestock production constitutes the mainstay of their economy." (p. 22) The Arusha mainly engage in agriculture as their main economic activity, the Njemps are fishers, and the Ndorobo are hunter gatherers. Also, Maa-speaking groups in general keep some livestock in addition to their main economic activities.

that by 1948, Maa-speaking people had occupied areas as large as 200,000 square kilometers which spanned from Kenya to Tanzania. In the process of occupying large tracts of land, Maa speakers are thought to have displaced several other tribes in both Tanzania and Kenya (Kivelia, 2007; Talle, 1988). Those who specialized in pastoral economic activities are the ones mostly referred to as the present-day pastoral Maasai. For simplicity, I will use Maasai to mean pastoral Maasai.

As discussed in the next sections, Maasai culture is ingrained in livestock keeping. Cattle play very important roles in the Maasai culture in terms of food (meat, milk, and blood), wealth, and clothing (animal skins). Ownership of large herds of cattle is considered respectable and prestigious (Maasai Association, n.d.; Talle, 1988).

Maasai age-set system/organization and its role in forest resources management. The Maasai ethnic group has an age-set system which puts male Maasai with a specific age range into one group; men of ages between 14 and 16, for example, may belong to the same age-set, although the age range within one age-set can be wider. The age-set system is applied only to male Maasai (Maasai Association, n.d.; Morton, 1979; Talle, 1988). Men thus belong to different age-sets and each man's age-set starts later after puberty; each circumcised group advances collectively from the junior age-set to senior groups (Maasai Association, n.d.; Morton, 1979; Talle, 1988).[14] Each age-set is given a specific name, and membership in each is maintained throughout one's life. If one starts as an

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14 Talle (1988) also notes that two age-sets, normally consecutive newly circumcised groups, can amalgamate to form one age-set which other authors refer to as generation-set (Maasai: olaji).

'okiseeya," for example, then he will remain as such.[15] Talle (1988) argues that age-set

organization is one of the important cultural features in the Maasai ethnic group which is

used to reinforce male dominance in the Maasai society. Age-set embodies

"organizational power of the age structure; these groups constitute the future decision-

making body in their community. They are the foundation of politics" (Talle, 1988, p.

94). The age-set also signifies the importance of a male Maasai in the community; the

name accorded also signifies a certain importance and how much respect a male Maasai

deserves. The age-set system determines when major events such as marriage can take

place for a Maasai male. Talle (1988) notes that another important aspect about age-set

organization is its role in uniting Maasai from different clans through cultural initiations,

which he refers to as age-set initiation and promotion ceremonies; every male Maasai

from a specified age-set is expected to attend and discuss issues of concern.

Male Maasai from a particular age-set (depending on age) are expected to behave

in a certain way—"The rules pertain mostly to eating habits, labor and sexuality, and they

govern relations between men of various age-statuses as well as relations between women

and men" (Talle, 1988, p. 92). The expectation is that junior males show respect toward

senior men; the same applies to women, who are expected to show differential respect to

men of different age statuses. If a junior shows disrespect or does something wrong to the

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15 Talle (1988) also reports three major age categories of male Maasai which are not necessarily within the age-set
system, namely, boys (olayoni, pl. Ilayiok). This age includes young males of ages 6-6, the second is the circumcision
age of 14-18, also called warriors (olmurrani, pl. ilmurran) Moran. The third major age category is the one that
comprises individuals beyond the age of circumcision (ages of 20-25), and elders (olpayian, pl. ilpayiani), a group that
includes those above the age of 30. At the age of 20 and above, individuals can marry if they are ready. The elders are
also further divided into junior and senior elders.

senior, the Maasai believe that such elder has the right to inflict a curse upon the junior by appealing to their God (*Enkai*); the person can be punished through experiencing a sudden illness or death. Talle (1988) also adds that a group can also curse their age-mate who behaves badly. While these curses are feared among communities, Talle (1988) adds that any curses can be effective only if morally justified, and that the "most potent curse is the one inflicted by 'seniors' on 'juniors'" and that "the ritual curse is in fact a powerful means of control in the hands of the elders" (p. 92).

The age-set organization helps us understand what role each age group plays in forest resources management and who can make decisions concerning these resources. Young male warriors (both the junior and senior Moran*),* for example, are understood as defenders of Maasai territories. As such, they are tasked with the role of guarding the forest and grazing land. The Morans are expected to arrest or take prescribed action against any person caught doing destructive activities in the forest or anywhere within boundaries of a particular Maasai territory. Elders play a big role in deciding how natural resources such as forests and water are utilized and help in resolving conflicts related to forest use and other aspects of the villages. If a village member cuts trees without permission, for example, they can be punished by requiring them to pay a fine (in the form of a cow, for example) and can be warned not to repeat the same act. The elders can decide on the type of punishment implemented on any village member engaged in destructive activities within their boundaries, despite the existence of village councils. Individuals who deliberately engage in wrongdoing and do not fulfill the punishment given by elders (without satisfactory explanation) may be cursed by their elders.

Senior elders are also a source of wisdom for younger generations. Various ceremonies are conducted within the Maasai communities. Some ceremonies concern only men while others concern both men and women. Others are very specific to particular age-sets and only individuals from a respective age-set can attend (Maasai Association, n.d.; Talle, 1988). In other cases, women are involved because they have to prepare food or play a specific role in men's ceremonies. At these ceremonies, important beliefs, customs, and information are passed from Maasai elders to young people (Sirima, 2015; Talle, 1988). Knowledge about forest resources use and management are also passed on from elders to young people during these initiations. While these traditional ceremonies are cherished by many young men and women, they are slowly disappearing. As reported by the Maasai Association (n.d.) and in Sirima (2015), young men in the Twenty-First Century do not feel the need to go through some of these traditional practices.

Forests play important roles in the cultural practices among Maasai people. The Maasai warriors (*Ilmurran*) engage in practices such as the *Olpul* (pl. *Ilpuli*) in which they go to secluded areas in the forest and engage in meat eating for a significant amount of time. Talle (1988) reports a two- to three-week time. Specific herbs are used to prepare the soup.[16] Whether these ceremonies have any impact on the health of the forests

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16 Talle (988) has also reported that while sometimes the Elders (Olpiron) might provide cows for slaughter during Olpul, often the warriors raid cows for this purpose.

depends on how much fresh wood is extracted during preparation of both meats and soups in relation to the abundance of species in a particular forest.[17]

Polygynous nature of Maasai and forest resources use. In Maasai culture, it is considered acceptable and prestigious for men to marry multiple wives. In fact, a man with multiple wives is considered wealthier as he can afford to pay the bride prices for multiple women (Talle, 1988). Similar reasoning behind polygyny has been observed in many African ethnic groups (Chojnacka, 1980; Tertilt, 2005). While this practice is socially acceptable and sometimes leads to food security among Maasai women (Chojnacka, 1980), the behavior can pose serious environmental health consequences. Due to their polygynous nature, Maasai family sizes are among the largest in Tanzania due to high household birth rates, and consequently among the tribes which evidence very high population growth rate. In Ngorongoro, where the majority of Maasai reside, for example, an average annual

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17 Many of these ceremonies are conducted for men; women go through ceremonies that focus only on circumcision and marriage (Maasai Association, n.d.). Talle (1988) and the Maasai Association describe some of the key ceremonies undergone by male youths, including "Enkipaata" (pre-circumcision ceremony), "Emuratta" (circumcision, performed soon after young men go through puberty), "Enkiama" (marriage), "Eunoto" (warrior-shaving ceremony – this is also a period of graduation from moran phase), "Eokoto e-kule" (milk-drinking ceremony), "Enkang oo-nkiri" (meat-eating ceremony), and "Olngesherr" (junior elder ceremony). According to the Maasai Association, circumcision (Emuratta) is the most important phase of young Maasai men's phase and many of them are always eager to enter this phase. Once the boys are circumcised and become warriors (Moran), they resume their responsibility as territory defenders. Eunoto (the warrior-shaving ceremony) is performed ten years after Emuratta, and it transitions a junior warrior to a senior warrior. At this stage, a warrior is permitted to marry. Eokoto e-kule (the milk-drinking ceremony) is performed by senior warriors a few months after "Eunoto". At the milk-drinking ceremony, young men are taught "to be self-reliant rather than dependent on their mothers who mostly prepare food for her husband and the young ones." At this phase, the young men must eat in their age-set and not alone. Enkang oo-nkiri (the meat-eating ceremony) is another phase most young warriors are eager for as it involves eating meat; warriors can eat meat prepared by the homestead meat or by themselves. The last age-set's ceremony is Olngesherr (the junior elder ceremony) which concludes the warriorship of a youth. Every young man in the age-set looks forward to this final ceremony too. Additional ceremonies held by young boys and girls include Eudoto/Enkigerunoto oo-inkiyiaa (related to earlobe making), and Ilkipirat (leg fire marks). Boys and girls must go through "Eudoto/Enkigerunoto oo-inkiyiaa" and "Ilkipirat" initiations before circumcision (Maasai Association, n.d.).

growth rate of 4.5 percent was recorded between the 1988 and 2002 censuses, and an annual growth rate of 3.5 percent was observed between 2002 and 2012 censuses (URT, 2006; URT, 2013). The polygynous nature of the Maasai ethnic group thus implies a higher population growth rate and possibly more livestock holdings (since livestock keeping is the main economic activity for the Maasai), if all other factors remain constant. Both higher human and livestock populations may in turn mean higher demand for forest products and thus more clearance of forested areas. Currently, overgrazing by livestock is one of the threats facing ECF because the number of livestock grazed in the forest each year exceeds the carrying capacity of the forest. The forest is used as grazing land during the dry season when pasture is scarce in the savanna plains. During my field trips, destruction due to grazing was evident in the area and local people pointed to livestock as one of the major causes of deforestation.[18] Moreover, due to increased population in the area and unpredictable rainfalls, more new areas (including forested areas) are being converted to agricultural fields. While in the field I witnessed many new farms that are owned by pastoral Maasai. Some Maasai adopted farming only as a supplement survival mechanism in an effort to adapt to climate change. If the population of the Maasai continues to grow at such a high rate, the number will triple in just two decades and the risks of forest destruction will only get higher.

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18 Non-Maasai local people always talked about how livestock were degrading the forest. The Maasai, however, argued against this reasoning by saying livestock cannot destroy livestock; that it is illegal loggers that have negative impacts on the forest. I assume that because livestock is not only important to them economically but also culturally, the Maasai will not let them perish for the sake of preserving the forest. It is therefore possible that they do understand the negative consequences of grazing livestock in the forest but meeting grazing needs is more imperative to them.

As observed in the Loliondo area and other parts of Northern Tanzania, more and more Maasai are shifting their economic activities from livestock to farming due to climate change, thus putting more pressure on natural forests. Larger human populations may also mean more livestock in the pastoralist areas, if all other factors remain constant.

1.3.5. Livelihood strategies among Pastoral Maasai and other ethnic groups

Pastoral Maasai have historically engaged in semi-nomadic life, keeping large herds of livestock in a *transhumance* fashion where herds are moved from one grazing land to another. In Loliondo, for example, they tend to graze livestock in the Serengeti Plains during wet season and on hills and near wetland areas during dry season. Cattle play an important role in the Maasai's economy because they are a source of meat, milk, and blood – the Maasai's major foods. These foods are often supplemented by corn or other grains, which in most cases they acquire through trading their cattle with cultivators (Talle, 1988). While most solely depend on livestock keeping as their economic activity, some Maasai have been reported to engage in small-scale farming as a supplemental economic activity (Kivelia, 2007). There appears to be a shift to the agro-pastoral economy, especially in recent years, due to various factors, including climate change. More Maasai are adopting farming as both a primary and a secondary economic activity (Kivelia, 2007). The drought that hit most parts of Northern Tanzania in 2009, for example, led to large numbers of losses of Maasai livestock which made livestock a less-reliable source of income among Maasai in the Longido and Monduli Districts (SFTZ, 2010).

The Maasai's effort to adopt farming as a supplementary economic activity started some decades ago, although the change has been very slow. Talle (1988) reports that the shifting of the Maasai's economy from pastoralism has been triggered by various events, including diseases,[19] governmentally induced efforts (colonial and post-colonial governments), and climate-related events. The severe rinderpest epizootic disease that broke in the early 1980s contributed to massive losses of Maasai livestock; prior to this disease, there was also another outbreak, the Contagious Bovine Pleuropneumonia (CBPP) (Talle, 1988). Moreover, consecutive droughts during the same period killed about 80% of the Maasai herds (as cited in Talle, 1988). These catastrophic events led some pastoral Maasai in Kenya to resort to farming, mostly by providing labor on other people's farms (Talle, 1988). Since they knew nothing about farming, Talle (1988) argues that they had to learn from their agricultural neighbors (the Kikuyu) whom they had maintained relationships with through inter-marriages and trade. Others also shifted to hunting for survival (Bernsten, 1970, as cited in Talle, 1988). From these accounts, we can see that attempts to engage in farming started decades ago (Talle, 1988).[20] It never really took off because evidence from both Kenyan and Tanzanian sides show that pastoral Maasai mainly cultivated smaller farms to supplement their dairy diet (Kivelia, 2007; Talle, 1988). The Maasai despised farming activity and for many years they

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19 Another disease that is noted is the smallpox epidemic that led to the loss of a large part of the Maasai population (Talle, 1988)

20 Talle (1988) argues that farming among Maa-speaking people started as early as the 1930s although this happened only in areas conducive for agriculture (areas with higher rainfall). Talle also argues that most farming was done by Maasai of mixed ethnic groups such as Maasai-Kikuyu descent.

perceived it as an inferior economic activity compared to livestock keeping (Talle, 1988). Talle also found that,

> Cultivation has been a pursuit which pastoral Maasai have turned to only in desperate circumstances, such as when their herds have been depleted by epizootics or drought. However, when destitute Maasai have had the option between cropping and employment as means of income they have usually chosen the latter. (p.40)

Kivelia (2007) also finds similar reasoning behind the Maasai's adoption of farming. One of his interviewees in Ngorongoro stated that, "In the past we were fed by our cattle. Now that we do not have enough cattle to feed our families, we have to cultivate." The literature also points to a decline in grazing land as a major factor that has led to more Maasai adoption of farming. Farmers (non-pastoralists) and government-sponsored development initiatives have largely contributed to conversion of rangelands to cultivated land; consequently, there has been a severe shortage of grazing land among pastoralists.[21] Talle (1988), for example, argues that encroachment of Maasailand by

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21 During colonial rule, most of the Maasai land was taken by German and British settlers through conversion to protected areas and agricultural areas (Talle, 1988; Ojalammi, 2006). Alleviation of Maasai lands happened on both the Kenyan and Tanzanian lands where the Maasai previously had had control. Additionally, most Maasai were also forcefully moved from their original habitats to new smaller areas (Talle, 1988; Ojalammi, 2006). Finally, programs that supported farming during the colonial period were prioritized, and thus little support was provided to the Maasai. The new constrained grazing areas did not conform to grazing practices of the Maasai. Due to the semi-arid to arid nature of most rangelands, Maasai practice a grazing system that allows seasonal movement between one grazing land and another (i.e., semi-nomadic or transhumant). During the wet season, livestock are grazed in the open savanna plains; in the dry season, livestock are moved to the hills and near swamps or wetlands where perennial grass can be found. This rotational system allows grazed grass to recuperate before it is grazed again. Talle (1988) has argued that because the rotational grazing of large herds requires large tracts of land, land restriction might pose negative impacts on the environment since the recuperation period between utilization periods is shortened.

agricultural farms has also been a factor in reducing the total grazing land for pastoral Maasai.[22] Kivelia (2007), however, finds that land cultivation—specifically in Loliondo and Ngorongoro Conservation Area—is not solely practiced by non-pastoralists; pastoral Maasai are also increasingly participating in farming. Identified motives for increased farming among the Maasai in the Ngorongoro District include a need to meet their subsistence needs caused by a declining livestock population and a need to maintain their large herds. Kivelia (2007) argues that wealthy Maasai people are more likely to cultivate large tracts of land and later exchange their crop yields with cattle to maintain large herds. Another motive provided by Kivelia (2007) is the need to deal with land tenure issues. Wealthier pastoralists acquire large tracts of land for farming and keep large herds on the peripheries of the area.

Overall, more and more Maasai are adopting farming as a mechanism for survival. The reasons provided are all rooted in increased population (either through in-migration or high birth rates) and climate change which has led to unpredictable droughts in drier areas. Other economic activities engaged in include wage-based employment, casual labor, selling of forest products such as firewood (by women), petty businesses, and tourist-related small-scale businesses. These economic activities are practiced to a very small extent, however (Kivelia, 2007).

Another tribe of significant importance in comparison to other minority groups in the Loliondo is the Sonjo, although it contributes a much smaller proportion compared to

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22 The ethnic groups who rely on farming were also moved during the colonial period and thus sought new arable land in unoccupied Maasai areas (Talle, 1988).

the Maasai. Unlike the Maasai, the Sonjo have always been sedentary agro-pastoralists and live in more compact villages like many other ethnic groups in Tanzania (Western & Wright, 1994). Sonjos also practice irrigated and rain-fed agriculture. Unlike the Maasai, Sonjo's keep smaller herds of livestock, practice beekeeping, and hunt (Ojalammi, 2006). Agricultural farming is well organized by Sonjo community members in the sense that even though farms are privately owned, they make arrangements for each field to be watered. For example, they may open irrigation ditches to allow water to go to farms on one side in the morning then in the evening water may be directed to farms on another side. Like the Maasai, grazing land is held communally. Only one (Tinaga) of the eight studied villages is inhabited by the Sonjo ethnic group.

Other minority ethnic groups are largely in-migrants and are found mostly in district headquarters and largely inhabited two villages: Loliondo and in some portions of Sakala. The minority groups in Loliondo engage more in smaller-scale to large-scale businesses in addition to farming, their main economic activity. Most waged employees are from the minority ethnic groups.

In relation to forest resources management in the Loliondo area, more engagement in farming means more clearance of forested areas and rangelands. Already, increased population is putting pressure on forest resources in many ways, including the need for farm extensions to accommodate livelihoods of large and new families as well as more demand for forest products.

1.3.6. Historical land tenure systems and the emergence of land-related conflicts

Understanding the history of land tenure systems in Tanzania helps us comprehend how land-related conflicts emerged between clans/sub-clans/tribes, ethnic groups, and between these groups and the government or foreign investors in various parts of the country, as well as in Loliondo. While discussing land conflicts in Tanzania is not the aim of this research,[23] it helps a reader grasp the nature of ongoing tensions in the Loliondo area and Ngorongoro District as a whole. It also helps to understand its potential impacts on both development and conservation projects. In particular, it helps the reader understand how these conflicts may have affected the study reported here. I first briefly describe land tenure systems implemented during three different periods (pre-colonial, colonial, and post-colonial) as well as how the changes in land tenure systems have led to land insecurities and land-related conflicts in Tanzania.

Land tenure systems in pre-colonial period. Prior to colonialization, the Tanzanian main land (also called Tanganyika during the colonial period) was administered under customary laws.[24] Chiefdoms[25] had traditional systems for dividing and sharing land and

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23 This has been done by other scholars (see Ojalammi, 2006; Rurai, 2012)

24 Cited from Larsson (2006);

   Customary law in Africa is the non-formal complex of codes of behaviour and social control that have guided rural life in tribes and societies from generation to generation. These "laws" vary among societies and also show local differences between villages within the same tribe. It is made up of fragments of rules, customs and taboos embedded in the tradition and comprises practical knowledge about methods of land management, procedures for dispute settlement, rules for social privileges and obligations within the society, as well as rules for leadership succession et cetera. (Ndjovu, 2003:75) Significant for customary laws is the oral tradition, whereas written documentation has not yet been fully accepted. Customary laws may seem conservative in preserving old manners and ethics, but they are also dynamic through their ability to transform over the years. (James, 1971:61f) (p.18)

the resources on it. Previously cited works report that during the pre-colonial period, land ownership was more identified at the community rather than at the individual level. This literature suggests that land ownership was never conferred upon an individual, and that the right to use the land was perpetual, unless the occupier terminated their user rights by not using the land. The following was presented in one court case (as cited in Tenga, 1992;

> The Bantu had no idea of a right of the land in itself in *re,* land was just there for cultivation and was in no sense a chattel. The general right over the land might be termed an usufructuary, occupational, agricultural right, and heritable. A man had security of tenure as long as he behaved himself and obeyed the chief and, if the land was agricultural, kept it under cultivation ... Allocation of the lands was in the hands of the handmen, elders, clan heads or chiefs … The land was there for the community … in other words the right of the community or the general good was overriding (p. 7).

The above argument may bear some truth among pastoral populations such as the Maasai who tend to have communal access rights to grazing lands or water points. This form of land access for grazing purposes has continued until today. Ojalammi (2006) also supports the above argument by saying most of the land found on the savanna plains is considered to be "collective property" where all the Maasai have the right to graze their livestock and access water. While communal ownership of grazing land is common

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25 Before colonization, the Bantu in Tanzania's mainland were organized into chiefdoms led by chiefs (Tenga, 1992). This social organization continued to exist until after independence under Mwalimu Julius Nyerere, Tanzania's first president.

among Maasai communities, some sub-groups of Maasai (e.g., specific clans or sub-clans) have been reported to claim ownership of specific grazing territories (Markakis, 2004). For people of different clans to use another clan's grazing land or water resources, negotiations can be carried out between the groups; if not, conflicts may erupt (Pkalya, Adan, & Masinde, 2004, as cited in Markakis, 2004).

Contrary to the anthropological argument presented above, Tenga (1992) argues that studies about African tribes provide evidence that different tribes had customary laws that guided land ownership and distinguished various forms of ownership, including ownership by "tribe, viz public lands, individual lands, communal lands, and land held by virtue of office, e.g. Chieftaincy or Priestly Office" (p. 8). Both the Haya and the Chagga, for example, have been reported to use traditional land tenure systems.[26] Tenga (1992) also argues that different tribes have been reported to have had their own protocols for land allocation, land holding, and land transfer, and that only those who belonged to a specific group enjoyed specific arrangements. For example, a clan might set aside land for different purposes such as graves, rituals, grazing, and for water protection. If a tribe is pastoralist or agro-pastoralist, they might set aside land for pasture and land for other practices. Tenga (1992) also reports that during the precolonial period, traditional authorities were put in place to allocate land; this was especially true for agricultural communities. Tenga (1992) further argues that land was not just there for anyone to use without following any rules; instead, traditional rules played important roles in

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26 Customary land rights are those practiced and used within a tribe or clan (Tenga, 1992; Larsson, 2006), and thus they may apply at either level or both.

determining the best way to utilize land resources. Other scholars, including Larsson

(2006) and Talle (1988), support this argument. The description provided by Talle (1988)

below demonstrates the existence of some of the traditional land tenure systems found

even in the Maasai populations.

> The pastoral Maasai acquire exploitation rights to land by virtue of territorial
>
> affiliations. Maasai and its inhabitants are divided into some twenty territorial
>
> sections (*olosho*, pl. *iloshon*) within which people are more or less free to exploit
>
> pasture and water resources. The various sections differ greatly in size and
>
> number of inhabitants. The borders of the sections are founded on customary use,
>
> but were formally decided on colonial time. The section boundary is not absolute,
>
> however; in times of drought and stress people negotiate access to pasture and
>
> water across sections. (p. 31)

Land tenure systems under German and British rule. Germany's colonization of East

Africa (Tanzanian mainland, Rwanda, and Burundi) started in the 1880s.[27] In 1895,

Germany enacted an *Imperial Decree* that declared all land to be *un-owned Crown land*,

entrusted in the German Empire (James, 1971). This meant that all land was under the

German Emperor unless one could prove ownership of the land (James, 1971). James

(1971) states that "any native land reserve could subsequently be alienated if the

governor so decided" (p. 15). James (1971; Tenga 1991, as cited in Ojalammi, 2006)

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27 According to James (1971, p.13, cited in Larsson, 2006), colonization of the Tanzanian mainland started when one of
the German adventurer and explorers, Dr. Karl Peters, acquired large tracts of land (through dubious agreements) from
local chiefs and established The German East Africa Company, which led to acquisition of imperial protection; this
marked the beginning of German influence in East Africa. The actual colonization followed the Berlin Conference of
1884-1885 which aimed at regulating European colonization and trade in African countries.

further observes that since indigenous land tenure systems were implemented through informal documentation (mostly orally), their land was often treated as unowned. Thus, most tribes were left with *permissive rights of occupation* which allowed them to use the land but not own it. Unlike native people, German settlers were granted documented freehold titles which allowed them to own land in perpetuity. Because the Germans were interested in increasing productivity in the area, individuals or families that did not meet development conditions had their lands confiscated and given to foreign settlers (Commission report, 1994, as cited in Larsson, 2006). Productivity was determined by looking at the amount of cultivated land or stocking, if land was given for livestock purposes (James, 1971).[28]

In 1919, Germany was forced to renounce its sovereignty over all its colonies under section 119 of the Versailles Treaty. Under this treaty, German colonies were also handed over to other powers within the League of Nations;[29] the Tanzanian mainland was given to Britain in 1920, while Burundi and Rwanda were given to Belgium. When the British took over German rule, they implemented various laws that restricted land use by the natives. For example, they enacted the *Game Reserve Ordinance* which led to the creation of protected areas in places where wildlife was abundant; some of these areas were already (or were planned to be) gazetted under the German Ordinance of 1908/1909. The *Game Reserve Ordinance* not only took away native lands for wildlife

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28 Under German rule, land ownership rights were granted for the benefit of the plantation sector (with crops such as sisal, coffee, cotton and rubber) and of the settlers. The indigenous people were viewed as subsistence producers and thus were not granted legal rights to land (Tenga 1991, as cited in Ojalammi, 2006).

29The League of Nations was an intergovernmental organization founded in 1920 as a result of the Paris Peace Conference to end World War I.

preservation purposes but also regulated their hunting rights. As stated in the law, "No person shall hunt any game unless he holds the appropriate Game License" (URT, 1994, as cited in Ojalammi, 2006, p. 29). Another land-related law was the *Land Ordinance* enacted in 1923; this law led to the abolishment of the German decree. Under this ordinance, land was declared as public, whether it was initially owned by natives or not. The governor was given authority over all the land on the Tanzanian mainland territory. Exception was given to land initially acquired as freeholds before the passage of this law; freehold titles and leases previously held by German settlers were passed on to the British (Commission report, 1994, as cited in Larsson 2006), although James (1971) argues that it is unclear to what extent these freehold titles were converted into English-type freeholds.

Under the *Land Ordinance* of 1923, the British implemented two types of land ownership on public land, *granted rights of occupancy* and *deemed rights of occupancy*. *Granted rights of occupancy* provided the person with rights to use and manage land for a period not exceeding 99 years in accordance with the agreed conditions. The governor had the power to grant and revoke these rights although the law also required him to consult with native laws and traditions.[30] Some scholars have argued that while the 1923 ordinance recognized customary laws and traditions, "it failed to establish a procedure to

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[30] Under section 4 of the Land Ordinance of 1923, "The Governor in the exercise of the powers conferred upon him by this Ordinance in respect to any land shall have regard to the native laws and customs existing in the district in which such land is situated."

safeguard that principle" (James, 1971, p. 19).[31] *Deemed Rights of Occupancy* were

implemented on native people and it simply allowed them to continue using the land they

initially owned but without any ownership rights (Tenga, 1992). Therefore, most native

people remained with no ownership rights to the land they previously owned.

Traditional authorities who were initially charged with land allocation were

replaced with native authorities under the *Native Authorities Ordinance of 1926* (as cited

in Tenga, 1992). The regulations in the Native Authorities Ordinance restricted the

amount of land that could be cultivated, and people faced sanctions whenever they failed

to abide by the rules (as cited in Tenga, 1992). Gradually, the native authorities were

replaced by local government authorities created under the *Local Government Ordinance*

of 1953 (as cited in Tenga, 1992). Unlike traditional authorities, the new local authorities

were elected by the people in their constituent areas. According to Tenga (1992), the

native authorities were completely phased out by the local government authorities, and

chieftaincy was completely abolished by 1963.

Other laws that had an impact on native land rights include the *Game Ordinance*

and the *National Parks Ordinance* which were enacted in 1940 and 1948, respectively;

these two laws had great impact on the establishment of conservation areas in rangelands

as well as on land alienation in the Serengeti and other places (Ojalammi, 2006).

Ojalammi (2006) also cites that despite the enactment of the two laws, "native property

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31 Ojalammi (2006) also cites that the Land Ordinance of 1923 "failed to establish the principle of protecting native rights
to land. Nor could the Ordinance prevent compulsory acquisition of native lands by the government for the benefit of an
immigrant. Furthermore, in the 1920s under the British colonial administration, the chiefs (the traditional land
allocation/governing bodies) were transformed by the colonial powers into Native Authorities established by the
Governor. This was done through the Native Authority Ordinance of 1926."

rights" of the pastoral Maasai who resided in the national parks were protected and ensured under the *Game Ordinance* of 1940 during this period.[32] Another law, the *Ngorongoro Conservation Area Ordinance* was enacted in 1959. This ordinance controlled entry and wildlife utilization and management in what is known currently as the Ngorongoro Conservation Area (Shivji & Kapinga, 1998, as cited in Ojalammi, 2006). We shall see how this changes in later years.

Land tenure systems in the post-colonial (socialist) period. When Tanzania became independent in 1961, it adopted the Land Ordinance of 1923 and made some minor amendments; various land-related laws were later enacted. Soon after independence, Mwalimu Julius Nyerere, Tanzania's first president, signed the *Arusha Declaration* in 1967. In this doctrine, he laid out plans for developing the country.[33] Tanzania was then committed to a policy that aimed to ensure socialism and self-reliance (*"Ujamaa na Kujitegemea"*). This development philosophy aimed to ensure that people worked hard and in a communal manner and that individuals did not pursue personal interests or ambitions but rather focused on communal goals. It encouraged communal ownership of basic goods, and collective achievements were emphasized and encouraged. For example, people were encouraged to create communal farms where every able-bodied adult was obliged to contribute their labor; the village government decided which crops to grow and

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32 Talle (1988) argues that protecting the Maasai in the protected areas was a way of preventing or restricting cultivators in the area.

33 Prior to the Arusha Declaration, there were other statues that had been enacted. Like the Arusha Declaration, the prior statues aimed at facilitating socialism and self-reliance through increasing agricultural productivity by the Tanzanian people. These statues include: The *Rural Settlement Commission Act,* 1963 and the *Land Tenure (Village Settlements) Act,* No 27 of 1965, amended by the *Rural Settlement Commission (Dissolution) Act,* No 17 of 1966 (Tenga, 1992)

what to do with the surplus. With regard to land rights, Mwalimu Nyerere reasoned that land should remain public property so that future generations could have access to land. He assured people that every Tanzanian citizen would have rights to use land (as cited in Larsson, 2006). His emphasis was that land should be publicly owned, with individual rights granted through leaseholds instead of a freehold system, where all decisions of property rights are individually owned.

In order to achieve development plans laid out in the Arusha Declaration, villagization reforms were planned by enacting The *Villages and Ujamaa Villages (Registration, Designation and Administration) Act, 1975* to facilitate smooth running of new villages. This law provided for the registration, administration, and designation of *Ujamaa Villages*. Villages could be registered as independent bodies; village councils were formed to operate these villages. The councils were given power to regulate economic activities and to decide how land within their jurisdiction would be used. Under this law, people were encouraged to move to *Ujamaa Villages* where they could implement communal farming as well as access services from central places (the village center). In order to encourage migration to *Ujamaa Villages*, various initiatives were put in place. For example, Larsson (2006) documents that financial support and other benefits were offered to those who were willing to voluntarily form *Ujamaa Villages*. Also, regional campaigns were conducted to create awareness among rural people. There was, however, resistance among many populations (Maliyamkono & Bagachwa, 1990), so the move was very slow despite these incentives (Larsson, 2006). Later the government decided that all rural populations needed to move by 1976, so they initiated what was

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called *Operation Vijiji*[34] to facilitate movement of people to *Ujamaa Villages* (Fimbo, 2004; Maliyamkono & Bagachwa, 1990). By the end of the operation, about 7,500 villages were completely restructured (Larsson, 2006). We shall see later how the villagization process later contributed to ongoing land-related conflicts.

Other laws that were enacted and implemented after independence include the *Range Development and Management Act,* which was passed in 1964. The act aimed to help regulate land use among pastoral ethnic groups. It required that pastoralists form and register Ranching Associations (RA) that would guide and implement a more effective grazing pattern on communal land within marked territories. Each Ranching Association would be given *Granted Rights of Occupancy* (GRO) to use the land for a period not exceeding 99 years (Tenga, 1994, as cited in Ojalammi). This was again problematic because if a person did not join the RA, then it meant they would not have rights to graze their livestock on the land; contrary to customary laws that allow every community member to enjoy communal resources. Moreover, RA members would decide who to give membership to, meaning that there would be no guarantee for some people to be part of a chosen RA. Also, the enactment of the *Wildlife Conservation Act* of 1974 negatively affected pastoralists in Northern Tanzania in that it not only controlled wildlife utilization in protected areas, but also restricted entry and livestock grazing in areas such as National Parks (URT 1994, as cited in Ojalammi, 2006). This meant that the pastoral populations could no longer enjoy their grazing rights in the Serengeti Plains as they did during the colonial period.

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34 Also referred to as "*Operation Sogeza*" (See Maliyamkono & Bagachwa, 1990)

Land tenure systems in the post-colonial (post-socialist) period. Various scholars have

argued that the consequences of villagization left chaos and confusion concerning land

tenure because it was neither thoroughly planned, nor legally established, (Chaula, 2004,

as cited in Larsson, 2006; Fimbo, 2004). As a result, land conflicts grew in number. In

order to correct land issues that resulted from the socialist period, the villagization

campaigns were halted in 1977 (Chaula, 2004, as cited in Larsson, 2006). In 1985,

Mwalimu Julius Nyerere resigned and was succeeded by Ali Hassan Mwinyi, the vice

president. Larsson (2006) argues that the new government foresaw the problems of land

rights and thus initiated a village titling program which aimed at surveying and

demarcating village borders in order to secure single right of occupancy for each village

as a whole. According to Fimbo (2004), this move was a result of the government's

dismay towards the land disputes that had been brought to the courts of law, majority of

which had been won by the peasants. Each village council would then be in charge of

granting leases to village members and individual ownership was not permitted (Fimbo,

2004; Larsson, 2006). Like Fimbo (2004), the land commissioner appointed to investigate

land problems argued that this effort aimed at abolishing customary ways of land

allocation (as cited in Larsson, 2006). Unfortunately, the initiative was not successful

because it turned out to be slow, expensive, and with numerous legal flaws (Fimbo, 2004;

Larsson, 2006). Other problems, such as double allocation, also arose as a result of a

village titling program (Tenga, 1992).

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After intensive research and discussion concerning land use issues,[35] a new

National Land Policy was enacted in 1995 (Zainab, 2004, as cited in Larsson, 2006). In

1989, a new land act was called for to correct a multitude of land issues that were

haunting many rural populations (Larsson, 2006). The *Land Act* and the *Village Land Act*

(relevant to village land only) were also passed by the parliament in 1999, and the Land

Ordinance of 1923 was finally repealed by the Land Act (Sundet, 2005). While the new

acts clarified many sections that were previously unclear, and provided for procedures for

how each section should be executed, Sundet (2005) argues that they also replicated

many fundamental problems that previously existed in the government system.

Consequently, land issues in Tanzania continued to exist.

Under the Land Act of 1999, two types of user rights were provided for,

Customary Right of Occupancy (implemented on village land) and the *Granted Right of*

Occupancy (implemented outside village land). Villages as groups of individuals were

granted rights to own land, but individuals could only obtain user rights. Under the 1999

Land Law, individuals could obtain perpetual user rights under the *Customary Right of*

Occupancy, but only up to a maximum of 99 years under the *Granted Right of*

Occupancy (Land Act of 1999). To maintain user rights under either occupancy right, the

user is required to use the land for the purpose it was planned for. While *Customary*

Rights of Occupancy are perpetual, Larsson (2006) argues that the restriction on land use

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35 Before the new National Land Policy was enacted in 1995, a number of studies commissioned by domestic and
   international experts, a presidential land commission, and a national workshop were implemented (Sundet, 2005, cited
   in Larsson, 2005). The National Land Policy also went through various drafts before it was enacted in 1995. "After two
   years of intense research and discussion on matters of land tenure, the land commission submitted its exhaustive
   report in November 1992." (Larsson, 2006, p.43)

"is meant to avoid people from trying to grab land for speculative purposes" (p. 35). The

government thus made a good attempt to secure customary land rights by enacting the

Land Act in 1999, although land use conflicts still persist today (Rurai, 2012).

1.3.7. Impacts of land-related legal reform on land tenure conflicts (and trust) among pastoralists in Loliondo

Most of the land conflicts experienced in Loliondo are a result of various land

laws implemented during and after colonial periods. As described above, most laws were

not implemented as intended; as a result, they have had negative social consequences

(James, 1971). The Land Ordinance of 1923, for example, included a statement that

required a governor to consider customary laws before acquiring land from native people

for leasing to settlers or for other government initiatives; but as discussed above, this was

rarely the case. Tenga (1992) recounts a land conflict case of National Agriculture and

Food Corporation (NAFCO), a government parastatal agency, and Barabaig, native

people of the Hanaga District. In this case, NAFCO acquired land that was initially used

by the Barabaig people for grazing, ritual practices, and as a graveyard, but the agency

that granted the rights of occupancy did not follow legal procedures specified in the Land

Acquisition Act of 1967 (Shivji, 1995, as cited in Tenga, 1992). While section 5 of the

Land Ordinance Act of 1923 required that the president consider customary laws when

exercising power, this was not the case in the NAFCO case. Moreover, the villagization

process that was implemented during the socialist period was not guided by any

legislation (Fimbo, 2004); consequently, rural populations across the country were

forcefully moved away from their own land and left with no security to land (Friis-

Hansen, 1986, as cited in Larsson, 2006). Tenga (1992) similarly argues that the *Villagization Operation* led to land insecurities and weakened local control over natural resources in rural areas of Tanzania.

Larsson (2006) also argues that the *Arusha Declaration* of 1967, which gave rise to the villagization process and the establishment of large-scale parastatal agricultural companies, also negatively affected the land tenure system in Tanzania. In the process of establishing government investments, many claim that most of the land that belonged to the native people prior to the colonial era was confiscated by the government. Consequently, village activities were disrupted and land tenure insecurities for rural populations were heightened as most were left with no secure access to land (Commission Report, 1994, as cited in Larsson, 2006; Maliyamkono & Bagachwa, 1990). Additionally, the need to move all rural populations has been found to have created controversy, as in some cases people were forced to move and there was little time for planning the implementation process (Friis-Hansen, 1986, as cited in Larsson, 2006). This forced migration created anger among people in rural areas as many of them lost land in the process (Maliyamkono & Bagachwa, 1990; Larsson, 2006).[36] Often land conflicts resulted when land was lost during *Ujamaa Villagization*, for example, when land was demanded back by the previous owners (Larsson, 2006). Other land conflicts

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36 Larsson adds that the government foresaw that land tenure would create big conflicts among populations, and so they initiated a Village Titling Program which aimed to demarcate village boundaries and secure single right of ownership to the villages as a whole. The Village councils would then have the mandate to give leases to individual members in the respective village. The Land Commissioner of 1994 (as cited in Larsson 2006), however, argues that this effort aimed to abolish the customary land tenure systems that were already in place. This "action turned out to be not only slow and expensive, but also assailed with legal and procedural problems" (Larsson, 2006, p. 17).

were due to double allocation of land (Havnevik & Hårsmar, 1999, as cited in Larsson, 2006; Talle, 1992).[37]

Rise of land-related conflicts in the Loliondo area and how this has led to mistrust among community members. In the case of Loliondo, land tenure reforms have been blamed for ongoing land conflicts (Ojalammi, 2006; Rurai, 2012). Land that was once traditional grazing land for the Maasai was converted to an area called the Loliondo Game Controlled Area (LGCA) in 1959.[38] This meant that pastoral grazing land was diminished greatly, especially considering the fact that both the Serengeti National Park and the Ngorongoro Conservation Area had also been carved out of the Maasai land. LGCA hunting block was initially used by the government for elite tourist hunting activities. In the late 1980s, in the wake of liberalization,[39] the LGCA hunting block was transferred to the state's parastatal company called the Tanzania Wildlife Company (TAWICO). In 1992, LGCA was leased to Ortello Business Corporation (OBC), a United Arab Emirate's based royal family.[40] Since the Maasai people historically used this land for grazing, they continued to do so even after it was converted to a game-controlled area. Unfortunately, hunting and grazing are conflicting land uses, and cannot be carried out at the same time

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37Double allocation may result especially because multiple government authorities may be involved in distributing one piece of land (James & Fimbo, 1973).

38 In 1959, Loliondo Game Controlled Area was formed by taking the Loliondo Division and a portion of the Sale Division (NLUPC, 1994, as cited in Ojalammi, 2006).

39 During economic liberalization Tanzania shifted from a state-run economy to a market-based economy. As such, most government-owned industries were privatized, and private companies were allowed to engage in wildlife-related businesses.

40 Based on Rurai's account (2012), the OBC uses the hunting land for leisure only; not for business. The initial lease was 10 years, which brought controversy as the Wildlife Act of 1974 required a maximum of five-year leases in the form of concessions.

in one area. This implies that oftentimes the grazing needs of the land collide with tourist hunting activities on the same land. According to Rurai (2012), the Maasai need to graze their livestock in the LGCA from June to December (the dry season) while hunting season begins in July and ends in December. The big overlap in time usage between the two land use types created a challenge.

To minimize land use conflicts, sometimes the pastoralists and the hunting company have to negotiate in terms of where to graze at specific times of the year so that herders do not enter an area when hunting is in progress (Rurai, 2012). This is not always successful, however, especially in times of scarce pasture. Rurai (2012) notes that the coexistence of grazing and hunting activities was not a big problem in the past because the populations of both humans and livestock were still very low. Land conflicts between the pastoralists and the OBC seem to have increased gradually with increased populations; especially in drought periods when pasture is scarce. As noted by Rurai (2012), resource conflicts in the LGCA were reported to have heightened in 2009 when drought hit most parts of Northern Tanzania. At this time, the pastoralists needed as much land as possible to meet their grazing needs and thus opposed to move out of the hunting area in fear of losing their livestock.[41] To resolve the issue, the Tanzanian government forcefully[42] evicted the Maasai to pave the way for hunting activities, which left Maasai feeling neglected by the government. The Maasai also felt that the OBC used the

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41 This meant that hunting activities were interfered with in some way since hunting cannot be conducted in the presence of grazing activities.

42 During this time, a number of Maasai homesteads were burned by the police force (Rurai, 2012). The case was viewed as a violation of human rights by human rights organizations while the government argued that the Maasai were being destructive to the environment.

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government to control the land they use for hunting (Rurai, 2012).[43] Land use conflicts in

Loliondo are complicated by the fact that villages exist within a game controlled area,

which means villagers can implement village land use plans based on the Village Land

Act of 1999. However, since the villages exist within a protected area, it also implies that

natural resource use in the LGCA is restricted by the Wildlife Conservation Act of 1974

and all its amended sections. However, since the pastoralists inhabited the land before

gazettement of the game controlled area, one might argue that the Village Land Act or

people's needs should take precedence, which has not been the case for the Loliondo.

 While the land use conflicts between the pastoral Maasai and the OBC have been

reported mainly in villages adjacent to the Serengeti National Park (Rurai, 2012)—none

of which were part of my study—the impact of these conflicts has been felt across the

whole district. As explained above, pastoral Maasai are semi-nomadic; this implies that

they still tend to temporarily migrate from one place to another in search of pasture for

their large herds; most of them graze in what they perceive as a communal grazing land,

the same land that is used for hunting. Because of this, the Maasai in my study area are

also affected by the ongoing land use conflicts taking place in the LGCA. Chapters Five

and Six discuss further how the land use conflicts in the LGCA affected the

implementation and success of the environmental education project reported here.

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43 While the company pays high hunting fees, this has not led to reduced land conflicts as most of the money goes
 directly to the government. A small portion (25%), which goes back to the district through the district local authority,
 rarely reaches the affected villages in the form of tangible benefits (Rurai, 2012).

1.3.8. Local politics and other contextual factors

Other contextual factors that might have had an impact on the environmental education project include presence of non-Maasai tribes in the area. As described in the demographic characteristics section, the non-Maasai minority groups inhabit the district headquarters area which includes Loliondo and part of the Sakala villages. Non-Maasai tribes also inhabit the Wasso village which is close to the study villages but also part of the district headquarters. The district headquarters is just a few kilometers away from the Enguserosambu Community Forest (ECF), the forest of concern. Informal conversations with village leaders in Maasai-dominant villages revealed that the Maasai perceive other tribes to be more destructive than theirs; they tend to argue that destructive activities such as illegal logging and charcoal burning are exclusively done by non-Maasai ethnic groups. While this may be true, it would be difficult to prove that the Maasai never engage in these destructive activities, especially with changing cultures and livelihood sources among Maasai communities. Moreover, it would be misleading to conclude that major destruction is done by non-Maasai ethnic groups only, considering that the Maasai people construct their homesteads and cattle enclosures primarily using wood which requires them to cut down live trees. Moreover, with limited pasture in other parts of the district, the Maasai have turned to forests as a major source of grazing land, especially during the dry season. The negative consequences of such a biased understanding of their behavior in relation to an environmental education project is that the Maasai may continue to engage in tree cutting and overgrazing inside the forest yet attribute any observed destruction to other tribes. Moreover, due to preconceived notions concerning

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other tribes, the Maasai may not take action to stop cutting down trees or restrict tree cutting in order to conserve the deteriorating forest. This means that implementation of an environmental education project may not necessarily change Maasai perceptions of other tribes and themselves with respect to forest use; as a consequence, they may focus on restricting other tribes from extracting forest products yet continue to over utilize through unplanned overgrazing and extraction of wood for construction.

Understanding local politics that stem from local non-governmental organizations (NGOs) was thus critical to planning how the project was going to be implemented to minimize negative impacts of politics on the project. Since ECF was the only forest surrounded by a large enough number of villages that had no ongoing environmental education-related project in the surrounding communities at the time of this study, it was determined that communities adjacent to the ECF would be a suitable study area. I thus had to plan how negative impacts from local politics could be minimized through clarifying the intentions of FZS and the proposed study. In an effort to ensure that local communities were clear about the purpose of the study and that FZS had no intention of confiscating their forest (which is legally impossible), I made sure we held meetings with village members, including leaders, elders, and non-leaders. We did this in each study village and at each phase of the study. At each meeting, we encouraged people to ask as many questions as possible with the hope that every doubt against FZS would be cleared. Despite all the efforts to address the doubts of the Maasai, the concern was brought up from time to time and it intensified during presidential and district council election

campaigns. Further details on how the doubts expressed against FZS were intensified and their impact on this study are discussed in Chapters Five and Six.

The other contextual factor that might impact the results of the environmental education project evaluated here is the presence of local NGOs in the area. Several NGOs operate in the LGCA, and many of them are involved in resource use conflicts (Rurai, 2012). The presence of NGOs is supposed to be a positive thing as these organizations may help facilitate local and international conservation efforts or help resolve resource conflicts. However, since many of the members in these organizations are from Maasai ethnic groups, some have been suspected of using the ongoing land-use conflicts to instigate mistrust among pastoral Maasai toward other non-local NGOs. Local NGOs have been advocates of land security for the pastoral Maasai, although their true intentions are sometimes questioned. Rurai (2012), for example, documents that the government and the public feel that many of the NGOs use existing land use conflicts as a way to secure funding from international and local donors. During my first field trip, I was informed by local people and staff from the Frankfurt Zoological Society (FZS) that the leaders from local NGOs (specifically PALISEP) seem to be against other organizations trying to operate in the area. Anecdotal stories show that this was the case in the year 2008 when FZS tried to help implement conservation initiatives among communities that surround the ECF. Local NGOs accused FZS of wanting to confiscate the ECF from Maasai communities, which led to fear among pastoral communities in Loliondo. Maasai people were convinced that this was the case, and so they became suspicious of FZS's conservation initiative. Maasai communities have continued to be

skeptical of FZS's intentions. This was evident during implementation of the environmental education project reported here. The doubts kept surfacing throughout the implementation period especially because the FZS funded this research and its staff was part of the project implementation team.

Other contextual factors, such as the presence of churches and mosques in the study area, did not seem to create any negative impacts on the project. On the contrary, the presence of these institutions probably had a positive influence on how people perceived the project in some villages. It was, however, difficult to assess whether the churches had any impact on the project because Maasai villages are spread out and only one small church was observed in one of the Maasai villages. If other Maasai villages had churches or mosques they were probably much smaller in size. The Maasai village that had a small church was equally affected by the local politics caused by political leaders (discussed in Chapters Five and Six) and did not seem to have environmental components in their teachings.[44] Big churches (Lutheran and Catholic) are found in Loliondo village, the non-Maasai village. Loliondo village also had a mosque, although not as big as the two churches. Interviews with three religious leaders all showed that the churches/mosques sometimes (though rarely) incorporate environmental awareness in their preaching but only in a general way about the need to protect the environment. The information is not provided in a systematic manner.

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44 I did not get a chance to talk to a church leader in the Maasai village, so I cannot conclude whether the Maasai church preacher incorporates any teaching about the environment. However, I am confident that teaching about the environment is not their focus.

1.3.9. Enguserosambu Community Forest (ECF): Management, ecological significance, and current threats

The EFC was previously owned by the central government. The ownership rights were not gazetted and the government did not direct any management efforts toward this forest (informal conversation with district officials). Consequently, the Maasai communities adjacent to the forest, have for many years perceived the forest as theirs. As of February 2011, the process for transferring management rights to adjacent communities was initiated, but full transfer would only be completed after a specified period, and then only if the surrounding communities prove that they can fulfill the management requirements (see Forest Act of 2002). Regardless of who has management rights of the ECF, the Tanzanian Forest Act of 2002 requires that each village form a natural resources committee that monitors forest activities taking place on village lands. Additionally, the Forest Act requires that villages adjacent to the forest create a board of trustees with representatives (elected by respective village members) from each adjacent village. In the case of the ECF, the board is made up of members from only the four Maasai villages. The board of trustees is responsible for monitoring forest use and reporting to the village councils of the four constituent villages. Every village council has a natural resources committee which oversees natural resource utilization in their respective villages. In addition to the formal forest management bodies, the Maasai and Sonjo ethnic groups have traditional elders (Laigwanani and Enamijie respectively) who influence management decisions. Village elders are consulted often on how cases related to violation of forest and other village rules should be handled. This is especially true

when the person involved is a village member. Village elders (normally above 30 years of age) tend to be more knowledgeable about traditional forest uses and management, and thus they help guide natural resources use and management within their territories.

The ECF comprises a "sensitive area", as defined by the Tanzanian Forest Act of 2002, because it not only preserves water sources important for local communities but is also a home to most rivers that run through important ecosystems, including the Serengeti National Park, Ngorongoro Conservation Area, Lake Natron, and others (FZS, n.d.). Both the Serengeti National Park and the Ngorongoro Conservation Area are part of the World Heritage Sites. Surrounding communities also depend on the ECF for ecosystem services such as rainfall and temperature regulation. Moreover, most local people in the area depend on forest resources found in the ECF in one way or another. Dependence on forest products has been observed in many ways. First, like in most parts of Tanzania, almost all households use wood as their primary source of cooking energy, either as firewood or as charcoal. The wood comes from the ECF and other nearby natural forests. Moreover, livestock keepers in the area depend on the forest to graze their livestock during the dry season when there is inadequate pasture in the Serengeti Plains. Second, wood is used as a primary construction material, especially by the Maasai and Sonjo populations. Houses, livestock enclosures and fences all require wood poles as primary raw materials. Those who use bricks as their primary house wall material also rely on wood from the local forests to fire these bricks. Finally, some households rely on lumbering or charcoal for their economic activities, even though these activities are not legally permitted in the adjacent forests. While village councils and elders have

guidelines (often undocumented) concerning how many trees and the minimum tree size or location for tree harvesting an individual can cut down for construction and other purposes, many of these guidelines are not based on scientific research. As a result, most tree cutting happening in Loliondo is not proper "selective cutting" that allows easy tree regeneration; consequently, the risk of forest depletion due to overharvesting is very high.

The dependence on forest products has led to a rapid decline in forest cover of the ECF and other nearby forests. Moreover, expansion of existing—and the opening of new farms—adjacent or inside the forest has been witnessed throughout the ECF and other adjacent forests. Kivelia (2007) reports a major decline in forest cover and rangeland due to increased land cultivation. While no forest inventory has been conducted in the past, it is evident that vegetation from the ECF is being lost at an alarming rate. Both physical observation and analysis of satellite imagery show evidence of deforestation (see Chapter Six). A similar analysis of the same area, conducted by Sirima (2015), reports signs of forest decline including forest loss by 7%, drying up of rivers and streams within the forest catchment area by of 30%, and increased scattered trees and grassland over the past 15 years. The environmental education project evaluated here thus aimed at improving local people's understanding of relevant environmental knowledge constructs with the expectation that improved knowledge would eventually lead to more engagement in environmentally friendly behaviors that are key to the sustainability of the ECF.

1.4. Summary of remaining chapters

In Chapter Two, I present relevant literature on natural resources management and environmental education, including scholarly work on forest dependency in rural areas, paradigm shifts in forest resources management strategies, the status of forest cover in Tanzania and some factors that have contributed to its health status, traditional ecological knowledge and its role on forest resources management, gender and age differences in forest use and management, mobile phone use and its applications, communication theories, history of environmental education and its effectiveness, and KAP study methodology. In Chapter Three, I describe my conceptual framework by highlighting how various theories influenced the design of the study, selection of questions, and the determination of a project evaluation strategy. I also describe the questions I explore in this dissertation as well as present relevant hypotheses. In Chapter Four, I briefly describe the ethical considerations made in all phases of the project. I also describe methods used for data collection and analysis. In Chapters Five, Six, and Seven I present research findings. Chapter Eight presents my conclusions and policy implications.

In Chapter Five, I evaluate the impact of two environmental education strategies on knowledge, attitudes, and practices. Study participants in one treatment group received environmental education via discussions in small groups; participants in another treatment group received environmental education via mobile phone texting. I first determine separately whether each of the strategies lead to improved knowledge, attitudes, and practices related to forest use and management. I then compare the findings of the two strategies to determine the more effective approach in the Loliondo area.

While previous studies have looked at how some face-to-face environmental education strategies affect knowledge, no similar study has been conducted in the Loliondo area. Moreover, mobile phone texting had yet to be employed as an environmental education strategy. The findings show a positive association between access to environmental education and knowledge, attitudes, and practices, but only for the face-to-face group discussion strategy. I find increased knowledge in some variables but no strong evidence was found in cumulative knowledge to suggest that mobile phone texting led to increased environmental knowledge. In the discussion of Chapter Five, I discuss some challenges that might have negatively affected the mobile phone texting experiment.

In Chapter Six, I assess the impact of using a participatory photo-mapping approach on knowledge about local forest health status. Muller and Wode (2002) defined participatory photo-mapping (PPM) as the process that engages local community members in identifying earth features on an aerial or satellite photo. Using evidence witnessed on the photo-map, participants discussed how the forest has changed over the past ten years. To assess whether their understanding of the forest health status improved, I analyzed land cover change between two different time periods using the same time reference period as in the survey questionnaire and determined whether the forest declined or not. I compared findings of the survey and interview responses to the land cover analysis results to determine whether participants' knowledge about the forest health status improved or not. Descriptive results of quantitative data showed no evidence that knowledge about forest health status improved. In fact, knowledge about forest health status seemed to decline after the experiment. However, excerpts from interview

transcripts revealed that participants' knowledge increased for individuals who participated in the photo-map experiment. It appeared that politics affected participant's responses during the post-test study. People were not willing to provide correct answers due to fear that their forest would be confiscated if they reported that the forest's health status was declining. I discuss further how politics might have interfered with the results.

In Chapter Seven, I use the post-test survey data to explore factors that influence engagement in environmentally friendly behaviors. The three factors I assess include environmental knowledge, attitudes toward environmentally friendly behaviors, and a sense of personal responsibility. As in previous studies, the findings reveal that for the contexts of Loliondo area, both forest-related environmental knowledge and sense of personal responsibility to protect the forest were positively associated with engagement in environmentally friendly behaviors. I also find that while attitude is positively related to engagement in environmentally friendly behaviors, it is highly correlated with knowledge and personal responsibility; this makes the effects of the other two explanatory variables disappear in the combined model.

2. Literature Review

The literature covered here serves various purposes. Overall, this review aims to provide background information concerning environmental education and its role in forest resources management—the topic explored in this thesis. Literature on communication theories and environmental education (EE) provides a background understanding of how communication of environmental information can be carried out, what information should be considered in EE programs, and strategies used in communicating forest-related information. The literature on the direct and indirect dependency on forest resources and how it complicates their management by locals and the government/NGOs helps the reader understand the links between this reality and EE projects. Similarly, literature on forest management paradigms and forest cover changes in Tanzania helps the reader understand challenges and benefits related to various management strategies and the health status of forest resources in Tanzania respectively. As with literature about dependency on forest resources, that on social capital helps the reader see how expected outcomes such as environmental behaviors may be altered depending on dominant social capital (i.e., bonding versus bridging, or both). Literature on traditional ecological knowledge (TEK) aims to demonstrate that although the aim of EE programs is to impart environmental knowledge with the hope of influencing people's behaviors, as a researcher I acknowledge the fact that indigenous or local people already possess complex knowledge about how forests function and about managing natural resources. The knowledge of traditional people can be as reliable as Western science despite some unsound beliefs. Other important literature, on studies of knowledge,

attitudes, and practices, is aimed at providing an understanding of what social constructs can be measured in EE programs and how to evaluate their effectiveness. Finally, literature on mobile phone usage helps the reader understand the extent to which this technology has been applied in awareness programs, that on gender and age differences in natural resources use and management helps the readers understand why men or women engage more in some forest-related activities and vice versa.

2.1. Forest dependency and local people's role in natural resources management

Communities that inhabit areas close to forest resources often depend on these resources for their livelihoods. As pointed out by Pimbert and Pretty (2000), "Individually and cumulatively, wild species can contribute to the food and financial security of rural households as dietary supplements, hedges against crop failure, income-generators, medicinal plants, construction materials, fodder and fuelwood." Basnet (1992), Hines and Eckman (1993), and Nielsen (2011), like many other authors, also assert the dependency of rural people on forest resources. Basnet (1992) adds that dependency arises mainly because rural people are isolated from the main markets, so they have minimal alternative sources of income and barely receive modern health services. Apart from the medicinal, food and financial security that forest resources provide, many rural people are also culturally connected to these resources (Hines & Eckman, 1993). Maasai warriors, an ethnic group found in Northern Tanzania and Southern Kenya, for example, engage in a ritual practice called "Olpul" which involve the use of forests. Olpul is practiced for renewal and rejuvenation purposes, and involves

going into the wilderness where they do nothing but eat meat and soup mixed with herbs, dance, and sleep. This high dependency of rural populations on forests makes it unrealistic for conservationists to expect local communities to stop using forest resources.

Scholars who promote conservation among local communities have recognized the dependency of local people on natural resources, and thus support the need for them to continue deriving direct benefits from the forests. These conservationists propose that there should be an equitable distribution of benefits accrued from conserved areas (Basnet, 1992; Chilimo & Ngulube, 2011; Nielsen, 2011). However, conservationists generally agree that under most management regimes, the local communities do not perceive any benefits, especially if they border protected forests such as national forest reserves, nature forest reserves, or local authority forest reserves (Nielsen, 2011). In Tanzania, for example, local people in the aforementioned forest types are restricted from utilizing forest resources under the 2002 Forest Act of Tanzania. Because most communities do not perceive benefits from nearby protected forests, they tend not to care about the well-being of these forests and so continue to illegally extract these resources in an opportunistic manner. Consequently, forests have suffered overexploitation, and thus deforestation has occurred. It is important that environmental education progams recognize local uses of forest products when designing curricula.

When thinking about forest resources in rural areas of developing nations, we must recognize that conservation may be perceived differently than in developed nations. Rural people in developing nations depend directly on these resources for their survival. Unlike the developed world, where some natural resources may be conserved for

purposes of recreation, rural people in developing nations may find it difficult to imagine.

Does their need to extract resources mean that rural people are not aware of the roles

played by forests on the environment? The answer is, "not necessarily." As argued by

Basnet (1992), many rural people do recognize the important ecological roles forests

play, and they have always protected these forests. Most indigenous people found near

forests have extensive knowledge not only on how they use forests but also on solutions

to a wide range of environmental problems (Berkes, 2012; IFAD, 2012). As argued by

Stevens (1997), indigenous communities often have land use systems and traditions that

minimize resource destruction. He further argues that where intruders have failed to

exploit natural resources found in indigenous communities, less degradation has been

witnessed compared to adjacent areas.

While this remains true for some indigenous populations, many of them have

changed their way of life due to factors such as climate change (Tsosie, 2007). Berkes

(2012) adds that changes in lifestyle as well as demographic and global economic shifts

have the power to change indigenous societies' values and, in turn, cause negative

impacts on biodiversity conservation. Consequently, human behaviors, including logging

and agricultural expansion, have continued to threaten the future existence of natural

resources in areas occupied by indigenous and non-indigenous communities across the

world.

2.2. Forest resources management strategies: History and paradigm shift

Early conservation initiatives focused on protecting natural resources from people, because human beings were perceived as destructive creatures. Some conservationists, including Bruner, Gullison, Rice, and da Fonseca (2001) advocated for total protection. In Tanzania, for example, forest protection has been implemented by designating "nature reserves" where no human activities are allowed (URT, 1998, 2002). Some scholars have argued that exclusive protection of natural resources by government institutions is the ideal strategy for managing natural resources, while others, including Drijver (1991) and Basnet (1992), have argued that resources never existed in isolation from people, thus there is a need to involve local communities. As research shows, "Statutory protection of species or habitats has been ineffective when local enforcement and social support are inadequate" (Clayton & Myers, 2015, p. 250).

Due to rural people's dependence on natural resources for their livelihoods, and cultural connections they have with these resources, the exclusionary approaches to managing these resources have continued to face resistance from local communities (Basnet, 1992; Drijver, 1991), as efforts of conservation agencies to protect natural resources conflict with residents' efforts to earn their living. Consequently, deforestation has been witnessed in public forests, especially in areas where the local government authorities have had limited resources for managing natural resources (Basnet, 1992; Bray et al., 2008; MNRT, 2006; URT, 1998). Even in areas where states have managed to prevent people from utilizing the natural resources, conflicts have resulted, because in

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most cases local people were the initial residents of natural resource areas before they were nationalized (Basnet, 1992; Drijver, 1991; Maass, 2008).

The illegal encroachment of forests and other natural resource areas has partly been attributed to tensions between residents and conservation agencies. Some of the conflicts have been a result of authorities preventing local people from collecting forest products such as firewood, which local people believe they have the right to utilize. In response to access restrictions placed on them, local people have sometimes deliberately set forests on fire out of anger. Clayton and Myers (2009) characterized such local people's reactions as "hostility and resistance" to the feeling that they are being prohibited from doing something they have the right to do. Observed conflicts provide evidence that managing natural resources without involving local people who typically depend on these resources is a failure (Maass, 2008). As populations continue to grow, more and more tension between local people and government agencies may be witnessed in many parts of the world.

The need for local people's participation in managing natural resources has been called for by many conservationists, including Bizerril et al. (2008), DeFries et al. (2005), DeFries, Hansen, Turner, Reid, and Liu (2007), Oviedo and Brown (1999). Additionally, the continued decline of natural resources, even though under the protection of states, suggests an ineffectiveness of exclusionary approaches in managing natural resources; this has resulted in the need to seek more local people's involvement (Bray et al. 2008; Basnet, 1992; Drijver, 1991; Maass, 2008; Nepstad, Stickler & Almeida, 2006; MNRT, 2006; URT, 1998). Even though the naturalist approach is still widely adopted by many

conservation projects, Ramirez notes (as cited in Lynam, De Jong, Sheil, Kusumanto, & Evans, 2007) that there is increasing recognition that positive impacts regarding natural resources can be achieved if the people found in the natural resource areas are engaged in the identification of problems and in the development of solutions. Bizerril et al. (2011) add that conservation seems to be much more feasible when local communities participate fully. The new conservation paradigm also recognizes that conservation usually focuses on natural resources; however, solutions to issues related to these resources lie within the local people (Jacobson, 2009). From recent studies, we see that residents in natural resource areas can be better managers of the natural resources than outside organizations and institutions such as the government and NGOs. For example, Bray et al. (2008) compared deforestation rates in community forests to protected areas of the Maya Forest of Guatemala and Mexico and found that the deforestation rate was a bit higher in "protected" forests than in long-inhabited community forests. Other scholars have also shown that community-managed forests can perform as well as protected areas or even better sometimes (Hayes, 2006, 2007; Nepstad et al., 2006).

Participatory approaches have for years been regarded highly in ensuring sustainability of natural resource management (Basnet, 1992; Western & Wright, 1994). Conservationists, including Keremane and McKay (2011), Nepstad et al. (2006), Ramirez (as cited in Lynam et al., 2007) have also recognized the need for local community' participation if we are to positively influence local communities' behaviors towards better management of natural resources. Various authors have also suggested that principles such as community participation and citizen engagement help communities

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engage collectively in managing their common resources (Ann Zanetell & Knuth, 2004; Drijver, 1991; Keremane & McKay, 2006a; Mutamba, 2004). Therefore, participation of local people is a critical criterion for managing common goods. This may not be a panacea in every circumstance, as in some cases this strategy has failed (Chilimo & Ngulube, 2011). Local participation in management of forest resources will, however, not yield conservation goals if people are not well equipped with the knowledge and skills they need to deal with environmental problems and if there is no transparency within local resource management institutions.

2.3.   The role of social capital in natural resources management

Per Putnam (1993, as cited in Ballet, Sirven, and Requiers-Desjardins, 2007), social capital is defined as "the features of social organization, such as trust, norms, and networks that can improve the efficiency of society by facilitating coordinated actions" (p. 167). While most scholars, including Ballet et al. (2007), acknowledge that social capital is an important aspect of every society, it can be very expensive to build and maintain. Moreover, the two types of social capital, bonding social capital identified by Putnam (i.e., social capital shared by one ethnic group *within* a community), and bridging social capital (i.e., social capital shared by different ethnic groups *across* communities) can have varying impacts on conservation, depending on which one aligns with desired conservation practices and prevails in the communities. For example, Ballet et al. (2007) point out that social capital can impede proper management of common resources if the embedded cultural dimensions support destruction instead of conservation. They also

note that bonding social capital can inhibit people from adopting new conservation practices, which can in turn prevent development of bridging social capital.

Mutamba (2004) adds that the benefits of social capital may be overshadowed if cultural dimensions play big roles in determining how people behave while the interests of the elites do not align with the poor majority. In Mutamba's case study, conducted in Zambia, the chief, who is revered by everyone in the community, misused his power by secretly proposing to sell a portion of village land without involving villagers. Mutamba described that since everyone was afraid they might face punishment—a cultural norm imposed on anyone who disobeys the chief—no one could confront him about this allegation. Power relations and cultural norms raise the question of how local participation in forest resources management can be ensured. Moreover, the question of which elements of culture have influence on local people's' participation in natural resources management, and how it can be influenced, may only be answered differently in different contexts. If any illegal destructive behavior is performed by elites, for example, others may fail to report such incidents; in this case, social capital may not be beneficial due to destructive cultural dimensions. The same would be expected if a friend or relative engages in destructive behaviors and one fails to report these incidences. As suggested by Drijver (1991), "It is important to know why people participate and why they support, adjust or resist the project. Only if this is known, can one come to a better understanding of how and under what conditions their participation might be intensified upon" (p. 131).

2.4. Forest status in Tanzania: Forest cover, deforestation and causes

Tanzania is one of the richest countries in the world in terms of biodiversity (UNEP, 2002). Due to its variation in altitudes, its natural forests vary in composition, ranging from Montane forests, to Coastal or mangrove forests, to Acacia Savanna, to Miombo Woodlands, and to Alpine Moorlands. There has been a wide variation in estimates of both total forested land and the deforestation rate, however. Reports presented in the 1990s and early 2000 indicated that in 1963, about 50% of the 88.6 million hectares of Tanzania's land was forested, but only 33 million hectares remained under forest cover by the late 1990s (URT, 2001); annual forest loss was estimated at 1 to 2% (URT, 1998, 2002). In contrast, a 2015 comprehensive report by the Tanzania Forest Service Agency, in collaboration with the government of Finland and the FAO, shows that total forest cover amounts to 48 million hectares and annual loss has been about 1% for the past two decades (MNRT, 2015; see Table 2.1 below). The discrepancy in the reported forest cover and annual loss was acknowledged in the Global Forest Resource Assessment country report (FAO, 2010). As stated in the report, "Based on the data sources, the present trend has been defined. Nevertheless, the estimate of forest change raises questions. In fact, it remains difficult to assess the forest changes" (p. 14). The National Forest Resources Monitoring and Assessment of Tanzania Mainland (NAFORMA) report also acknowledges the discrepancies in the early estimates provided by the Tanzanian ministry by stating that,

> In the Global Forest Resource Assessment (FRA) country report, Tanzania has
> reported an annual deforestation area between 130,000 ha and 500,000 ha and was

among the six countries with the largest annual net loss of forest area for 1990-

2000 and 2000-2010 (FAO 2010a; b). However, these figures are known to be

uncertain because they rely on linear interpolation of change estimates derived

from a comparison of historical land cover maps and are therefore not based on a

consistent methodology (MNRT, 2015, p. 98).

Based on the methods employed in the NAFORMA study, the 2015 MNRT report seems

to provide more accurate estimates of both total forested land and annual losses, but only

at the regional level. The 2015 study completed by the MNRT was conducted to establish

a more thorough baseline for forest resources monitoring and assessment on the

Tanzanian mainland. It shows that 48.1 million hectares (55%) are currently under forest

cover and that annual forest loss is currently at about 1% (MNRT, 2015). Despite the

differences in the forest loss estimates, a 1% annual loss translates into 480,907 ha per

year, implying that the deforestation rate in Tanzania is still very high and needs to be

addressed urgently.

Forests in Tanzania are categorized in four groups based on management rights:

national forest reserves, local authority forest reserves, village forests, and private

forests.[45] Under both the central government and the local district authority, there are

forests sub-categorized as "general land" where no funds are allocated for their

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45 National forest reserves include forest reserves, nature forest reserves, and forests on general land. Local authority
  forest reserves include local authority forest reserves and forests on general land. Village forests include village land
  forest reserves, community forest reserves created out of village forests, and forests which are not reserved but are on
  village land and the management is vested in the village council. Private forests are forests on village land held by one
  or more people under a customary right of occupancy and "forests on general or village land of which the rights of
  occupancy or a lease has been granted to a person or persons or a partnership or a corporate body or a Non-
  Governmental Organisation or any other body or organisation for the purpose of managing the forest" (URT, 2002).

management. As with total forested land and annual loss, there has been a discrepancy in the reported size of forests under the general land category. Initial reports documented that about 57% (19,038,000 ha) of total forested lands are under the general land category (URT, 1998). However, the 2015 MNRT report shows that only about 5.7% (2,733,824 ha) are under this category. Experts from MNRT suggest that, "This difference may be due to new definition of general land in the Village Land Act Cap 114 [R.E. 2002]". While it is not the focus of this dissertation to understand the amount of forest under various management rights, it helps to understand to what extent forests in Tanzania are threatened, as these threats differ depending on the level of protection provided on each forest type. For example, it has been cited that most overexploitation takes place on general land, and that general lands are vulnerable to overexploitation because only limited resources are allocated for management purposes of forests under this category (FAO, 2010).

Table 2.1. Comparison of NAFORMA LULC map with previous figures

Forest types in Tanzania	Pre-NAFORMA figures* (1995)	NAFORMA figures (2015)	Percentage difference
Growing stock (forest and woodlands)	1,237 mill m3	2,831 mill m3	129%
Growing stock (other wooded land)	116 mill m3	140 mill m3	21%
Total area of forest and woodlands	33,428, 000 ha	48.090,700 ha	44%
Average growing stock (woodlands)	37 m3/ha	55.1 m3/ha	49%
Average growing stock (shrubs and thickets)	10 m3/ha	21.8 m3/ha	118%
Average growing stock (natural forest, excluding mangroves)	185m3/ha	125.1 m3/ha	- 32%
Average growing stock (Mangroves)	120 m3/ha	48.8 m3/ha	-59%
Total annual loss of forest and woodlands **	403,000 ha	372,871 ha	-8%

Source: MNRT, 2015
NAFORMA: National Forest Resources Monitoring and Assessment of Tanzania Mainland
*Source: (FAO, 2010b) ** Source: Comparison of NAFORMA LULC map with 1995 HTSL map.

Illegal logging and forest clearing by both local communities and outsiders has continued at high rates despite implementation of the National Forest Policy of 1953 and amended policies. The main causes are said to be heavy pressure from agricultural expansion, livestock grazing, wildfires, overexploitation, logging, and other human activities, which mainly occur on the unprotected forests (FAO, 2010). A USAID report prepared by Byers, Aloyce, Munishi, and Rhoades (2012) provides details about specific types of threats in various types of forests and their causes (Table 2.2).

Table 2.2. Threats and causes of loss or degradation of ecosystems in Tanzania

Ecosystem	Threats	Causes
Montane Forests (Eastern Arc, Mt. Kilimanjaro, Mt. Meru, Albertine Rift Mountains	• Loss, fragmentation, & degradation from: • Agricultural expansion (mainly subsistence smallholders, "slash and burn") • Firewood cutting & collection • Bushmeat snaring and hunting	• Use of agricultural practices that do not maintain soil fertility • Lack of sustainable fuel wood and charcoal, and of alternative cooking fuels • Inadequate land use planning and agreements • Low capacity to monitor and enforce laws and regulations
Coastal Forests	• Loss, fragmentation, & degradation from: • Agricultural expansion (subsistence smallholders, and large-scale commercial) • Illegal logging, charcoaling, firewood collection • Bushmeat snaring and hunting • Mining and/or hydrocarbon exploration and development	• Use of agricultural practices that do not maintain soil fertility • Lack of sustainable fuel wood and charcoal, and of alternative cooking fuels • Inadequate land use planning and agreements • Unclear, insecure, and/or overlapping land and resource tenure • Low capacity to monitor and enforce laws and regulations
Acacia Savanna	• Conversion to agriculture (rainfed & irrigated) • Blockage or degradation of movement corridors and wet/dry season migration routes by roads, fencing, mining, and/or agricultural development • Poaching of elephant (a keystone, umbrella, and landscape species) • Loss of river flows (e.g. Mara, Tarangire) from reduction & poor management of mountain forests, & upstream water abstraction • Climate change	• Inadequate land use planning and agreements • Unclear, insecure, and/or overlapping land and resource tenure • Low capacity to monitor and enforce land and wildlife laws and regulations • Inadequate resources for anti-poaching control

Miombo Woodland	• Agricultural expansion (mainly subsistence smallholders, "slash and burn") • Blockage or degradation of movement corridors and wet/dry season migration routes by roads, fencing, mining and/or agricultural development • Firewood cutting & collection • Charcoal production • Poaching of elephant (a keystone, umbrella, and landscape species) • Inadequate resources for anti-poaching control	• Use of agricultural practices that do not maintain soil fertility • Lack of sustainable fuel wood and charcoal, and of alternative cooking fuels • Inadequate land use planning and agreements • Low capacity to monitor and enforce laws and regulations • Unclear, insecure, and/or overlapping land and resource tenure
Alpine Moorlands	• Global climate change (alpine warming & vegetation zonation shifts)	• Global economy based on unsustainable fossil fuel energy
Montane Forests (Eastern Arc, Mt. Kilimanjaro, Mt. Meru, Albertine Rift Mountains	• Loss, fragmentation, & degradation from: • Agricultural expansion (mainly subsistence smallholders, "slash and burn") • Firewood cutting & collection • Bushmeat snaring and hunting	• Use of agricultural practices that do not maintain soil fertility • Lack of sustainable fuel wood and charcoal, and of alternative cooking fuels • Inadequate land use planning and agreements • Low capacity to monitor and enforce laws and regulations

Source: Byers et al. (2012)

While agricultural expansion, livestock grazing, wildfires, overexploitation, and illegal logging have been noted as the main causes of deforestation, corruption, poverty, and high population growth are cited as the main underlying deforestation drivers. As stated by Byers, et al. (2012), the long-term root cause of ecosystem degradation is "Lack of sustainable livelihood opportunities for poor, rural, small farmers and fishers" (p. 41). Furthermore, other studies, including Angelsen, Shitindi, and Aarrestad (1999), Kapunda (1994), and UNEP (2002), have argued that trade liberalization has also contributed to

increased deforestation through increased market demand for forest products and expansion of the agricultural sector.

High population growth is another factor that leads to high deforestation rates in Tanzania. Tanzania's human population has almost doubled in only three decades between 1988 and 2012. A large population implies high demand for natural forest products such as fuelwood, building poles and timber, as a large proportion (92%) of Tanzania's population depends on wood for cooking, either as firewood or charcoal (UNEP, 2002; SFTZ, 2010). A large population also implies more demand for agricultural and grazing land, adding more pressure on scarce natural forests (MNRT, 2006; URT, 1998). While it is expected that as more people in Tanzania become better educated the fertility rate will decline, Tanzania's population will continue to grow rapidly for many more years. It is crucial, therefore, that innovative ways are found for curtailing overexploitation of forests and other natural resources in Tanzania.

Other scholars have argued that the decline of forests on both protected and unprotected lands was exacerbated because management rights have been kept by the central government, and communities surrounding these resources have often been excluded from participating in management plans (Maganga, 1993, as cited in Hamza & Kimwer, 2007). This exclusion has left most communities feeling that it is not their responsibility to protect forests found on public lands. Consequently, instead of protecting forests near them, local people steal from them and keep each other's secrets (Author's conversation with local people in Loliondo, Summer 2012). To address the problem, the National Forest Policy of 1998 was formulated to allow participation of

local communities and other stakeholders in the management of forests on public lands through the Participatory Forest Management program, which became formalized in the Forest Act of 2002. The implementation of Participatory Forest Management has been very slow, however, due to reasons such as high implementation costs and lengthy management conversion processes (Development Partners Group, n.d.). By 2009, only about 4 million ha of forest had been converted to Participatory Forest Management (Blomley & Iddi, 2009). This suggests that most forests are still under the threat of being depleted as they are still under the "general land" category where no protection is provided by either the government or the adjacent communities. Other scholars have shown that if involved, local people can help ensure that forests on general land are conserved (see Blomley & Iddi, 2009; Blomley et al., 2008; Blomley & Ramadhani, 2006; Treue et al., 2014; Vyamana, 2009; Wily, 2001). However, they can only implement what they know or are accustomed to.

2.5. Traditional ecological knowledge (TEK) and its contribution to forest resources management

This section presents a brief description of what is referred to as Traditional Ecological Knowledge (TEK) or Indigenous Ecological Knowledge (IEK). Since the group I study may comprise native people like the "Sonjo" who may not necessarily be identified as indigenous people, I use the term TEK to incorporate all the knowledge possessed by local people found in the Loliondo area. I define what the terms mean, briefly discuss how this knowledge is acquired and transferred between generations, and discuss its benefits and shortcomings in the context of current debates and in relation to

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my study. I thus show that while I report the impacts of an environmental education on local people's knowledge, attitudes, and practices, I also acknowledge the knowledge (TEK) already possessed by the indigenous (Maasai and Sonjo) and other local people found in Loliondo, my study area. The knowledge in question is one related to forest resources use and management.

TEK definition. The term TEK with respect to environment and natural resource use only spread in the 1980s although traditional practices have existed throughout human life (Berkes, 2012). Berkes (2012) adds that application of TEK to contemporary natural resources management problems came to be recognized internationally during this time. TEK has been defined differently by various authors. Huntington (2000), for example, defines TEK as "the knowledge and insights acquired through extensive observation of an area or a species. This may include knowledge passed down through oral tradition, or shared among users of a resource" (p. 1,270). Berkes, Folke, and Colding (2000) similarly define TEK as the "cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment" (p. 1,252). Other definitions have been provided by other scholars. For various reasons, other terms have also been used in place of TEK, including *indigenous ecological knowledge*, *ecological literacy*, *experiential knowledge*, and *knowledge of the land* (see Berkes, 2012). Sometimes *local knowledge* has been used because it is the least problematic (Ruddle, 1994; Raffles, 2002, as cited in Berkes, 2012), however, argues that *local knowledge* likely fails to capture the fact that

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indigenous knowledge is relational or situated knowledge. Berkes (2012) also argues that

local knowledge "conveys neither the ecological aspect of the concept, nor a sense of

temporal dimension and cumulative cultural transmission"(p. 8). Some definition

problems pointed out by Berkes (2012) concerning *indigenous ecological knowledge* is

that the word "indigenous" restricts the use to people referred to as indigenous people and

that there is specific knowledge understood as indigenous. This study uses the term TEK

as defined in Berkes (2012) who restricts the meaning to land-related knowledge because

forests are found on land. Furthermore, I use TEK because it accounts for any traditional

practices (use and management of forests) employed by local people in the Loliondo area

rather than just by individuals understood as indigenous people. Berkes (2012) points out

that the two terms, *indigenous ecological knowledge* and *traditional ecological*

knowledge are, however, often used interchangeably.

Acquisition and transfer of TEK. Indigenous people develop knowledge through daily

contact with nature and through cultural practices that integrates natural resources

(Nabhan, 2000; Vogt et al., 2002). Indigenous people have always been in contact with

nature because they live in the natural environment, depend on natural resources for their

daily sustenance, and practice cultural practices that require direct contact with the

environment (Berkes, 2012; Drew, 2005). Constant contact with nature leads to complex

understanding of various plant and animal species as well as ecological processes; this

understanding allows them to adapt to changes that take place on their landscape (Berkes,

2012). It is this close link between nature and indigenous people's cultures, as well as

their long-term interaction with their landscape that enables a holistic understanding of

the ecological processes of the environment (Nabhan, 2000; Vogt et al., 2002). As mentioned in the previous section, TEK is location-based, meaning that the TEK that exists among a particular group of indigenous people may only be known in that specific area or group (Berkes, 2012). Also, the methods for knowledge transfer between generations differ greatly between places and ethnic groups due to variation in cultures (Berkes, 2012). The quote below demonstrates how knowledge is instilled from one generation to another among Native American people of the Colombia Plateau of north-western, North America:

> moral precepts are inculcated by means of a body of "Cayote' stories". A Colombian Plateau Elder may know more than 60 such stories, each constituting a full evening's performance. To appreciate the meaning these stories convey requires an intimate knowledge of the local natural environment, local animals and plants being the main characters and local places the stage on which they act out the human drama. Children learn the moral precepts that will guide them in their social and ecological relationships by listening to their elders tell these stories. Thus religion, art and ecology are one. Traditions are thus ecological in the sense that they represent a complex and integrated system of practices and beliefs (Hunn, 1993, p. 14).

Among the pastoral Maasai, knowledge and traditions are transferred from older to younger generations through respected people known as customary or village elders, the *"Laigwanani"*. Talle (1988), for example, describes how Maasai elders in Kenya transfer knowledge about the forests and life in general to younger generations. Through

various traditional ceremonies, which are age and gender specific, elders pass the knowledge they possess to younger people. Men in the age-set above a junior or senior Moran group will organize a cultural ceremony, and at this event, a selected elder will guide younger men (normally the junior and senior Morans) through various life events and how they ought to behave based on their phase in life. In her dissertation, Sirima (2015) also describes how the Pastoral Maasai in Loliondo pass down their wisdom and knowledge about forests in a similar manner. According to Sirima (2015), in the Loliondo area, customary elders play critical roles in shaping traditional knowledge among young generations and ensuring its survival among future generations. This was stated by one of her interviewees as follows;

> *We are enforcing the traditional laws as planned, sometimes we travel to other places to look for more elderly people who knows more than us to give us their opinions for the things that we are not sure. We also make sure that traditions are respected and observed by current and future generations.* (p. 60)

Sirima (2015) identifies three main approaches used by pastoral Maasai in Loliondo to transfer knowledge: age group meetings, traditional ceremonies, and traditional bomas (*Manyata*).[46] According to Sirima (2015), customary elders hold informal meetings with young men within a certain age group[47]; it is at these meetings that knowledge about "customs and traditions, culture and its relations to the forest, and other life skills such as endurance, patience and self-respect" are passed on from elders to

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46 Emanyata is a specific ceremony held for Morans during graduation from Moran-ship to becoming junior elders.
47 As stated in previous sections, Maasai men are categorized by age-sets which are basically groups of men who were circumcised at the same time – sometimes two groups circumcised consecutively are combined to form one age-set.

young men (p. 60). The knowledge transferred is very important for the young men before transitioning to being young elders. The age group meetings are held to sensitize youth to be responsible members of their society because they play a big role in protecting the forest (Sirima, 2015). Talle (1988) also reports similar responsibilities assigned to Morans; they are responsible for protecting the forest and defending Maasai territory. Other means of knowledge transfer among pastoral Maasai include through traditional ceremonies—such as when young men (Morans) led by an elder go into the forest and engage in various traditions to overcome selfishness and pride (Sirima, 2015). In Loliondo, forests are an important component of the pastoral Maasai's traditions not only because some ceremonies are held in the forest but also because "in all the traditional practices there are special trees used to graduate youth from one stage to another" (Sirima, 2015, p. 62). Also, Sirima (2015) quotes that "Throughout these ritual practices emphasis on the importance of the forest to all the traditional practices is made" (p. 62). The *Manyatta* provide another means of knowledge sharing among the pastoral Maasai. *Manyatta* is mainly attended by Maasai who are about to initiate an age-set and are ready to become responsible adults in the society (Personal Communication with a Maasai friend). Sirima (2015) also documents that "Before attending traditional bomas, young adults are required to have made several visits to the forests as a rite of passage to becoming responsible society members" …. "The main emphasis during *manyatta* is how to live in societies and transfer traditions. It is an important rite of passage that recognizes young adults before they can fully participate in decision making.

The mode of knowledge transfer through customary elders has also been observed among the Sonjo. Like the Maasai, the Sonjo elders (*Enamijie*) are responsible for protecting forests and enforcing any rules with regard to forest use (and other natural resources) and management. Like the *Laigwananis*, the *Enamijie* are also responsible for ensuring that the knowledge they possess is transferred to younger generations.

Arguments for and against TEK. Various myths have been associated with the relationship between indigenous people and the environment**.** For example, Westerners may consider indigenous people as the 'the Exotic other", meaning that **"**traditional peoples are close to the land and intrinsically attuned to nature, which makes it possible, in some vague way to live "in balance" with their environment' (Berkes, 2012, p. 239). Westerners may consider traditional people to be "ecologically noble savages" and thus cannot do anything harmful to the environment (Buege, 1996). Another myth associated with the indigenous ways of living is "Intruding Wastrel". This myth is actually opposite to the first myth as it places humans in the destruction category and sees humans as intruders and destroyers of the natural environment (Evernden, 1993, as cited in Berkes, 2012). This myth also assumes that primitive people or the indigenous people are not noble savages as claimed by others; it also questions whether traditional peoples ever lived in harmony with nature (Berkes, 2012). This myth also portrays humans as destructive beings whose negative impacts on the environment were only obscured by their low population although they always had a tendency to cause environmental damage through their actions (Berkes, 2012). A second myth, "noble savage" or "fallen angel", like the first myth, places indigenous people in the non-destructive group. Westerners who see

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indigenous people as "noble savages" perceive them as primitive individuals meant to live in harmony with nature and thus should not be contaminated with the outside world lest they become corrupted (like the "fallen angel") and never again live in harmony with nature. People with this view prefer that indigenous people remain primitive so they continue to live in balance with the environment (Berkes, 2012). As argued by various scholars, including Berkes (2012), it is safe to say that indigenous people are none of those three things, although there may be some truths in each myth.

Scholars, including Drew (2005) and Berkes (2012), have argued that acknowledging the existence of traditional or indigenous ecological knowledge in natural resource conservation is critical as it allows the incorporation of this knowledge in conservation planning. Indigenous people possess conservation knowledge and are also responsible for planning land use (Sirima, 2015). In other cases, it has been shown that sometimes indigenous knowledge works better than top-down approaches Drew (2005). In the Loliondo area, for example, it has been shown that TEK play a very important role in ensuring that forests and other natural resources are protected, although there are several challenges that limit reliance on TEK. Water catchments, important trees and areas important for traditional practices, are fenced so that access is regulated (Sirima, 2015). Among both the Maasai and Sonjo ethnic groups, anyone who breaks access rules is fined or cursed if they do not do as agreed by the elders (Personal conversation with customary elders, Summer 2014). Recognized traditional land use planning in the Loliondo is documented in Sirima (2015) as follows;

Four land uses have been identified in the area: farming, grazing, residential and forest areas. Grazing land is divided into two: based on the season and age of the cattle. In terms of livestock age, there is special grazing grounds for calves known as *lokeri* and areas for grazing other. Lokeri are often located in lush green areas in close proximity to water sources. With regards to season, there are grazing ground for dry and wet season. During the wet season cattle roam around open areas close to homesteads while during the dry season cattle are allowed to enter designated grazing areas inside the forest. The allocation of both dry and wet season helps protect pasture throughout the year. (p. 63)

Despite its potential to help address environmental challenges, some scholars have warned that TEK is often exaggerated when perceived as the main approach for keeping the environment pristine. High environmental knowledge among traditional groups does not necessarily lead to conservation as some groups may lack conservation ethics (Redford & Stearman, 1993). Berkes (2012), for example, cites that the native people in New Guinea who demonstrate high environmental literacy yet are among the most destructive people toward the environment. As shown in two of the three myths described above, some Western environmentalists have been reported to perceive indigenous people as non-destructive, and that they live in harmony with nature, even when this may not always be the case. As argued by Berkes (2012), "Tradition is not always adaptive, and traditional people do not always act as wise stewards of the environment" (p. 241). Similarly, Johannes and Lewis (1993) argue that "the acceptance of all traditional ecological knowledge as infallible is an extreme position, almost as

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unfortunate as that of dismissing it. Traditional peoples are not infallible, and some of their misuse of natural resources have been, and are, substantial" (p. 106). In the Enguserosambu Ward, part of my study area, Sirima (2015) observed that the Enguserosambu Community Forest, a local forest owned and managed by the Maasai indigenous people, had declined significantly between 2000 and 2015. Similar findings for the same forest were observed by the author (reported in Chapter Six). These findings demonstrate that despite its importance, TEK is challenged due to various factors, including mere lack of conservation ethics, increased population and changes in climate which leave many ecosystems among indigenous people vulnerable to human degradation. It is, however, clear that ignoring TEK may not benefit conservation goals for critical forests such as the ECF, but it should be incorporated with skepticism. As argued by Berkes (2012), just as with some Western science, indigenous interpretations may sometimes be incorrect. On the one hand, there are many cases where traditional knowledge has been found to be correct compared to Western science (see Freeman, 1992; Johannes, Freeman, & Hamilton, 2000). On the other hand, there are many examples that demonstrate that Western science provides more correct interpretations of the environmental conditions compared to traditional knowledge (see Johannes & Lewis, 1993).

Moreover, while many cases demonstrate that indigenous people live in harmony with nature, many have also shown otherwise. Kay (1994), for example, argues that "Native Americans had no effective conservations practices and the manner in which they harvested ungulates [such as elk] was the exact opposite of any predicted

conservation practice" (p. 359). Such an argument is plausible when one considers the number of animals that had remained prior to colonialization of the U.S.A, although this does not necessarily mean the natives were worse exploiters of natural resources compared to the Europeans. Similarly, Sirima (2015) shows that despite management of the ECF by local natives, the forest has declined, meaning that overexploitation must have played a large role in its decline. Here again, it is difficult to determine whether the destruction is done largely by the indigenous people or by outsiders such as neighboring communities.

Despite the imperfections of TEK (as with Western science), understanding the modes of knowledge transfer among indigenous and native people is critical for assessing their feasibility to serve as potential alternative EE dissemination strategies. More importantly, understanding the existence of TEK is critical for acknowledging the environmental knowledge base that already exists among the Loliondo people, to identify any misinterpretations about the environment that exist in the community, and to determine which information is critical for incorporating into the EE curriculum.

2.6. Gender and age differences in forest use and management

The literature on gender and age differences in forest use and management helps us to understand how forest-related activities, rights, and responsibilities vary between men and women and between individuals of different age groups. Understanding these differences is critical, as these factors may influence levels of knowledge, attitudes, and practices expressed by individuals. Understanding the gender aspect in forest use and

management responsibilities is crucial for strategizing how women and men and individuals of different age groups can participate in forest-related educational projects. Research has shown that household labor contributions differ between men and women and between individuals of different age groups; and the manner in which various labor activities are divided differs from one culture to another (Eckman,1996; Eckman, O'Shaughnessy, Barber, & World Vision Ethiopia, 1995; Feldstein & Jiggins, 1994; Leach, 1992; Rocheleau & Edmunds, 1997). This is true for activities related to agriculture and forest resources. Eckman et al. (1995) and Eckman (1996) have also shown that labor division also tends to vary between seasons—i.e., tasks that may be performed by young women or girls during the dry season, for example, may be performed by older or elderly women when girls are in school.

Gender and age not only determine how labor is distributed at the household and community levels, but also determine who has rights to use and control resources at each level (Leach, 1992; Rocheleau & Edmunds, 1997; World Bank, n.d.). As argued by several scholars, when compared to men, women often face cultural constraints not only with regard to rights to access land and natural resources, but also to many other resources (Campese, 2011; Fonjong, 2008; World Bank, n.d.). Women often have fewer rights to access and decision making in land and natural resources; consequently, their participation in projects related to these resources tend to be hampered (Gurung et al., 2000). Similarly, individuals of different age groups have unequal access to various resources, including access to forest resources products (Byers & Sainju, 1994; World Bank, n.d.). Because of the inequalities in benefits accrued from natural resources,

knowledge, skills, roles, and practices towards natural resources management may vary between men and women (Gurung et al. 2000; Homberg, 1993). While gender dynamics change over time, it is important to remember that women are still disadvantaged when it comes to rights and access to natural resources such as land, water, and forest products. In addition to gender and age, factors such as ethnicity, marital status, religion and wealth status have also been found to determine rights to use and control both private and communal resources (Rocheleau & Edmunds, 1997; World Bank, n.d.). Poor women may rely on "in-between"[48] spaces in the landscape for tree products while women from wealthy households may have access on private woodlots (Rocheleau, 1991). Other factors found to influence women's rights and responsibilities in natural resources include order of marriage in polygamous households. Bradley (1991, as cited in Rocheleau & Edmunds, 1997), for example, found that older widows (compared to younger ones) among the Luhya in Kakamega, Kenya, had greater decision-making power with respect to activities such as tree planting and other woodlot-related activities. Wealth is also a significant factor; wealthier women are more likely to have easy access to resources and play part in decision making compared to poorer women (Chimedza 1988).

In this case, it was expected that much of the variation in responses to KAP questions would be determined by gender and age. Identification of gender differentials in natural resources could provide insights for sustainable management of these resources, specifically by creating policies that accommodate these factors (Fonjong, 2008) and by paying attention to these differences when implementing environmental

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48 "In-between" space could be space on the edges of someone's farm or between plot boundaries.

education programs or any forest-related programs. The United Women (United Nations Entity for Gender Equality and the Empowerment of Women) defines gender as;

the roles, behaviors, activities, and attributes that a given society at a given time considers appropriate for men and women. In addition to the social attributes and opportunities associated with being male and female and the relationships between women and men and girls and boys, gender also refers to the relations between women and those between men. These attributes, opportunities and relationships are socially constructed and are learned through socialization processes. They are context/time-specific and changeable. Gender determines what is expected, allowed and valued in a woman or a man in a given context.

While gender has been understood differently in various communities, evidence shows that gender roles that shape natural resources management exist. Access to rights and management responsibilities differ between men and women because rules, norms and values in specific contexts govern the gender division of labor and gender distribution of resources (Ogunlela & Mukhtar, 2009). Sometimes gender-biased practices and taboos continue to cause discrimination against women despite various initiatives to ameliorate this. For example, Fonjong (2008) found that women in Northwest Cameroon were discriminated against in participation in natural resources management. The author reports that taboos such as women "can neither enter nor cultivate certain crops in sacred forest and shrines", "do not belong to traditional sacred societies, like the Kwifon, which take major decisions over resource and management", or that "they are prohibited from climbing trees or harvesting certain resources" (p. 468)

have all contributed negatively to women's abilities to access resources. Fonjong (2008) argues that while many taboos are directed at protecting natural resources in specific areas, such as shrines, sacred forests, and burial places for chiefs (Colding & Folk, 1997), many of these taboos are directed at women rather than both genders.

Gender distribution of roles is implemented at both the family and community levels. For example, in most developing nations, it is the women's responsibility to collect forest products such as fuelwood, herbs for food or thatch grass for roofing homes while men are more responsible for collecting construction materials (Leach, 1992). Women may also collect forest products for making household items such as baskets or mats which they may, at times, sell to earn some income (Leach, 1992). In Tanzania, for example, gender specific harvesting and utilization of forest products have been reported across the country (FAO, 2013; MNRT, 2015). Some scholars have argued that the gendered nature of resource utilization and management roles has created varying levels of interest in natural resources management between men and women. A study by Fonjong (2008) revealed that men and women in the Northwest Cameroon have differing interests and take different roles in environmental conservation. Due to differing interests in natural resources, conflicts between men and women may arise: a forest product might exhibit conflicting interests for men and women as each group may need to use the same product for different purposes. In the case of Cameroon, Fonjong (2008) reports that women were more interested in using forest trees for fruits and fuel wood while men were interested in using the same trees for shrines, roofing, and furniture.

Gender differences have also been observed in who has rights to access specific resources, what spaces women can access to extract various natural resources, what time of the day or year women can access specific natural resource areas, who is responsible for performing specific management tasks, and who can participate in decision making (Rocheleau & Edmunds, 1997). Eckman (1996), Eckman et al. (1995), and Rocheleau and Edmunds (1997), for example, argue that rights to access land and resources differ between men and women. Rocheleau and Edmunds (1997) also observes other ways in which men and women differ with respect to access to forest resources; the author argues that the spaces on which women access resources differ from that of men. Women are more restricted in terms of where they can extract resources and thus tend to access resources in bushes or common lands and in areas close to their homesteads or neglected places (e.g., spaces between the field and the road).

Rocheleau and Edmunds (1997) observes that women are also restricted in terms of when they can access specific areas. Barrow (1992, as cited in Rocheleau & Edmunds, 1997), for example, describes a situation in which land strictly managed by men for cattle fodder during the dry season may be turned over to women during the wet season for cassava cultivation, fuel wood collection and grazing goats. Also, Rocheleau and Edmunds (1997) argues that there are gender differences between tree species that are often owned or harvested or which trees can be accessed for fodder, fuelwood, or fruits and other tree products and in what conditions the product should be in for access by one gender or the other.

Gendered nature of rights and access to natural resource. Across Africa, gender

differences have been observed in rights and access possessed by men and women with

respect to natural resources such as land, trees, water, and animals (Rocheleau &

Edmunds, 1997; World Bank, n.d.). Generally, women are less likely to hold formal titles

to land compared to men (Lastarria-Comhiel, 1995, as cited in Rocheleau & Edmunds,

1997). Some scholars have argued that the lack of ownership of land titles has caused

most women to depend on men for trees and other forest resource access. Consequently,

women have little control over which crops can be grown on which plot, where trees are

cut or planted, or how fallow fields should be managed (Rocheleau & Edmunds, 1997).

In many cases, women have rights to use resources but these rights are often mediated by

their relationships with men, as most of them do not have ownership rights like men. The

negative impact of women's reliance on men for rights to access resources is that these

rights are often prone to being lost whenever women's relationships with men end; in

cases of death of spouse, for example, women tend to lose rights to farmland (Drimie,

2003). Rocheleau and Edmunds (1997) further argues that when women have rights to

use the resources on another person's land, their privileges may be terminated once the

previous or new owner imposes new restrictions on the land through "formal land titling

or land tenure reforms" (p. 1,354). Consequently, some scholars, including Agrawal

(1995) have called for an increased need for women to have rights to land ownership, so

that they do not fall victims when land is privatized.

Attribution of gender to deforestation – Can one gender be blamed for deforestation? The

gendered nature of forest resources extraction has prompted some scholars—more

specifically those with the ecofeminist and Women in Development (WID) viewpoints—

to dub women as less destructive to the environment compared to men (Leach, 1992).

Scholars from these philosophical views argue that because women heavily depend on

the environment to provide food for their families, they tend to be in touch with the

environment on a regular basis. It is this closeness to the environment, they suggest, that

gives them distinct interests in natural resources (Leach, 1992).

Ecofeminists have argued that "patriarchal" development and cultural values have

ignored the link between women and the environment; as a result, both the environment

and women have been oppressed (Shiva, 1989, as cited in Leach, 1992). Leach (1992),

however, argues that such discussions about women and the environment fail to account

for why women undertake particular activities and hold certain responsibilities. Leach,

also contends that "the idea that women are universally 'closer to nature' may be

misleading considering the differences between one culture and another. She suggests

that it is not enough just to focus on what women do; instead "we must also examine their

rights of access, control, and decision-making over natural resources. This helps to reveal

reasons for women's current activities and decisions. Women, for instance, may sell tree

food products from communally managed land areas, partly because they lack access to

income from trees on private holdings" (Leach, 1992, p. 15). The author adds that

women's roles in managing and using natural resources are exaggerated if men's roles are

ignored. The author notes further that women's relations with men are obscured, when

women's roles are considered in isolation to their relationships with household members.

This "ignores the ways that women's work, responsibilities, and rights arise through the

organisation of gender relations; and how women's interests and opportunities are shaped by their changing relationships with men and with each other" (p. 16). Instead of looking at the role of women in natural resources management, for example, Leach (1992) suggests that women and men should be viewed as individuals who interact with the environment within specific gender relations and processes that determine resource use (Leach, 1992). Leach suggests that rather than focusing on women's (or men's) roles,

examining how the uses of resources are differentiated by gender is a more helpful basis for identifying people's different interests and opportunities. Within a process such as agricultural production or tree planting, we can look at differences and divisions between distinct social groups, including those between men and women but also between, for example, age groups or patrons and clients. Divisions include those of work, responsibility, knowledge; and rights to use and decide the use of resources and products (Leach, 1992, p12).

2.7. Mobile phone use and its applications: A possible modern environmental education tool?

Mobile phone use has been increasing rapidly across the world. In 2010, the International Telecommunication Union's (ATU) estimate of the percentage of the world's population who were mobile phone owners was 67% (ATU, 2010). In 2015, the Pew Research Center reported that at least 60% of adult populations in African countries owned mobile phones – a percentage much higher than in 2002 (Pew Research Center, 2015). While almost every adult in developed countries owned mobile phones by the early 2000s, mobile phone adoption in many African countries increased rapidly only in

the past decade (Pew Research Center, 2015). By 2013, the penetration rate was estimated to be almost three times the rate of developed countries (ATU, 2013). Increased mobile phone usage has been observed in both rural and urban areas. In 2009, for example, it was estimated that half of the users of mobile phones in Africa inhabit rural areas (United Nations Foundation, 2009). According to Aker and Mbiti (2010), this rapid adoption can partly be attributed to the ease of use of the technology, its compatibility with people's culture, as well as minimal resources required to use the technology. In Tanzania, one can spend as low as TZS200, an equivalence of $0.09, to call for a maximum of about 15 minutes and free texting per day. This implies that those who cannot afford to call and text daily, can afford at least a few days a week. Salespersons at small businesses can easily make these transactions, so even non-literate individuals can buy these small calling/texting bundles.

Mobile phone usage has been observed among both owners and non-owners of mobile phone devices (Wesolowski, Eagle, Noor, Snow, & Buckee, 2012). Individuals who do not own mobile phone devices sometimes own a SIM (Subscriber Identity Module) card which they use on their friend's or relative's phone to make calls or text. Other people use public access points such as phone kiosks for the brief use of mobile phone service (Abadi, Kabiry, & Forghani, 2013; Kazemi, Nilipour, Kabiry, & Hoseini, 2013, p. 6; Okello, Kirui, & Gitonga, 2012). In past decades, mobile phones were primarily used for dealing with issues such as family emergencies, keeping in touch with or seeking help from friends and relative, taxis, and so forth (Souter et al., 2005; Wesolowski et al., 2012). Present day mobile phone use has diversified; they are now a

survey implementation tool, money transaction medium, educational tool, and information access tool. The high adoption rate of mobile phones has attracted many researchers to test the effectiveness of this technology in service delivery.

Short message service (SMS) usage. SMS (or "texting") is a relatively simple technology for sending and receiving messages on mobile phones or any other device. The three most relevant advantages of SMS include its far-reaching capacity, cost-effectiveness and ability to send uniform information. With SMS, more people can be reached at once (Stross, 2008). Mobile phone users can send multiple messages to multiple distant people in a few seconds. This is an attractive feature as it allows communication of information to multitudes of people. SMS is also very cost-effective. Worldwide, SMSs are minimally priced; sometimes the service is provided free of charge. This implies that sending text messages to thousands of people can cost almost nothing compared to voice calling (Dickinger et al., 2004). Moreover, unlike a voice calling service, SMS prevents distortion of information as the same message can be sent to a target group.

While SMS is inexpensive compared to voice calling, the ability to use the service varies among individuals. As shown in some studies, including Lenhart, Purcell, Smith, and Zickuhr (2010) study, minority groups (non-white) in the United States, for example, are more likely to use text messaging services compared to their white counterparts. Lenhart et al.'s (2010) study also shows that older people are less likely to use text messaging services compared to younger people. In the USA, the differences in text messaging between races and ages may be explained by income differences, as whites are

relatively more prosperous than non-whites. Wealthier people are more likely to pay for unlimited voice calls. Furthermore, elderly people have limited technological capabilities and many of them have some disabilities that may deter them from texting. Similarly, other studies have shown that developing countries use text-messaging more compared to developed countries (Head et al., 2013). This is not surprising since voice calling is more expensive compared to texting even though the study does not disaggregate between ages.

SMS applications. Researchers from various fields have tested applications of text message service, and their findings are promising. In health-related studies, text messages sent via mobile phones have been tested for their effectiveness in awareness provision (Lund et al., 2012; L'Engle, Vahdat, Ndakidemi, Lasway, & Zan, 2013; Mahmud et al., 2010); surveillance and monitoring of diseases (Asiimwe et al. 2011; Kamanga, Moono, Stresman, Mharakurwa, & Shiff, 2010; Gitonga et al. 2010; Nsanzimana et al. 2012; Mahmud et al., 2010); worker support of less skilled health workers (Zurovac, Larson, Sudoi, & Snow, 2012; Zurovac et al., 2011); drug supply chain and stock management (Lester, Gelmon, & Plummer, 2006; Tomlinson et al, 2009); and teacher service monitoring (Aker & Ksoll, 2015). While most studies acknowledge that urban areas perform better compared to rural areas, many studies reported positive results such as improved targeted behavior, more accurate disease diagnosis, and fewer deaths due to targeted diseases. Moreover, work efficiency and cost effectiveness were among the major benefits of using mobile phones compared to traditional face-to-face approaches (Mahmud et al., 2010; Aker & Ksoll, 2015).

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In business, text messages are commonly used to market products and services to potential customers. Free promotional informational messages are sent to consumers' mobile phones; they may respond or comment via SMS as well, thus ensuring a two-way interactive communication. Consumers can respond instantly once they receive a message, credit permitting. Mobile phone companies can send information about where customers can buy phone credit when it runs low, or remind them that their credit is low. Also, financial services offered via phone companies have been a success in many developing nations. In the agricultural sector, mobile phone services have been employed to update farmers with agricultural inputs prices and market prices of farm produce.[49] If implemented well, text-messaging has the potential to improve service delivery in many sectors, including in natural resources management.

2.8. Communication theories

Defining communication. Communication is incorporated in many fields of studies. In fact, in some fields, it is treated as a primary sub-field while in others it is treated as secondary (Littlejohn & Foss, 2010). For example, in sociology, it is treated as a primary sub-field because it is one of the critical social factors in societies. Similarly, anthropologists treat communication as an enabling factor in developing, maintaining, and changing cultures (Littlejohn & Foss, 2010). Due to its various usages (although with common goals), it is defined differently depending on the purpose. From a human standpoint, communication is defined by Merriam-Webster as "a process by which

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49 Having lived in Tanzania during the beginning and evolution period of mobile phone service, I have witnessed friends and family use mobile phones for various purposes.

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information is exchanged between individuals through a common system of symbols, signs, or behavior." Similarly, in Cobley and Schulz (2013), communication is understood as "an account of how human beings use semiotic systems, especially language, to symbolize their interactive thinking, speaking, and bodily practices, i.e., behavior as culture" (p. 63). Also, communication has been defined as the process of transmitting information and common understanding between people (Keyton, 2011). Lunenburg (2010) notes that the definition provided by Keyton underscores common understanding as an important outcome in any successful communication—i.e., there should be an outcome of understanding between individuals or groups of people in any good communication.

Dance (as cited in Littlejohn & Foss, 2010) looks at the definition of communication from a different perspective. The author identifies three key elements of communication that differentiates types of communication. The first element is the level of observation or abstractness, in which, the author argues, some definitions are more broad and inclusive while others are restrictive. For example, the definition of communication as "the process that links discontinuous parts of the living world to one another" provided by Ruesch (1957, as cited in Littlejohn & Foss, 2010), is very general. On the other hand, communication defined by Merriam-Webster (1986, as cited in Littlejohn & Foss, 2010) as "a system (as of telephones or telegraphs) for communicating information and orders (as in a naval service)," is considered more restrictive. The second distinction in the definitions of communication is made when a message possesses a particular purpose (intentionality) or none. To illustrate intentionality, Littlejohn and Foss

(2010) provide an example of a definition provided by Miller (1966): "Those situations in which a source transmits a message to a receiver with conscious intent to affect the latter's behaviors." This definition is contrasted with one quoted in Cartier (1959), that "It is a process that makes common to two or several what was the monopoly of one or some" (p. 5), as it contains no intentionality. The third dimension or element of communication identified by Littlejohn and Foss (2010) is the normative judgement. The authors argue that some definitions include statements that suggest that the communication process was successful, effective, or accurate, while others do not. An example of a definition with a normative judgment statement is one provided by Hoben (1954): that communication is the "verbal interchange of thought or idea" (p. 77). Without further explanation, the definition provided here assumes that the idea is successfully exchanged. On the other hand, the definition that "Communication [is] the transmission of information", as provided by Berelson and Steiner (1967), acknowledges that the information is transmitted, and that despite transmission, one cannot be sure that it is received nor understood. Several other definitions have been cited in Axley (1984), but it is not the focus of this study to discuss the variants of definitions in the literature. Due to the never-ending list of definitions provided by various scholars, Dance (as cited in Littlejohn & Foss, 2010) has called for a family of concepts rather than have a single idea or theory about communication.

In this study, I adopted the definition of communication with two elements (1) communication that allows transmission of information with a conscious mind to influence the participants' behaviors—defined by Miller (1966, as cited in Littlejohn &

Foss, 2010). Similar to Keyton (2011), (2) communication has to lead to a common understanding. I acknowledge Littlejohn & Foss's argument (2010) that information may be transmitted but may not necessarily be received nor comprehended. In all education strategies evaluated here, I thus aimed to ensure that these elements of communication were achieved—e.g., by checking if participants understood various environmental topics—by asking them to explain what they had learned.

Theories about communication. Various models and theories have been proposed to help explain the communication process—i.e., how communication between individuals or groups of people is expected to happen. One of the earliest models of communication is that proposed by Shannon and Weaver (1949). The authors propose that communication requires that a sender sends a message (information) to the receiver through a specific channel (a medium for sending the message). The authors also acknowledge that the message sent may, however, be interrupted by noise before it reaches the receiver. Critics of this model of communication argue that the model misses a critical component of communication, i.e., feedback. According to Berelson and Steiner (1967) without feedback, there is no way of knowing that the receiver got and understood the message. Schramm, Chaffee, and Rogers (1997) modified Shannon and Weaver's model and proposed additional factors that affect communication, including the context of the relation between individuals or groups of people. He argues that depending on the nature of the relationship, the communication will either be facilitated or hampered—a good relationship might facilitate effective communication and vice versa. One additional factor included in Schramm et al.'s model is the social environment. They argue that the

social environment, (i.e., the physical and social setting) in which communication takes place can influence both the sender and the receiver either positively or negatively. This implies that sometimes the social environment can act as a barrier or a facilitator to effective communication.

Communication process/elements of communication. Similar to previous theorists, Lunenburg (2010) provides a clear model of communication by showing how different elements ensure that communication is successful or unsuccessful. The two basic elements of communication are the sender and the receiver. The sender comes up with an idea and composes a message which he/she sends to the receiver or the intended person. According to Lunenburg (2010), the message is a product of deliberate selection of words, symbols, and gestures. According to Lippmann (1946), for effective communication, this message must be clear, credible, contain relevant information, and align with the context. The encoded message is sent via a medium, the third element of communication, before the receiver gets the message. Lunenburg (2010) notes various media/channels of communication, including, "face-to-face conversation, telephone call, email, or written report" (p. 2). Through a decoding process, the receiver finds meaning in the received message. Another element identified by Lunenburg (2010) is noise. Lunenburg defines noise as anything that leads to misinterpretation of the intended message. The author identifies the following as examples of noise: "different perceptions of the message, language barriers, interruptions, emotions, and attitudes" (p. 2). The final element of communication is feedback, which occurs when the receiver responds to the sender's message by sending them back a response. Feedback is important because it

allows the sender to determine whether the message he/she sent was received and understood (Lunenburg, 2010). In summary, successful communication can happen only when the sender sends meaningful information which can be decoded easily, the information is received by the intended person, and the receiver understands the message, and provides a meaningful response (feedback) to the message (see Figure 2.1).
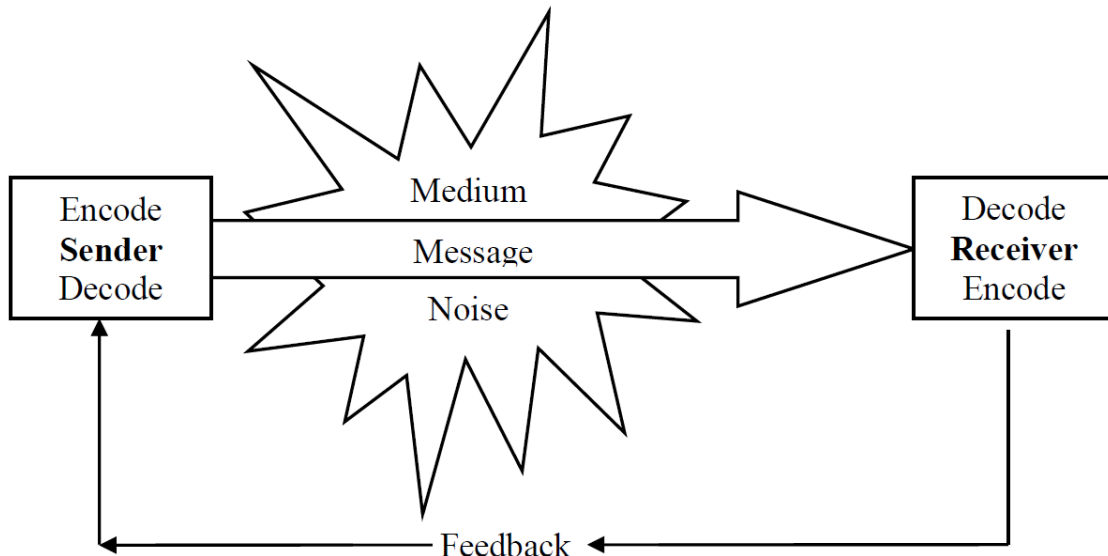
Figure 2.1. Communication process (Source, Lunenburg, 2010)

While there are various theories of communication, those concerned here are those employed in everyday interactions that ensure that an intended message is received and understood by the recipient. The most relevant communication theories are thus those that are applicable to the environmental education and communication fields, which provide an understanding of how environmental information can be communicated to various groups of people in a more effective manner.

Barriers to communication. There are several barriers to communication which can make communication unsuccessful. Eisenberg (2010, as cited in Lunenburg, 2010) identifies

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four categories of barriers, which he also refers to as noise. They include process barriers (e.g., missing an important step in a communication process), physical barriers (e.g., distance between the sender and the receiver), semantic barriers (e.g., difficulty in language or jargon used), and psychosocial barriers (e.g., feeling ineligible to deliver a message or lack of confidence). Similarly, Button & Rossera (1990) cites and describes barriers to communication such as language (lack of fluency in a language or unfamiliarity with jargon used), available technology (available technology can limit the medium used for communication), familiarity with technology (i.e., proficiency in technology used for communication), distance apart (communication that involves travel can be limited by distance between the sender/communicator and the receiver), cultural background (differences in cultural background may limit understanding of language or social cues between people), personal relationships (types of relationships will determine whether the receiver will pay attention to the sender or not), and education (individuals of different levels of education will have different levels of understanding). Another factor, lack of trust and confidence between the communicator and the receiver of information, is considered a barrier. Other factors that may impede the effectiveness of the communication process are discussed by Alexander (1972) in his model of human communication; they include failures to conceive and encode a message. This failure may be due to lack of experience in a particular culture, lack of familiarity with the symbols used, and improper conceptualization of ideas (e.g., the author provides an example of a case when the communicator may use an incorrect word such as cardinal instead of ordinal). Alexander (1972) also argues that the communication process may be

ineffective if the communicator fails to express the intended message (if, for example, he/she stammers). Additionally, one may fail to correctly pronounce a word, or noise from machinery or onlookers may be a hindrance to the audience. Finally, the recipient may have difficulties hearing (if he/she has hearing impairments) or understanding what is communicated to them due to an unfamiliar accent and if there are contradictions between words and gestures used by the communicator. Other barriers in individual-to-group communication include misalignment of language/words used and audience (i.e., the information tailored for one audience is given to a different audience) and wrong timing of information dissemination.

While most of these barriers can occur in communication between individuals, others such as language can also occur between individual and groups, i.e., communication between an individual and a group which may happen when a researcher is disseminating findings or other educational information to the public, policy makers, government officials, NGOs, etc. Addressing these and many other barriers is critical for any effective communication.

2.9.   Environmental education: Need, history and effectiveness

Our dependency on natural resources reminds us of the need to sustainably manage these resources, as well as to seek alternatives that aim to sustain their consumption. However, sustainable utilization of natural resources requires understanding what contributes to its degradation, including how ecosystems function (Cutter-Mackenzie & Smith, 2003). In other words, one needs to be "ecologically

literate" before one can deal with environmental issues. According to Orr (1992),

"ecological literacy" incorporates an understanding of how people and societies relate to

each other and to natural systems, and how they might do so sustainably" (p. 502). Orr

(1992) expands the definition of ecological literacy to include not only understanding the

biology of conservation but also the political basis for conserving societies. Smyth (as

cited in Bizerril et al. 2011) adds that the level at which environmental education goals

will be achieved mainly depends on people's degree of environmental awareness. This

begins with environmental understanding, environmental responsibility, environmental

competence and finally reaches environmental citizenship. For instance, Roth (1992)

defines environmental literacy as a person's capacity to perceive and interpret the state of

the environmental systems and take appropriate action to manage, restore or improve

those systems. For people to reach the level of literacy necessary to competently solve

environmental issues, Wals (1999) further stresses that there is need to create an

environment where learning can take place, and that multilevel content knowledge of

biodiversity should be emphasized, including, ecology, values, and politics of nature.

Many populations are perceived as "ecologically illiterate" or unable to

understand, care and practically solve environmental issues competently (Cutter-

Mackenzie & Smith, 2003). As stated in Coyles (2005) for example, a study conducted in

the USA revealed that although many people have some basic environmental awareness,

they are generally poorly informed about environmental issues; more educated people

(with college degrees) are more knowledgeable and vice versa. Environmental education

has thus been advocated for by many conservationists and various conservation

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organizations, including the World Wide Fund for Nature (WWF) and Wildlife

Conservation Society (WCS), because it is found to be highly correlated with

engagement in environmentally friendly behaviors. Moreover, environmental education is

one of the most important goals set by the United Nations Educational, Scientific, and

Cultural Organization (UNESCO) during the 1975 workshop on environmental issues.

Their goal was

> To develop a world population that is aware of, and concerned about, the
>
> environment and its associated problems, and which has the knowledge, skills,
>
> attitudes, motivations and commitment to work individually and collectively
>
> toward solutions of current problems and the prevention of new ones" (p. 3).

UNESCO's statement implies that awareness about environmental problems and

consequences of destroying or preserving the environment alone is not enough if people

are to adopt environmentally friendly behaviors. People should have the knowledge and

skills on the use of both forest and alternative resources. In addition, people must work

collectively to protect their common resources. Roth (1973) further points out that the

goal of environmental education should be to encourage individuals to develop the

capabilities of making thoughtful decisions that will impact the environment in a positive

manner, and consequently improve the quality of one's life. Clayton and Myers (2009,

2015) further support Roth's notion by stating that environmental education should focus

"on people's abilities to increase their understanding greatly over the long run, thus also

affecting their world views, attitudes, and behaviors, as well as the horizons they perceive

for their own lives" (p. 182).

Despite the reported positive impacts of environmental education, other scholars have argued that it should not aim to change people's behaviors, as this contradicts its purpose, which is developing independent critical thinking among individuals, just like any education (Robottom & Hart, 1995). Other arguments have focused on whether environmental education has any impact at all. Despite the general consensus that environmental education is crucial for improving people's environmental awareness and participation in environmentally friendly behaviors, some scholars have argued that its impacts on conservation goals have been difficult to prove. Norris and Jacobson's (1998) study revealed that only 45% of all conservation education projects yielded at least half of the projects' conservation objectives. They argued that for environmental education to be successful, both formative and summative studies should be incorporated in the project activities. Nevertheless, there is a wide consensus among scholars that environmental education is a valuable tool for improving people's comprehension of environmental issues and their solutions. It is believed to be highly associated with positive attitudes toward the environment and environmental conditions as well as engagement in environmentally friendly behaviors (Clayton & Myers, 2009; Heimlich & Ardoin, 2008; Cutter-Mackenzie & Smith, 2003), and thus it is highly supported (Coyles, 2005).

While environmental education is critical for creating environmental awareness among populations (with the aim to positively influence engagement in environmentally friendly behaviors), scholars, including Clayton and Myers (2009, 2015), propose that many other factors have greater influence on people's behavior toward the environment.

Some of these are in the category of "behavioral affordances", that is, behaviors that are enabled by a physical and social environment that would promote sustainability. These include knowledge of alternative resources of forest products, social norms (i.e., people are more likely to do what others do; especially what family members do), and reinforcement contingencies. These contingencies are positive or negative rewards given to the actor, with positive rewards having a superior response compared to a negative reward.

High ecological illiteracy among many populations propelled conservationists to propose environmental education as one of the critical tools to achieving sustainable development. At the end of Twentieth Century, environmental education was being implemented in various forms, although the modern form evolved in the 1970s (Clayton & Myers, 2009, 2015). Modern environmental education employs various approaches, including both formal and informal means. Formal means range from environmental education acquired from kindergarten to graduate studies, including traditional courses, instructional materials, field trips, and community investigations (Volk & McBeth, 1998, as cited in Clayton, 2015). The informal form of environmental education includes "nature centers, environmental learning centers, residential camps, zoos and aquaria, park interpretive programs, outdoor or wilderness learning, extension programs, community projects, citizen-science projects, service learning, and community project learnings, industry-based training, responsible ecotourism, peer groups around a kitchen table" (Clayton & Myers, 2015, p. 243).

While the above types of informal learning approaches have been employed world-wide, most reflect formats used in the developed world. In rural, less-developed areas, indigenous people mainly acquire environmental knowledge from their elders and through first-hand interactions with nature (Berkes, 2012; Berkes, Colding, & Folke, 2000; Davis & Wagner, 2003) as formal environmental education is rarely implemented. Environmental education strategies commonly employed in developing nations are implemented using video/films, drama, radio or television, printed materials, and community projects; these examples can be found in studies reported by Bell et al. (2005) and Bizerril et al. (2011). In some studies, one environmental education strategy was employed in achieving a conservation goal while in others a combination of two or more strategies was used. While some approaches are more effective than others, decisions to employ specific strategies may depend on context, the purpose of the environmental education, and budget. In a study conducted in central Brazil, for example, a combination of three environmental education communication strategies was used to achieve the program's conservation goals (Bizerril et al., 2011). These communication strategies included: preparation of a community book that described the region where the project took place; use of traveling cinema in places such as churches, schools, public squares, farms, and community centers. The use of community communication on environmental education matters used many forms of media including printed materials (such as newsletters, newspapers, brochures), radio (i.e., radio soaps and educational spots) and audio-visual materials. According to Bizerril et al., these communication methods yielded higher conservation goals than expected.

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Like with health programs (Ka'opua, Park, Ward, & Braun, 2011), environmental education can be integrated into church programs (Strife, 2010). A statement by Oelschlaeger (1994) that "religion is a necessary condition for the resolution of ecocrisis"[50] (p. 22) demonstrates the potential for EE strategies that incorporate religious ethics in solving environmental issues. Similarly, Hitzhusen (2006) encourages other environmental educationists to explore religious platforms and ethics when planning environmental education programs. Implementing programs through churches thus has potential to lead to improved environmental awareness as well as positively changing people's behaviors among participants when educators incorporate warmth and caring connected to people's faith.

Mobile phones provide another means of communication that has not been fully explored in terms of its application as an environmental education tool; it has the potential to bring about a quick transfer of information from one person to another. A few studies have tested the effects of smart phones as environmental education tools, but these studies have been carried out only among students. Uzunboylu, Cavus, & Ercag (2009), for example, employed m-learning (mobile learning) in Cyprus by applying both social constructivist theory and conversation theory which expects that people "act and reflect within an environment" and that learning "requires a continuous two way conversation" between individuals (p. 381). The mobile phone intervention thus involved student participation in identifying environmental problems, sharing, and discussing the issues with other students within a class. Each student was required to take pictures on

50 Ecocrisis is "ecological crisis"

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any observed environmental "blights and social events" using their smart phones, and post it on the project website. Each student had access to posts from other students and could comment on these posts via their mobile phones. Additionally, discussions were held every week focusing on the website posts. The intervention was employed for six weeks, and the post-intervention results increased significantly.

In implementing these communication techniques, there is a need to consider other factors that might interfere with the operation of these techniques to avoid undermining the method. Rönnqvist (2009) suggests that in cases where a gathering of people is required before any information is disseminated, strategies of using music, cinema shows, songs and dance can be used. These gathering methods have also been used in various studies, and they seem to yield positive results. In addition, there is a need to consider financial and other constraints that may be specific to project areas before deciding which communication means to use. Methods of communication need to fit well with the local context and have fewer constraints for adoption by local communities. Other factors that play important roles in determining environmental education impact include knowledge content being delivered, medium of delivering the knowledge, the deliverer, and values (Ann Zanetell & Knuth, 2004; Clayton & Myers, 2009).

2.10. Knowledge, Attitudes, and Practices (KAP) Study Methodology

Conservationists and natural resources managers/practitioners attempt to positively influence people's knowledge and attitudes with the hope that they would engage in more behaviors that have a positive effect on natural resources such as water,

wildlife, or forests. They do this by implementing environmental education campaigns using a wide range of strategies. In order to determine if an educational campaign had any impact, however, evaluation of the program has to be conducted using acceptable methods. In her *"Training modules for evaluating the social outcomes of water quality projects"*, Eckman (2013) recommends a KAP study methodology for implementing and evaluating water-related environmental educational programs. A KAP study involves measurement of three main constructs: knowledge, attitudes, and practices. Knowledge possessed by individuals or a community is the level of understanding about a topic under investigation. In the case of Loliondo, for example, the knowledge referred to is the understanding of the local forest's health conditions, causes of destructive behaviors, negative impacts of degradation, and solutions to deforestation. Attitudes towards a resource or behavior refers to feelings toward a problem, as well as any preconceived ideas people might have toward a problem, resource, or behavior (Eckman, 2013). Practice is the way in which people "demonstrate their knowledge and attitudes through their actions and behaviors" (Eckman, 2013, p. 26).

While the module was designed for water projects specifically in Minnesota, it can be adapted to any natural resource problem and any location. The KAP study methodology was thus adapted to the deforestation problem in the Loliondo area, Northern Tanzania. The KAP study was used in accordance with the definitions and guidelines provided by Eckman in her training module as well as her unpublished about using KAP methods for natural resources projects. Other important literature on the KAP study was also borrowed from Adhikarya (1994) and other reports by FAO and The

Population Council (See Marías & Glasauer, 2014 and Population Council. Demographic Division, 1970). In the following sections, I provide a brief overview of the KAP study methodology by providing a definition of the method, describing the methodology, and how it is implemented.

Overview of the KAP study methodology. KAP studies are defined as "short focused surveys that measure changes over time in human *knowledge, attitudes and practices* as a result of a specific initiative or project" (Eckman, 2013, p. 26). The World Health Organization (WHO) similarly defines the KAP study as "a representative study of a specific population to collect information on what is known, believed and done in relation to a particular topic" (WHO, 2008, p. 6). Knowledge, attitudes, and practices are the three constructs typically measured in a KAP study. According to Eckman, the three core constructs are measured because they were identified as the key areas where one would expect to see changes in a positive direction as a result of a project intervention. For programs implemented by international organizations such as the Food and Agriculture Organization (FAO) and the World Health Organization (WHO), KAP was identified as an essential first step in providing information useful for understanding the logic and rationale of a campaign (Adhikarya 1987, as cited in Eckman, 2011; Adhikarya, 1994). The constructs are measured before and after the intervention and are used to determine whether a particular project was "successful in achieving the desired social outcomes, and in motivating individuals to change basic behaviors" (Eckman, 2011). The behaviors referred to here can relate to a health practice, water, or forests. KAP studies are thus particularly valuable in impact assessment and evaluation of projects. According to Pelto

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and Pelto (1997, as cited in Eckman, unpublished), the combination of a limited focus and before-and-after data collection is what defines most KAP studies.

KAP studies are aimed at problem-solving and generally operate at a micro-level (Adhikarya, 1994). They are useful for planning education or extension campaigns, goal formulation and strategy development for programs and projects (Adhikarya, 1987, as cited in Eckman, 2011). The literature conducted by Eckman (2011) further shows that KAP studies have been used widely not only for project planning, but also for identifying barriers and constraints and for both formative and summative evaluation studies. According to Eckman, a typical KAP study is customized such that it aligns with project goals and objectives. Understanding the three core dimensions (knowledge, attitudes and practices) will allow a project to track changes in them over time, and may enable the project to tailor activities to the needs of that community (Vision 2020 n.d., as cited in Eckman, 2011). Each KAP study is thus customized to a local context, project objectives, and community. While the typical KAP study measures only three constructs, the method has evolved over time to include additional constructs. Researchers for water quality experiments conducted in Minnesota, for example, added barriers and constraints for adopting recommended practices as the fourth construct (see Eckman, Brady, & Schomberg, 2015; Eckman, Fortin, Nuckles, & Were, 2011; Eckman & Henry, 2012).

The three KAP constructs can easily be measured because they can be linked to project goals and objectives, and thus are useful in assessing project results (Eckman, 2011). By comparing the pre- and post-KAP data, project outcomes and impacts can be measured and quantified. If a project is successful, the researcher might see a positive

change in the three constructs: knowledge about a specific topic would increase, participants might gain a more positive attitude toward a particular practice or behavior, and more participants might adopt a desired practice. While scholars acknowledge that a positive change in the three constructs is expected (Ulrich-Hebel, 2006, as cited in Eckman, 2011), they also caution that the change in them might happen at different periods of time and at unequal levels (Eckman, 2011).

Implementing and assessing KAP study. Typically, at least two KAP studies are implemented in an evaluation research project: one before (pre-test) and another after (post-test) the intervention (Adhikarya, 1994). The pre-test study serves as the baseline for comparison in evaluation research. Baseline data are useful because they can help "inform project planning, can aid in designing education and outreach activities, and can yield information about specific barriers, constraints and preferences for an intended" project (Eckman, 2011). When KAP studies are implemented as baseline studies, results can be used to determine types of information to send to specific groups as well as determine communication strategy suitable for various groups (Adhikarya, 1994). Furthermore, FAO points out that baseline data provides the necessary benchmark for comparison of impact or summative evaluation.

To evaluate a KAP study, Eckman (2011, 2013) recommend that three major questions should be answered: (1) Did participants' knowledge about specific behavior increase? (2) Did participants' attitudes about specific behavior change positively? and (3) Did participants adopt and maintain new practices related to a specific behavior? In her 2013 training module, Eckman also recommends that a fourth question should be

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asked to identify factors that may act as barriers or constraints to engagement in environmentally friendly practices.

3. Conceptual Framework

In this chapter, I present the conceptual framework used to design the study and to answer research questions explored in this dissertation. I start by presenting the three major theoretical domains critical to the design of this study: program evaluation theory; social learning theory and models for engagement in environmentally friendly behaviors (EFBs); and communication theories and environmental education and content delivery. Program evaluation theory describes how evaluation studies are implemented when theory of change and other factors are accounted for, rather than assuming a "Black Box" model in which mere implementation of an intervention is expected to lead to desirable outcomes. I show why program evaluation theory is the preferred approach to conducting evaluation studies, how it is used, its benefits, and how I attempted to employ it in this study. I also show how I adapted program theory to my study by describing why I chose a particular study design, resources/inputs and activities involved, along with expected outputs and outcomes. Within program evaluation theory, I describe the theory of change used—i.e., how access to environmental information might lead to motivation for people to engage in environmentally friendly behaviors. Additionally, I show how mediators (defined below), contextual factors, and personality traits were expected to influence the outcomes. On the one hand, using social learning theory as the grounding theory, I describe how learning and behavior change can happen. On the other hand, using models

for engagement in EFBs, I show what and how various factors can influence engagement in environmentally friendly behaviors. Using communication theories, I briefly describe how communication between and among individuals and groups of people happen, barriers to communication, and what enables a successful communication. Environmental education and content delivery was used to show how environmental education programs are implemented and how messages to be disseminated are determined depending on the context and the goal of the program. In this chapter, I also describe the four major questions addressed in this study as well as provide respective hypotheses for the expected findings.

Figure 3.1 conceptualizes the three major theoretical domains that informed the design and theoretical constructs for understanding the role of environmental education in forest use and management in Loliondo. My dissertation research thus conceptually draws from the intersection of program evaluation theory, social learning theory, models for determinants of engagement in environmentally friendly behaviors, communication theories, and environmental education and content delivery. The sections that follow describe each theory and how it has been applied in this study.

Figure 3.1. Three major theoretical domains

Program Evaluation Theory

Social learning Theory
Models for Engagement in EFBs

Environmental education and
content delivery
Communications theories
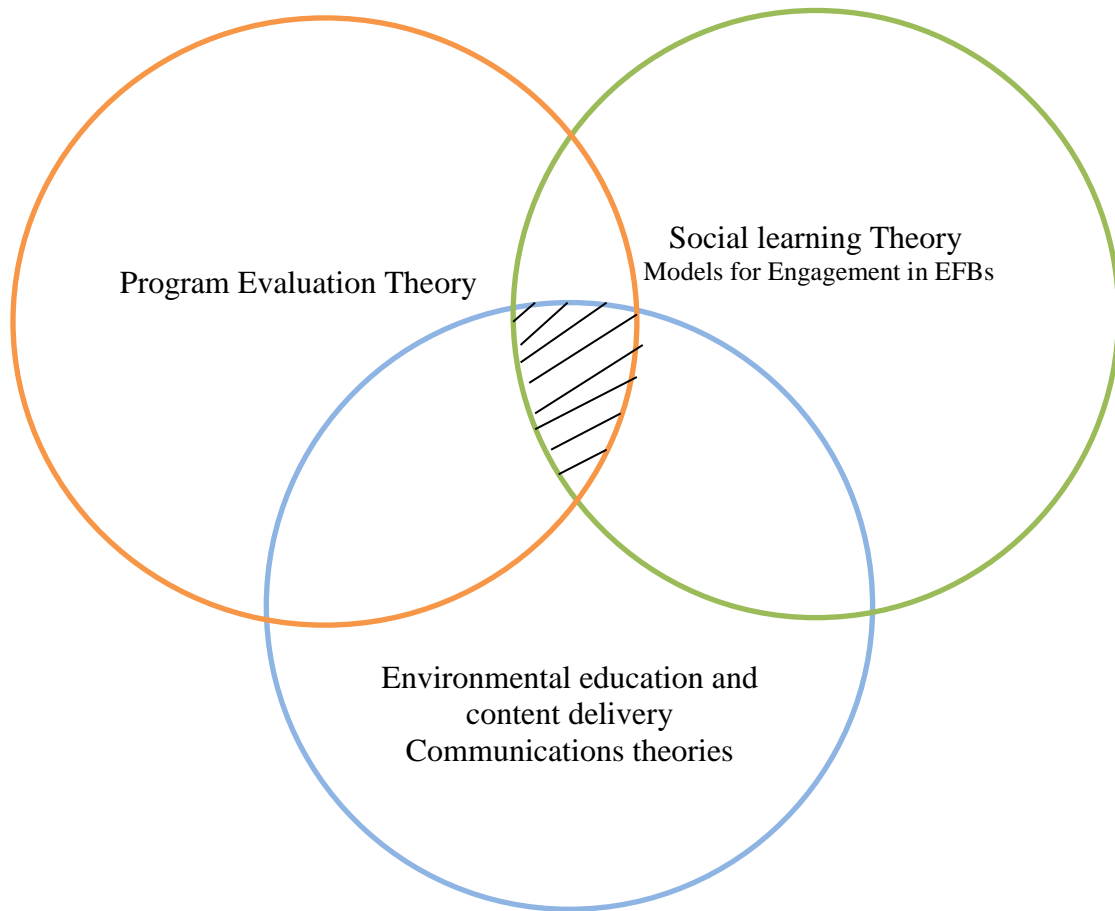
3.1.   Program evaluation theory

Rogers, Petrosino, and Huebner (2000, as cited in Bamberger, Rugh, & Mabry,

2012) define program evaluation theory as "an explicit theory or model of how the

program causes the intended or observed outcomes and an evaluation that is at least

partly guided by this model" (p. 182). Program evaluation theory provides the big picture

on how a project such as environmental education may be carried out to ensure that the

project's objectives are achieved and that the project's successes and failures are

measured accurately. Scholars have noted that understanding how intervention programs/projects bring about change requires that researchers use evaluations to measure program effectiveness and outcomes (Bamberger et al., 2012; Eckman, 2013; Funnel & Rogers, 2011). Program evaluation theory helps to identify resources and activities necessary for the program/project implementation, intended outcomes, and provides causal assumptions linking program resources, activities and intermediate outcomes and program/project goals (Wholey, 1987, as cited in Bamberger et al., 2012). Program theory evaluation is known by various names despite its similar usage and applications;[51] I, therefore, use it as understood in Bamberger et al. (2012). Also, while the term "program" is used, program theory has also been used in project evaluation.

Per Bamberger et al. (2012), program evaluation theory or simply program theory combines the impact model and the implementation model (not used here), which can be constructed separately or combined into one. The impact model addresses how the program is designed, resources and inputs involved, implementation strategy (activities involved), mediators (factors that may motivate participants or block them from participation), outputs (immediate results), outcomes and impacts (short-, medium-, and long-term changes in conditions), and how contextual variables might influence project design and implementation. Program evaluation theory has been used in various programs because it addresses the purpose of the program, the rationale for choosing an approach and how the program is expected to operate (Bamberger et al., 2012).

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51 As cited in Bamberger et al. (2012), Program evaluation theory is also referred to by other names, including "program theory (Bickman, 1987), theory-based evaluation, (Weiss 1995, 1997), program theory-driven evaluation (Donaldson, 2007), and program logic (Funnel 1997, 2000; Lenne & Cleland, 1987)."

To understand how an intervention may bring about change, program evaluation theory requires that a researcher clearly explain the underlying theory of change or assumptions for the changes expected (Bamberger et al., 2012; Funnel & Rogers 2011). Each program or project should outline it's theory of change, that is, how will THIS specific program cause participants to change their behaviors or acquire new knowledge. What is so special about this particular program that would induce people to do things differently? How does the program explain or motivate a change in human behavior that will lead to an improvement in the local environment? In the case of an environmental education project, for example, a researcher needs to address questions such as: How are people going to learn new environmental behaviors? What processes will be involved in learning? What outcomes and impacts are expected from the intervention? Why should they adopt a new behavior? Using assumed theory of change, I explain the processes that participants were expected to go through while learning new environmental information and how the new information would lead to improved attitudes and behaviors.

Proposed components of the program theory relevant to the environmental education project are shown in Figure 3.2 and described in the sections that follow. Figure 3.2 represents my conceptual model that includes the theory of change. Figure 3.2 also describes how approach to implementation of the environmental education program could be improved.

Figure 3.2. Conceptual model for the environmental education project

Program design
- Theory of change
- Educational content
- Delivery (group meetings versus texts messages
- Experiential design with control
- Program evaluation plan

Mediators
- Spouses and family members help one another learn new EI
- Village leaders emphasize the importance of EE project and or vice versa

Social learning theory (Self-facilitated social processes):
- Discussions of EI in groups, on phones, and at homes and social events

Inputs
- Personnel (project facilitators, driver)
- Incentive for village leaders and study participants to attend meetings (snacks, drinks, sugar)
- Paper and pens for group discussions
- Airtime bundles for mobile phone treatment group
- Satellite imagery

Activities
- Build awareness of village leaders and members through meetings
- Train the EE facilitators
- Discuss EI in groups
- Send airtime bundles and EI to participants via text messages
- Map geographic features inside forest on satellite imagery
- Pretest and posttest studies
- Prepare EE implementation guide

Outputs
- Number of people who access EE
- Number of village representatives who attend introductory meetings

Outcomes
- Improved access to environmental information
- Improved environmental knowledge, attitudes, and practices
- Identification of the education delivery and communication methods most effective
- Barriers to access to EE identified
- Barriers to participate in forest conservation identified
- Preferences for getting environmental information identified
- Recommendations for FZS to improve its educational strategies

Key:
EE = Environmental education
EI = Environmental information
EBF = Environmentally-friendly behavior

Contextual variables
- Political climate
- Social capital (bonding and bridging, power relations, norms)
- Cultural practices and traditions
- Available sources of forest products
- Demographic characteristics: literacy levels
- Economic factors (livelihood sources)
- Available infrastructure (road, wireless networks, electricity, radio/television signals)
- Forest management rights (policy)

Learning and engagement in EFBs depends on:
- Mode of learning (use of media, live demonstration, oral instruction)
- Cognitive factors (ability to pay attention, encoding capabilities, retention capabilities, ability to reproduce behavior)
- Personal motivation factors
- Whether message was received and understood,

Source: Adapted from Bamberger et al. (2012)

3.1.1. Program design

Underlying theory of change for the environmental education project. Identifying the theory of change is one of the first steps in designing a specific project if a researcher or project manager intends to apply program theory in implementation and evaluation of the program's impacts. Theory of change links outcomes and activities to help explain "HOW and WHY the desired change is expected to come about" (Clark & Anderson, 2004, p. 12). Eckman (2013) also notes that the theory of change is useful in that it helps to clearly define "why a particular social outreach strategy was used, and how it is expected that human actions and knowledge will change" (p.18). Because CREATE did not explicitly identify the theory of change to be used in the environmental education project evaluated here, I assumed that a context-specific theory of change was implied. While I used social learning theory for grounding my understanding of how people convert knowledge to actions, I applied a assumed theory of change specific to study area to show how an EE would lead to expected outcomes. Access to environmental information would lead to increased awareness about environmental issues; in turn, this knowledge would make people become more conscience about consequences of their behaviors toward the local forest. Higher awareness and consciousness, and social learning through communication with family and community members would motivate participants to change their behavior into positive practices.

The EE project ensured that participants in the treatment group received forest-related environmental information, with the expectation that people would become more informed about the health, ecological and economic benefits provided by the local forest,

threats facing the forest and consequences of these threats on the sustainability of the

forest, and finally about potential solutions to current management challenges. Higher

knowledge in forest-related issues would also potentially create concern for the future of

the forest's condition as well as the availability of livelihood sources. Most of the

participants depend on the local forest either directly through utilization of forest

products or indirectly through regulatory services. Increased knowledge would lead to

more positive attitudes toward the local forests and practices that affect its health

conditions. Both positive attitudes and increased knowledge, specifically of solutions to

forest-related problems, would be transformed into actions that would help sustain the

forest, assuming that all other factors are held constant.

Overview and application of social learning theory. Social learning theory combines

behavioral and cognitive theories to explain how human beings acquire new knowledge

and convert this knowledge into behaviors in a socially mediated process. In social

learning theory, the roles played by the symbolic, vicarious, and self-regulatory processes

in psychological functioning of a learner are emphasized. Symbolic processes enable a

person to use symbols to represent events, analyze experiences, communicate with others,

engage in foresightful actions, and so forth; vicarious processes enable humans to learn

new behaviors through observing others; and self-regulatory processes enable humans to

internally process information about new behaviors and decide which behaviors to act on.

This implies that humans have different ways of encoding and processing information

about observed behaviors before reproducing what they learned. Individuals with better

encoding capabilities can reproduce more information than those with low capabilities. In

this study, it was expected that individuals with higher encoding capabilities would retain more new information learned via group discussions or mobile phone texting.

In social learning theory, learning of behaviors is expected to happen in three different ways: (1) through physical demonstration of a desired behavior to observers— i.e., a person demonstrates the desired behavior before the learner tries out the practice; (2) through verbal instruction in which a person describes a desired behavior and how to engage in such behavior; and (3) through symbolic demonstration in which desired behavior is demonstrated using media, such as television, or the internet. While some behaviors require physical observation of a modeled behavior for one to learn and reproduce a similar behavior, other behaviors may need only an oral description for people to understand or be reminded about what behaviors are preferable and how they are performed. As an example, people do not need a live demonstration of dry wood collection; rather, they need to be reminded that it is a sustainable practice compared to cutting living trees. However, people may need a live demonstration (or "hands-on" training) of tree planting or other sustainable agricultural practices in addition to oral instruction. While it is clear that some modeling strategies tend to have more impact than others, deciding which one to use may be influenced by many factors, including context and the budget of the project (Bamberger et al., 2012; Funnel & Rogers 2011). In this research, oral instruction was employed as an approach to creating environmental awareness because it was the most feasible (due to the short project timeline) and most affordable approach. Over three months, participants thus learned new environmental information through group discussions and via text messaging on mobile phones.

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For people to learn and transform a modeled behavior into action, Bandura (1971, 1977) emphasizes that the following must happen. First, the observer needs to pay attention to the modeled behavior. The level of attention differs among individuals due to differences in their abilities to pay attention as well as their interest in the modeled behavior. Second, the observer must retain the information about the modeled behavior through encoding into his/her brain. Third, the observer must reproduce the modeled behavior, which will depend on how much information about the modeled behavior the individual retained. In this case, an observer may need to try the behavior and correct him/herself before accurately reproducing that behavior. Therefore, reproduction of a behavior can be impacted by the complexity of the modeled behavior; the simpler the behavior, the easier it is to reproduce. For behaviors discussed in the EE project, it was expected that most of them would be simple behaviors, and thus reproduction mainly depended on the participant's cognitive abilities; that is, whether he/she could recall multiple pieces of information when asked about what they knew. Although the aim of environmental education was to influence participants' forest-related behavior positively, participants had to first recall the new behaviors they learned through the environmental education project and then how to implement them. This implies that participants were less likely to engage in any new behavior that they had not yet mastered (i.e., any practice perceived as difficult to implement). Moreover, while it is possible for individuals to retain and reproduce the modeled behavior, other factors such as motivation may interfere with a person's decision to engage in a target behavior. Individuals may be more likely to engage in a behavior if they perceive the outcomes of engaging in such behavior

as positive. Behaviors perceived as less likely to contribute to preservation of the local

forest were not likely to be practiced even after implementation of EE.

In addition to the factors described above, social learning theory considers the

interrelationships between cognitive, behavioral, and environmental factors, and how

humans and environments influence one another. The interpretation of this relationship in

relation to environmental behavior is that although most people have the capabilities of

storing observed behaviors or acquired kills, environmental factors such as economic or

political situations can interfere with their willingness to respond to a stimulus (e.g., to

engage in environmentally friendly behaviors). Additionally, depending on

circumstances, environmental factors may inhibit behavioral performance, while in other

settings personal factors can overpower environmental factors. For example, in the

Loliondo context, if an individual has a strong belief in the existence of a specific tree

species due to its cultural values, personal factors may overpower some environmental

factors such as being bribed by a local person or an outsider so he/she can engage in

illegal logging. If, however, dry wood is scarce and the cost of using electricity as an

alternative source of cooking energy is high, environmental factors can overpower

personal factors and individuals may cut down trees for firewood despite either their

belief in the forest or their understanding of the consequences of cutting the trees.

Application of social learning theory in designing the environmental education

project also meant the need to adhere to traditional and cultural practices of people in the

study area to ensure that socially mediated processes of learning were facilitated. Using

the face-to-face group discussion approach, for example, imitated the traditional way of

information transfer among local people, as people in the area are accustomed to accessing information through word of mouth. Another cultural value of importance was the role of gender in Maasai societies. For example, from my experience working in Maasai communities, men and women often sit in different sections of the room when in one meeting room; in most cases, women do not voice their opinions when men are present. Instead, women tend to talk more freely when men are not present. Although female empowerment efforts have increased Maasai women's participation in decision making in recent years, the gender gap is still large (Grabe, 2015). To ensure women's participation, discussion of environmental information took place in separate groups of men and women. In a few cases, where it was not feasible to have separate groups, facilitators encouraged women to contribute to the discussions. Second, since the majority of participants (59.8%) in the study area were less fluent in Swahili, all discussions were conducted in their native language. Discussing environmental information with peers in separate groups of men and women and in their native languages created a socially structured learning process, which was critical for learning in the Loliondo context.

In the mobile phone treatment group, the social learning process was facilitated by sending environmental information via text messaging on male and female participants' mobile phones, or on their relative's or friend's phone. All the messages were written in the Swahili language because it was expected that any literate person would be able to read in Swahili, the medium of learning used in public primary schools. Increasingly, mobile phones are used by men and women for social connections and

economic gain (Souter et al., 2005; Wesolowski et al., 2012). For example, my baseline study revealed that over two-thirds (68.1%) of the sample of participants reported having accessed general[52] information via mobile phones (see Chapter Five). Ability to access information via mobile phone does not, however, mean that an individual owned a mobile device, since people tend to share mobile phone devices (Aker, 2015; Wesolowski et al., 2012). Access could thus be via relatives' or a friend's mobile phone; sometimes a person would own a SIM card and would borrow a friend's or relative's phone whenever they want to call or text someone. Evidence also shows that mobile phone use in rural Africa has become ubiquitous, nevertheless (Pew Research Center, 2015).

Receiving environmental information as text messages was expected to happen in a social setting, where individuals would read, share, and discuss the information received. If an individual read a message while other people were present, sharing was expected to happen right away; if, however, an individual read a message while alone, sharing was expected to happen later, either during a family gathering or at social gatherings (such as at the market or a bar). Inquisitive non-participants were also expected to read any environmental information received by study participants if they were interested. If a participant was non-literate, it was expected that their literate spouse, child, or friend would read for them.

Experimental design, delivery strategies, and research evaluation plan. To fulfill the requirements of program evaluation theory, implementation of the environmental

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[52] In this study, general information included news about what was happening in their village, nearby villages, and other places.

education project followed three main stages. In the initial step, I conducted a pre-test study between summer and fall of 2013 to establish baseline KAP values before the treatments were implemented. The baseline study acted as a "formative study", as it helped identify *gaps* in the three main constructs: knowledge, attitudes, and practices. The baseline study also helped identify any behavioral constraints and behavioral facilitators—factors that inhibit people from engaging in environmentally friendly behaviors and those which make it easy for them to engage in such behaviors, respectively. Furthermore, the baseline study helped identify suitable and feasible strategies for implementing the environmental education program in the Loliondo area. Identification of educational strategies was possible because, from baseline findings, I could identify common communication strategies within and between villages as well as understand cultural values in each village.

The baseline study was then followed by implementation of an environmental education experiment in spring 2015, as informed by the findings from the baseline study. Finally, a post-test study was conducted between the summer and fall of 2015 to assess changes in KAP values by answering the following questions: Did people's KAP values change? Which dissemination strategy was more effective as measured by change in KAP values? What factors acted as inhibitors or facilitators of information access? And which factors were more associated with behavior change?

In addition to pre- and post-test establishments, the project was implemented as a controlled experiment to allow the comparison of KAP values between the control and treatment groups and to determine if any observed changes resulted from the

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environmental education project and were not due to random chances. Two villages were thus assigned to the control group where no environmental education was provided. Six villages were assigned to treatment groups where I implemented environmental education. In three treatment villages, environmental education took the form of small group discussions of environmental information. In another three villages, it entailed sending environmental information as text messages on participants' or participants relatives'/friends' mobile phones.

To ensure uniformity in implementation of the two information delivery strategies, I created procedural guidelines for both experiments. For example, the discussion guide included a description of all the environmental information that was to be discussed in each group and how to facilitate the discussions. More detailed versions of the same messages were sent to participants in the mobile phone treatment. The two information delivery strategies are described in detail in Chapter Five. This design enabled me to test which strategy had more impact on KAP—the group discussions (the more traditional approach) or the mobile phone texting (the more modern approach). The decision to implement two separate strategies was based on the fact that FZS, the funding agency, was interested in implementing an experiment that would lead to more engagement in environmentally friendly behaviors by local people and in identifying cheaper ways of implementing environmental education projects. This partly is due to the fact that most local governments in Tanzania have limited budgets for managing natural resources, especially when these resources are on *general lands* where almost no resources are allocated for their management. Moreover, studies reported in the health

(Gitonga et al. 2010; Kamanga et al. 2010), business, and agricultural (Tomlinson et al,
2009) fields have demonstrated high potential for mobile phone applications in
knowledge transfer, yet mobile phone application in environmental studies has been
explored to only a limited extent. Since mobile phones are very cost-effective, especially
when SMS service is used in place of voice calling (Dickinger et al., 2004), it would be
an ideal environmental education strategy for countries with limited resources for natural
resource management, if effective. The schematic depiction of the study design is shown
in Figure 3.3 below.

Figure 3.3. Schematic depiction of the study design

Study communities
(Eight villages)

Treatment group
(Six villages)
♀♂

Control group – no
EE disseminated
(Two villages)
♀♂

Group discussion
and PPM treatment
(Three villages)
♀♂

Mobile phone
texting treatment
(Three villages)
♀♂
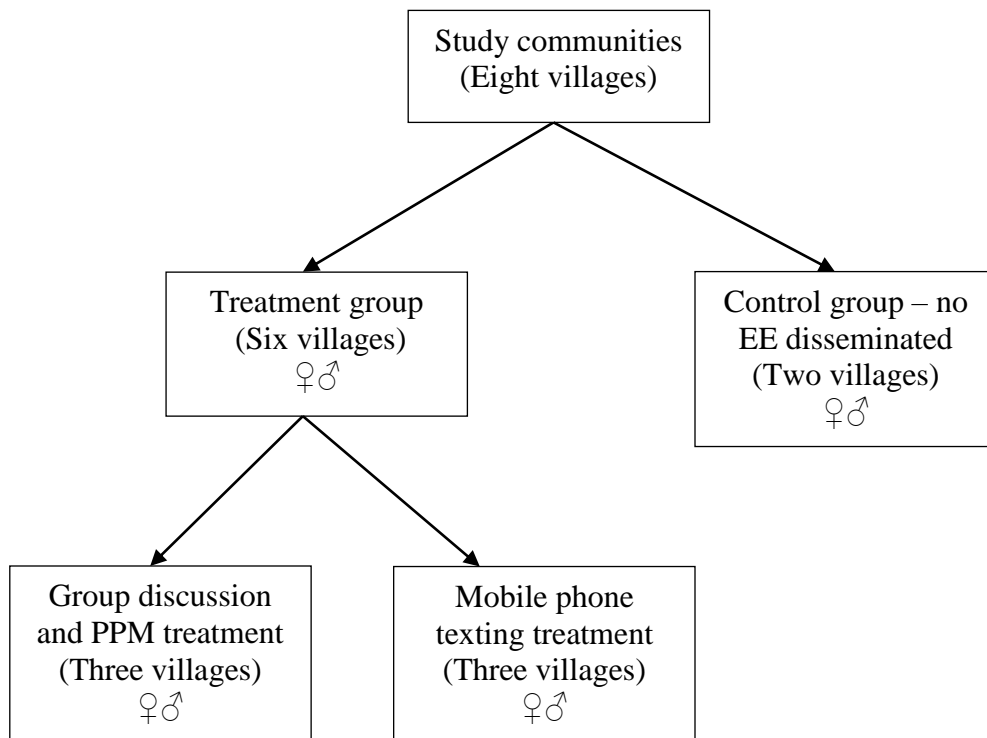
3.1.2. Inputs and activities

At all stages, Frankfurt Zoological Society, the funding organization, provided most of the input resources required to complete the project, including vehicle, fuel, and personnel (field assistants and driver), refreshments for participants who attended meetings, stationery supplies for group discussions and village meetings, small gifts (one kilogram of sugar per participating household), and airtime bundles for participants in the mobile phone treatment. The purpose of the refreshments and small participation gifts was to encourage participants to attend meetings and help them focus on the discussions rather than influence them to engage in any environmentally friendly behaviors. The gifts were small enough not to influence the results of the experiment while they served as a "thank you" not only for agreeing to participate in the project but also for their time. FZS's field personnel and I ensured that the purpose of the gifts was clarified to all participants; that the small gifts were not meant to serve as "compensation" for their time/participation. Similar gifts have in the past been provided by other NGOs that do research work in similar areas and seem to be appreciated by most communities, although they can be controversial at times. Small airtime bundles were provided to every study participant for every text message received to encourage them to respond to environmental education messages and thus make the process more interactive and social rather than a one-way learning process.

To prepare for environmental education that employs a KAP study methodology, Eckman (2013) recommends that a researcher should engage in a "discovery process" which basically allows one to go through seven steps that will help identify a problem

and its historical causes, and consequently determine the solution for dealing with that problem. The first step involves *situational assessment*; a step that allows a research team to identify and clearly articulate a problem. This step helps a researcher think about what may already be known about the problem and the context in which the problem is currently occurring. This step helps facilitate identification of factors contributing to a natural resources issue by focusing on "what is known (or not known) about those factors" (p. 14). The second step is the *Gap exercise* that will help one determine what is not known about the problem. The third step involves summarizing information gaps and needs in a table. The fourth step involves selecting methods to be used to collect missing information. The fifth step involves conducting biophysical and social science research to address information gaps as well as establish a monitoring plan. Step six involves monitoring, analyzing and interpreting baseline results, as well as relating these to decision-making. This step helps researchers decide on what to do about the issue, what strategy would address the problem adequately, and why and how project progress should be monitored. The last step involves evaluating outcomes; information from the evaluation should then be used for "strategic planning and to inform future projects" (p. 17). Eckman (2013) also recommends that evaluation should include determining whether knowledge, attitudes and practices changed as a result of a project; and whether the health conditions of a focused natural resource also improved.

While the discovery process was not carried out in a step-by-step fashion per Eckman (2013), most activities were implemented accordingly. For example, the situation analysis involved consultation with Frankfurt Zoological Society's personnel to

ensure that the forest problems in Loliondo were clearly articulated. The identification of the problem did not involve local people/stakeholders, however. Also, both the pre- and post-test KAP studies were designed and implemented in consultation with Frankfurt Zoological Society's personnel; gaps identified in the baseline study were used to determine the type of information to disseminate to local people and educational strategies to use. The monitoring plan, specifically for the mobile phone texting group, was formulated to ensure that participants received text messages and understood each message (described in Chapter Five). Finally, methods for data collection were determined based on *information gaps* identified during both the planning and pilot phases.

3.1.3. Mediators

According to Donaldson (2003, as cited in Bamberger et al., 2012), mediators are "intervening variables potentially affecting project performance that the project may be able to influence" (p. 192). Bamberger et al., describe further that mediators are factors that may either motivate or hinder someone from participating in a program. In this environmental education project, factors that possibly acted as mediators include assistance provided by men or women to their spouses. For example, if only a husband in the household owned a mobile phone, a wife's access to environmental education via mobile phone depended on whether the husband considered sharing the message with the wife as important or not. In cases where the husband felt the need to help the wife access and understand environmental information, this acted as a motivation factor for the wife as she was more likely to learn the same information as the husband and vice versa.

Likewise, if one of the spouses missed an environmental education discussion meeting or did not understand the environmental education discussed at the meeting, initiation of a discussion in the household would have acted as a positive motivator for participants in the respective households.

Similarly, village leaders had a big role in either encouraging or discouraging study participants to acquire more environmental information or better understand it by either emphasizing at village council or general meetings that participants pay attention to the information they received and vice versa. To influence the actions taken by village leaders, I held meetings with them at each stage of the project. At each meeting, I described the project in detail and emphasized their role in ensuring that participants accessed the information through the project, and that sharing among village members was encouraged. Spouses were also encouraged to share all the information accessed via the project with both participants and non-participants within their residential villages.

3.1.4. Outputs, outcomes, and impacts

Project outputs include the number of participants who received environmental education either via group discussions or mobile phone text messaging and village leaders who attended project-related village meetings. Measurable outcomes include improved forest-related environmental knowledge, attitudes, and practices or behaviors; other outcome variables are as shown in Figure 3.2 above. Not shown in the model is the overall impact of the environmental education project which are the goals set by the funder, Frankfurt Zoological Society through the CREATE project: (1) *Improve understanding of the links between poverty, human health, disaster management, and*

environmental sustainability and (2) *While actively informing local and international decision making and policy development in two key African ecosystems.* While both outputs and outcomes could be measured at the end of the project, the impacts of the project on forest resources use and management could not be determined because of time and budget limits. Accurate measurement of the impact of environmental education on natural resources use and management may require that a social science study conducted a few years after project completion, as well as obtaining biophysical measurements, rather than relying solely on self-reported answers.

3.1.5. Contextual factors

Contextual factors can highly affect the success or failure of a project (Bamberger et al., 2012; Funnel & Rogers, 2011), and thus need to be addressed. Most contextual variables were not expected to vary much between individuals, however. One of the major contextual factors in the Loliondo area was the political climate. People in the Loliondo Game Controlled Area (LGCA) have been experiencing land conflicts for many years. Many of the conflicts are related to land management rights, as described in Chapter One. Some of these conflicts have implicated the Tanzanian government and some tourism business companies, the major one being the Otterlo Business Corporation (OBC). Others have involved two ethnic groups, the Sonjo and Maasai tribes (Ojalammi, 2006; Rurai, 2012). On several occasions, OBC has been accused of providing no societal benefits to the people in the area, harassing and killing people, as well as practicing non-sustainable hunting (Feminist Activist Coalition [FEMACT], 2009; Hicks, 2012; Ngoitiko, 2008). While OBC does not operate near the eight study villages included in

the study, communities in these villages are aware and are not happy about these conflicts; most of them graze their livestock in the hunting blocks leased by OBC, and have relatives from conflicted zones.

Conflicts between the Sonjo and Maasai tribes are a result of various factors, including traditional practices such as cattle raiding by the Maasai and villagization in the 1970s (Ojalammi, 2006). According to Ojalammi, during the boundary demarcation of villages in the 1970s, Sonjos felt that the Maasai were favored, thus boundaries between villages remained unresolved. The land conflicts between the two tribes have led to several deaths of Maasais and Sonjos in the past (Ojalammi, 2006).

Observations made by the author during the baseline study showed that some land conflicts have led to political instability in the area. Informal conversations with local leaders and district government officials revealed that some local non-profit organizations, particularly the Pastoralists and Livestock Services Project (PALISEP), have in the past used some of these land conflicts to raise suspicions in some communities of any organization or persons interested in working in Enguserosambu Community Forest. Rumors in the area suggested that PALISEP and some elected leaders encourage local people to mistrust organizations trying to work in the area by convincing them that the organization might confiscate their forest. An official from Frankfurt Zoological Society also noted that PALISEP is very "active in Enguserosambu area and protective of anyone working in Enguserosambu area as a potential threat". Even though village leaders requested Frankfurt Zoological Society's assistance to protect the Enguserosambu Community Forest, it became clear that the political climate would deter

local people from wanting to participate in the environmental education project and thus would influence the success of the project.

Another relevant contextual factor was the perceived management rights of ECF and the location of households in relation to ECF. The central government is in the process of giving participatory management rights of the ECF to villages that are adjacent to it, including seven villages that are part of the environmental education project evaluated here. However, four villages from one ward claim they are the only ones entitled to the forest because most of ECF land was part of these villages; they argue that the other three villages just border the forest and the small portion of their lands that were included in the ECF are already deforested. It is thus possible that people who live in the latter villages might not engage in some environmentally friendly behaviors due to fears that they would be considered as intruders. Even though the direction provided in section 16 (subsection 1A) of the Tanzania Forest Act of 2002 requires that joint management of the national forest includes "the director and any person or organisation in the public or private sector providing for the management within the vicinity of that national forest reserve, community groups or other groups of persons living adjacent to and deriving the whole or apart of their livelihood from that national forest reserve"(Forest Act of 2002, p. 23), this has only been done on paper for the ECF case. Furthermore, understanding geographic boundaries of the forest, as well as what is happening in the forest, may depend on how far one's household is from the forest and whether the person visits other parts of the forest. Individuals whose houses are located near the boundaries of the forest may be more likely to understand what is happening in the forest and thus may be more

willing to engage in some environmentally friendly behaviors such as forest guarding, compared to those located farther from the forest, although this was less likely to be the case in Loliondo.

Other contextual variables include cultural practices, specific gender and age differentiated roles, available sources of forest products and grazing land, economic activities, demographic characteristics, and infrastructure found in the area. Cultural practices that are related to forest use and have negative impacts on forests include use of tree bark of specific tree species for making traditional medicine and other items, as well as the construction of homes using specific trees from the natural forest as primary materials. In most cases, the Maasai people, the majority ethnic group in the study area, live far from town centers where health facilities are located. Thus, they still rely heavily on traditional medicine prepared from forest products. Other factors related to cultural practices are gender- and age-differentiated roles among the Maasai and other tribes. The *Morans* are expected to guard the forest and graze livestock while elders may only participate in decision making. Gender differences in household responsibilities may influence how participants perceive some EFBs and how they engage in them. On the one hand, women may appear to engage more in behaviors such as tree cutting for firewood because it is a gender-based responsibility; on the other hand, men may appear to engage more in behaviors such as grazing livestock in the forest.

Another contextual factor is that there are no alternative sources of forest products and grazing land. In the Loliondo area, there are no planted forest blocks for harvesting. This means that most people depend on the ECF and other nearby natural forests for

forest products. Moreover, while some tribes depend on both livestock herding and agricultural activities for economic activities, Maasai still depend largely on livestock. Scarce forage, especially during the dry season, forces most herders to graze their livestock inside the forest, thus degrading the ECF. People who own livestock may not restrict grazing in the forest unless they have alternative grazing land. Conservation in this case may mean minimizing extraction of living trees by relying more on dry dead wood for uses such as firewood or construction of cowsheds or regulated tree cutting rather than a total restriction. Understanding cultural and economic practices was thus crucial for determining which environmental information was suitable for dissemination and understanding the sources of differences observed in the results.

The high population growth rate is another contextual factor that may influence the use and management of the forest in Loliondo. As in many parts of Tanzania, the population growth rate of the Loliondo Division[53] is still very high; in 2002 and 2012, the division's estimated annual growth rates were 4.5% and 2.9%, respectively (URT, 2006; URT, 2013). High population implies an increased need for forest resources and land for cultivation and grazing, consequently leading to overexploitation of the local forests. This further implies that even with increased knowledge about environmental issues and their solutions, people in Loliondo may still be less likely to engage in EFBs as long as they have no alternative sources of forest products to meet the needs of the people and have no alternative land to cultivate and graze their livestock. This may increasingly be true in the future. Moreover, most Maasai adults have either very low levels of education or have

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53 In Tanzania, a division is a third geographic level (administrative level), after region and district.

never attended formal education. All study villages had poor roads and limited access to electricity, while most of them had limited wireless network. Based on informal conversations with village leaders during a preliminary study conducted in the summer of 2012, radio signals were only available between 7:00 p.m. and 8:00 a.m., making it hard for people to listen to news even when they have radios. Only a small percentage of households in one of the study villages had access to electricity. Determining which environmental education strategies to implement thus partly depended on the available infrastructure and demographic characteristics of the area. The contextual factors observed here are at the household, village, ward, and division level, although from experience working in the area, there may be some consistency across the district of Ngorongoro.

3.2. Other theoretical domains

In addition to program evaluation theory, other theories were employed to conceptualize the role of environmental education in natural resource use and management. Communication theories helped me design EE messages in a way that was easy for the participants to understand as well as to access and understand the EE information. Communication theories also helped me think about ways to ensure that the participants understood the information disseminated to them. Environmental education and content delivery helped me identify dissemination strategies and types of environmental topics to cover in the EE curriculum. Finally, literature on models of determinants of engagement in environmentally friendly behaviors (EFBs) helped me understand how various personality and environmental factors might influence

engagement in EFBs despite increased environmental knowledge. The three groups of literature are briefly described below.

3.2.1. Communication theories

As discussed in the literature review chapter, communication is critical for everyday life—therefore, it is essential to ensure that it is implemented effectively. Keyton (2011) and Lunenburg (2010) note that effective communication is necessary for ensuring that the information exchanged between individuals or groups of people is understood as intended. To achieve effective communication, Lunenburg (2010) and other scholars propose that the message should be carefully encoded—i.e., the message should be designed such that it can easily be decoded, and thus easily be understood by the receiver. This also implies that one needs to select words that are appropriate for a specific audience and purpose. For example, one cannot use words not familiar to his/her audience and expect that everyone will understand. In addition, the message should be delivered using a medium that facilitates easy access by participants. One cannot expect, for example, poor rural people to access news or educational materials via the internet when the majority are non-literate and cannot afford to buy computers or other web-enabled devices. Sometimes this is a cultural problem rather than a shortage of resources. Ensuring that these barriers (also referred to as noise or environmental factors) are addressed is critical for effective communication. Another important element critical for effective communication is feedback (Lunenburg, 2010). Without a response from the receiver that shows that he/she received and understood the message sent to him/her, it is

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impossible to judge that the message was received and understood. If the EE message is not understood, no change in EFBs can be possible.

Unfortunately, effective communication cannot be achieved easily because, as illustrated by many scholars, there are many barriers (see Alexander, 1972; Eisenberg, 2010, as cited in Lunenburg, 2010; Button & Rossera, 1990). Barriers such as lack of fluency in a language, culture, or experience can all lead to poor encoding of messages— and finally to failure in communication. Specific communication barriers need to be identified and addressed. Other barriers to communication are discussed in the literature review chapter.

In this study, an application of communication theories meant that I had to pay attention to the people I was dealing with—the Maasai-dominant populations who have low levels of education or no formal education at all. Since most had very little formal education, I used simple familiar messages that could easily be understood; this was the case for group discussion and mobile-phone texting. I also ensured that the communication channel employed was accessible to most participants. To do this, I implemented face-to-face group discussions which were accessible to every participant, although accessibility was limited to those who were available on the scheduled day of EE implementation. With mobile phone texting, it was assumed that a larger proportion of participants had access to mobile phone use (not necessarily the device), either via the participants' or relatives' devices. This assumption was based on baseline findings that revealed that most people had access to general information via mobile phones. I also ensured that EE facilitators were familiar with the cultures and fluent in the languages

spoken in the area. Additionally, I made sure that participants provided feedback to determine if they understood EE messages discussed in groups or received via mobile phone. In the group discussion treatment, feedback was requested by asking participants to summarize what they learned; for the mobile phone group, participants were asked to say whether they received and understood each EE message, either by texting back or calling the facilitator.

3.2.2. Environmental education and content delivery

As discussed in the literature above, research in this body of literature shows that environmental education projects do successfully lead to achievement of project goals in some ways. Research in this body of literature also shows that various strategies have been employed to implement EE and have all lead to different levels of success. Various studies have reported positive impacts of environmental education, including improved knowledge, attitudes and behaviors (Clayton & Myers, 2009, 2015), although they also acknowledge failures of some projects due to various factors. This is especially true when long-term impacts are measured (Kuhar et al., 2010). Literature on environmental education and content delivery helped me identify types of information suitable for the Loliondo and the purpose of the project, as well as to determine feasible informal education strategies for adult men and women. The literature also helped me identify expected outcomes of the environmental education project. Additionally, review of this body of literature helped me identify strategies for communicating environmental information in a way that ensured social processes were adhered to. Selection of the dissemination strategies employed in this study, and the choice of content of information,

were all aimed at maximizing the outcomes of the environmental education project in Loliondo.

3.2.3. Models for determinants of environmentally friendly behaviors

While social learning theory explains clearly how people learn new behaviors and the importance of a socially mediated process in learning, it was not developed for addressing specific behaviors such as environmental behaviors. Other models that stem from Bandura's (1977) social learning theory have, however, attempted to identify what factors influence engagement in such behaviors; some of them have been applied successfully. Models such as those developed by Bamberg and Möser (2007), Hines et al. (1987), and Hungerford and Volk, (1990), were all developed in an effort to identify which factors determine choices to participate in desirable environmental behaviors. While these models are different in some ways, they all agree on some key determinants of participation in environmentally friendly behaviors, including knowledge, locus of control, personal responsibility, and situational factors (these terms are defined in Chapter Seven). In this study, I applied a simplified version of the responsible environmental behavior model by Hines et al. (1987) to identify determinants of an individual's choices to participate in forest-related environmentally friendly behaviors. The model is described in detail in Chapter Seven.

3.3.   Research questions and hypotheses

To fulfill the aims of my dissertation research, I investigated four major questions. The first two questions are addressed in Chapter Five and use pre- and post-test KAP

data. I used a customized KAP methodology to measure and assess the impact of an environmental education program on the three KAP constructs: knowledge, attitudes, and practices. I compared the impacts of the two strategies employed – face-to-face group discussions and mobile phone texting—on the KAP values. The third question is addressed in Chapter Six. It explores the applications of satellite or aerial images in creating environmental awareness. Change in perception about the local forest's health condition is assessed by comparing pre- and post-test information on perceptions. This is complemented by qualitative responses and analysis of land use land cover of the ECF. The last question, addressed in Chapter Seven, explores factors that are associated with engagement in forest-related behaviors by using post-test data collected in Loliondo. I run multivariate models to identify factors associated with engagement in environmentally friendly behavior.

The four questions addressed in Chapters Five to Seven are:

1. What is the impact of environmental education on people's knowledge, attitudes, and practices (KAP) related to natural resource use and management among the Loliondo people?

2. Which educational strategies have the most impact on Loliondo people as measured by knowledge, attitudes, and practices?

3. What is the impact of participation in participatory photo-mapping (PPM) on the Loliondo people's perception about health conditions of the ECF?

4. What factors are associated with engagement in forest-related environmentally friendly behaviors among people in the Loliondo area?

Hypotheses. Following the social learning theory by Bandura (1971, 1977), I

hypothesized (a) that, controlling for other factors, environmental education disseminated

via either group discussions or mobile phone texting would lead to increased knowledge,

positive attitudes and engagement in more environmentally friendly behaviors. In line

with the theory of change, individuals' knowledge about forest-related problems and

solutions was likely to increase among participants who received environmental

education via the EE project. Higher awareness was, in turn, expected to lead to concern

for the environment, and thus positive attitudes. Finally, due to improved attitudes toward

EFBs, individuals were expected to transform the acquired knowledge into sustainable

practices. The level of the impact, however, was expected to be determined by various

personality and environmental factors as discussed above. This hypothesis also follows

findings from other studies that observed improved knowledge, attitudes and engagement

in EFBs among individuals who participated in environmental education programs. The

hypothesis considered the fact that some people already possessed higher environmental

knowledge prior to project implementation compared to others. It was also expected that

the process of information dissemination helped reinforce some knowledge and thus

reignite positive attitudes and practices.

I further hypothesized (b) that, controlling for other factors, the face-to-face

group discussion strategy – the more traditional approach – would have a greater impact

on knowledge, attitudes, and practices. This hypothesis again follows the theory of

change employed in the EE project and literature on environmental education and content

delivery which acknowledge that the effectiveness of different education strategies can

have varying impacts on participants. This hypothesis was also based on previous studies that show that word-of-mouth still prevails as a communication strategy in rural areas where the level of education is low and infrastructure is limited (Souter et al., 2005). Previous studies that compared the impact of mobile phones and face-to-face strategies on service delivery also show that face-to-face outperformed mobile phones.

I also hypothesized (c) a positive relationship between participation in PPM and correct perception of the ECF's health conditions. According to social learning theory, learning can happen in various ways, including through images which facilitate visual learning. Individuals who participated in identifying and marking earth features on a photo-map[54] were more likely to have a better understanding of the forest's health conditions and how it had changed over the past 10 years. Better understanding of where deforestation was taking place was expected to help participants and village leaders direct their management efforts toward areas where forests are prone to destruction. Better understanding of forest conditions was expected to lead to increased concern for the future availability of the forest, with the hope that this understanding would trigger people's need to engage in environmentally friendly behaviors. The hypothesis considered the possibilities that responses to the question about forest health conditions might lead to biased responses, however, due to local politics that surround natural resources in Loliondo. I discuss these politics in Chapter Six. To address bias, sensitivity analysis was conducted by analyzing other questions that provided descriptive information.

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54 Photo-map is a map created from satellite or aerial photo mosaics.

Finally, I hypothesized (d) that, both higher cognitive factors (such as environmental knowledge) and personality factors (such as positive attitudes toward EFBs) would have a positive association with engagement in environmentally friendly behaviors, controlling for other factors. Furthermore, I hypothesized that individuals who felt a sense of personal responsibility to help protect the ECF were more likely to engage in environmentally friendly behaviors compared to those who felt that it was the responsibility of the village leaders, the government, or NGOs. Models for engagement in EFBs acknowledge that awareness and concern for the environment (which results into positive attitudes) can lead to more engagement in environmentally friendly practices, and that the level of impact of attitudes can be much lower compared to that of knowledge. Personal responsibility is also identified as a necessary factor in the environmental behavior models if people are to transform their knowledge into actions.

4. Methodology and Data Analysis

In this chapter, I describe the procedures and methods employed in data collection and analysis. I start by describing the research ethics I followed before initiating my study. I point out relevant ethical issues and how they were addressed as well as list all types of research permits I had to obtain before initiating my research. I also describe how I ensured that the data and participants' privacy were protected. Second, I describe data collection procedures, including acquiring sampling frames, sample size determination and sampling strategies. Third, I describe the questionnaire formats and interview procedures, hiring and training of enumerators, and questionnaire piloting. I also describe the methods of analysis employed, including specific descriptive and inferential statistical methods employed. Data analysis methods are described only briefly in this chapter; more details are provided in Chapters Five to Seven, the results chapters. Data collection and analysis of satellite images is covered in detail in Chapter Six. Finally, I discuss reflexivity in research and how I employ it in this study. Describing my reflexive process helps readers understand further the context of the study and the quality of data analyzed here; consequently, it helps readers correctly interpret reported findings.

4.1. Research ethical considerations

In line with best practices for social science research, this study had ethical issues that needed to be considered. Although there were no real risks of involvement in the study, issues of privacy and confidentiality were likely to pose potential harm to study participants in various ways. Protection of study participants' privacy and confidentiality

was achieved through five major ways. First, the study was conducted carefully to avoid inciting and igniting conflicts and violence. For example, prior understanding of land resource issues in the study area enabled me and my assistants to clearly explain the purpose of the study to everyone and avoided initiating conversations that would have ignited such conflicts. Second, only respondents aged 18 and above were interviewed; no vulnerable young individuals were part of the study. Third, participation in the study was voluntary. Consent forms for participants were prepared, and enumerators read the consent forms and explained the purpose of the study to participants before interviewing them. Individuals who agreed to participate were required to give their oral consent. Fourth, names of all respondents were recorded; however, as soon as data analysis was complete, they were removed and kept in the master identification file. All the data collected are encrypted to ensure data security. Fifth, the study was conducted with the approval of the Institutional Review Board (IRB) of the University of Minnesota. It was previously approved by the Tanzania Wildlife Research Institute (TAWIRI), a parastatal organization under the Ministry of Natural Resources and Tourism. TAWIRI is responsible for conducting and coordinating wildlife-related research and research that takes place in wildlife areas such as national parks, game reserves and game controlled areas. Finally, any shortcomings encountered during the study are reported.

Since permission to conduct research in Tanzanian villages was obtained from multiple levels of authorities, it is important to understand its governance structure. Tanzania governance is mainly divided into three categories: central governance, regional governance, and local (district) governance. While there is an appointed regional

commissioner, regional governance operates only through its district authorities. The local governments implement the country's plans as they are closer to the people. The 1977 constitution of the United Republic of Tanzania Article 145, mandates the establishment of these local authorities, while Article 146 stipulates the general functions of these authorities (URT, 2005). According to Article 146, "Local government authorities shall have the right and power to participate, and to involve the people, in the planning and implementation of development programmes within their respective areas and generally throughout the country" (p. 83). The local government is divided into urban and rural authorities. Urban authorities are divided into towns, municipalities, and cities, which are further divided into wards, and wards into streets (mitaa)—see The Local Government (Urban Authorities) Act of 1982 and The Local Government (District Authorities) Act of 1982. The rural authorities are divided into districts, districts into wards, wards into villages, and villages into sub-villages (see Figure 4.1). In most cases, villages comprise two or more sub-villages/hamlets (*"Vitongoji"*). A sub-village is divided into ten-cell units where households are normally assigned to a leader called *"Balozi"* (ten-cell leader), although this is not legally required. The *"Balozi"* assists with smooth running of village activities.

A sub-village (*"Kitongoji"*) is composed of a chairperson and a secretary, elected by the adult members in the respective sub-villages. Since the sub-villages do not operate as local authorities on their own, the sub-village chairpersons become part of the village council. Additionally, the village assembly elect additional village members to become part of the village council. The village council thus comprises between 15 and 25

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members, of whom a third must be women.[55] In addition to these members, the Village

Executive Officer (VEO), a government official, is also part of village government

because he/she serves as the village secretary. The VEO performs administrative tasks of

the village and works closely with the village leadership. The VEO is the only village

council member formally paid a salary by the government. With the exception of the

VEO, the elected council members stay in office for five years. Section 142 of the *Local

Government (District Authorities) Act* of 1982 gives power to the village council to run

village affairs. As stated in this act, "A village council is the organ in which is vested all

executive power in respect of all the affairs and business of a village". The village

council may appoint individuals, from elected council members to serve in various

committees such as the natural resources/environmental committee to assist in running

affairs of the village.[56]

Figure 4.1. The Local Government System in Tanzania

Central governance				
Regional governance				
Local governance				
Urban authorities			Rural authorities	
Cities	Towns	Municipalities	Districts	
Wards				
Streets/mitaa			Villages	Townships
			Sub-village (Vitongoji)	

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55 A village assembly comprises any resident of a respective village aged 18 years or more. Section 141 of the *Local Government (District Authorities) Act* of 1982 identifies the village assembly as "the supreme authority on all matters of general policy-making in relation to the affairs of the village as such, and shall be responsible for the election of the village council and the removal from the council of any or all of the members of the council, and for the performance of any other functions conferred upon it-by or under this Act or any other written law."

56 The Village Natural Resources Committee helps protect the natural resources such as forests but cannot make decisions on its own.

For this study, the first step to obtaining research permits in Tanzania involved obtaining a permit from TAWIRI. TAWIRI's letter was directed to the Ngorongoro district where my study was located. The letter was then presented to the district executive director (DED), who then wrote a letter to the village executive officers requesting that village leaders provide me with support during the entire research period. Finally, I presented the letter from the district executive director to the village executive officer, who then organized a meeting and shared the letter with village council members. Village elders were also invited to the meeting, even if they did not have formal leadership positions in the village council, because they are respected people who provide advice to the communities. Their opinions and decisions are highly respected.

All the permission letters were acquired and presented to the respective authorities before initiation of the study. This was critical to avoiding confusion and misunderstanding among study communities. Additionally, I met with all the leaders in each village and discussed the purpose of the research and planned activities before proceeding with scheduling research activities. At each meeting, I also made sure that additional village members were present, at least two men and two women from each sub-village. Having more representatives from each sub-village was meant to increase the chances of transferring correct information about the study to other community members who did not attend the meeting. The hope was that this would minimize concerns that communities might have had toward the study. At the meetings, attendees were encouraged to ask for any clarifications.

Because the research involved multiple visits to the study villages, I met the

leaders and other village representatives on each visit to remind them about the purpose

of my study and the specific purpose of each visit. Holding meetings during each visit

was meant to ensure that every leader was well informed about my research; this was

especially important because village leadership changed during my research period.

While I took all these precautions to avoid misunderstandings about the study, politics

did get in the way during my final phase of data collection. I discuss this in Chapters Five

and Six.

4.2.   Data collection procedures

This study employed a mixed-methods design, using quantitative and qualitative

methods in collecting data (Creswell & Clark, 2007). Quantitative and qualitative

approaches were employed during the pre- and post-test stages of the study. Application

of the survey and key-informant design and administration followed established protocols

and guidelines as described by Babbie (1992), Krueger and Casey (2000, 2009) and

Rubin and Rubin (2011), among others. A team of three highly trained enumerators

collected survey data under the supervision of the researcher and FZS staff.

Hiring and training of enumerators. For the pre- and post-test studies conducted in 2013

and 2015 respectively, I hired and trained three enumerators to collect survey data; all of

them had completed at least a diploma or bachelor's degree in relevant fields. All the

enumerators were fluent in English, Swahili and Maasai languages. Frankfurt Zoological

Society (FZS), the main funding organization, covered all the enumerator stipends and

other field expenses. Additionally, trained FZS staff supervised data collection and

intervention activities in collaboration with the researcher. Enumerators were trained on

data collection processes, content of the survey, research ethics, and on how to collect

data using a Personal Digital Assistant (PDA), a hand-held electronic device. The training

took about six days and included enumerators practicing using the PDA and interviewing

one another. Interviewing one another enabled enumerators to check one another, and

thus to determine whether they understood the questions and interview procedures in the

same way or not. In addition, interviewing one another using the PDAs enabled

enumerators to practice troubleshooting the PDAs before they began collecting actual

data. Apart from receiving training, the enumerators participated in translating questions

from Swahili to Maasai and participated in the pilot study.

Pilot study. To understand the contextual components of knowledge, attitudes and

practices related to forest resources use and management, I first conducted a pilot study

outside the study villages. The pilot study involved interviews of men and women aged

18 years and above for two days. The enumerators and I met each evening for debriefing

on field procedures, challenges, and questionnaire revision. Misunderstood questions and

other problems like typing errors were addressed and discussed with the enumerators.

Any questions that seemed to be understood differently or translated incorrectly during

interviews were clarified or revised accordingly to ensure that questions aligned with the

context of the Loliondo communities. The pilot study helped me ensure that questions

and answers were valid and reliable before administering an actual survey.

Sample size determination and sampling strategy. Before drawing a sample for the study,

I first had to determine an appropriate sampling frame. In Tanzania, village leaders maintain lists of residents for various purposes, although in most cases the lists are outdated or incomplete. I obtained a list of household head names from village leaders from each study village. Since the lists of household heads provided by the village leaders were outdated or incomplete in many cases, I updated the sampling frames by consulting sub-village leaders and other knowledgeable village members. In most cases, it was easy for sub-village leaders to update or provide a list of household head names because they know, liaise and work with these residents.

A stratified random sampling method was applied to select a sample to ensure that all eight villages were equally represented in the sample. Due to the expected varying distributions of wealth and population within each village, a proportionate number of households was drawn randomly from each sub-village to obtain a total of about 30 households from each village. In each household, up to four individuals (two males and two females) of age 18 years and above were included in the sample—the sample in the baseline study thus composed of 417 individuals. Inclusion of up to four individuals from selected households aimed at increasing sample size, improving sex ratio, as well as minimizing survey costs.[57] It was also appropriate to include multiple members from each household because responses to various questions were expected to differ even within households. Additionally, larger sample sizes not only allowed for analysis of knowledge, attitudes and practices to be disaggregated by various demographic factors but were also crucial for meeting other statistical data analysis conditions (Dillman,

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57 Sample size determination was constrained by the available funding from the funder.

2000).

While the sample size of 417 may appear to be too smaller to run complex analyses on the data, it was adequate for the types of analyses selected. This conclusion was based on the "rule of thumb" for sample determination (as opposed to power analysis), as proposed by Green (1991). Rules of thumb vary—for example, some do not require upfront determination of expected effect size; instead, one simply specifies a minimum number or the ratio of the sample to the number of predictors (Green, 1991)—historically, for example, ratios of at least 10:1 were more preferred (Harris, 1985, as cited in Maxwell, 2000). Some rules of thumb seem to provide more unstable sample sizes than others (Green, 1991). Green (1991) applies effect sizes provided in Cohen (1988) to develop a newer and simpler rule of thumb for determining sample sizes—According to Cohen (1988, as cited in green, 1991), for multiple regressions, the effect size of 0.02 is minimum, 0.13 is medium, and 0.26 is large. Based on Green's analysis (1991), the sample sizes determined using the newer rule of thumb provided very similar samples to those obtained using power analysis (see Table 1 in Green, 1991).

Assuming I expected a minimum effect size (of 0.07),[58] the required minimum number of subjects to be included in the study is given by 107 + (m-1), where m is the number of predictors. Since I had eight predictors that could be included in the equations, I needed a minimum sample of 114 (i.e., 107 + (8-1) =114) to estimate a linear multiple regression model. Following this rule of thumb for estimating required minimum sample

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58 This is the Minimum effect observed in the field of behavioral studies as proposed by Cohen (1988, as cited in Green, 1991).

size, I can confidently argue that the 417 sample was large enough to estimate effects of the EE project using multiple regression models. While the sample was satisfactory for all multi-attribute constructs and all non-skip questions, it was not enough to analyze the data at village-level because the samples were much smaller in individual villages— because of this, I could not run fixed-effects models at village-level.

Questionnaire design. The KAP study design was guided by Eckman's (2013) module for implementing KAP studies for natural resources management. As such, I ensured that questions on knowledge, attitudes, and practices specific to forest use and management in Loliondo were adequately addressed. Other topics that were covered focused on barriers and constraints to engagement in environmentally friendly behaviors as well as on how information is transferred between people within and between villages.

Unlike many studies, including those reported by Chao (2012), Pe'er, Goldman, and Yavetz (2007), Sah and Heinen (2001), and Van der Ploeg, Cauilan-Cureg, Van Weerd, & De Groot (2011) that used the Likert Scale to measure knowledge, attitudes, or behaviors related to environmental topics, this study employed open-ended questions with pre-defined categories of answers. That is, each of the three main constructs— knowledge, attitudes, and practices—were asked as open-ended questions and allowed for multiple answers. This was a preferred format of questions because a large proportion of the population in the area is non-literate. As evidenced in some studies (Bernal, Wooley, & Schensul, 1997; Chachamovich, Fleck, & Power, 2009), the Likert Scale does not work well in some cultures and with non-literate populations such as the Maasai. The Likert Scale format may be appropriate for industrialized societies but may not function

properly in African cultures that do not share the same values or world views. Also, my previous experience working in similar communities showed that respondents had difficulties providing answers to the study questions that were in Likert Scale format. As a result, it was likely that answers were skewed in one direction, when based on the Likert Scale. By using an open-ended questionnaire, respondents were able to provide multiple answers to each question, and the enumerator assigned an appropriate category for every answer. Depending on the purpose of each question, some were asked during both pre- and post-test studies while others were only asked in one of the periods.

Questions were translated into two languages, Swahili and Maasai; the PDA programming included both languages. Since all the enumerators were fluent in both languages, respondents were interviewed in either Swahili or Maasai, depending on which language they were most fluent in. The interviewers were randomly assigned to respondents.

One of the limitations of using open-ended questions is that study participants were likely to report some variables, but not all. For example, it was possible for a respondent to mention four benefits of the forest, even when they knew seven of them. The number of knowledge attributes reported, for example, depended on how much the respondent remembered at that moment, whether they were willing to provide answers, as well as whether the survey administrator was patient enough to probe for more answers. The open-ended format of questions was expected to lead to conservative but reliable answers, as it relied on the respondents' cognitive skills. Consequently, I assumed that the reported frequencies represented the general knowledge of environmental topics

related to forest use and management of the studied population. For example, if a benefit

was either not mentioned by any respondent or was mentioned only by a small proportion

of participants, I concluded that the population was less knowledgeable about that

benefit.

Survey administration procedure. The survey interviews were based on face-to-face

encounters between the interviewers and the participants in their villages. The answers

were recorded on the electronic device. Oral administration of surveys was necessary

because most respondents are non-literate. Enumerators went from house to house and

ensured that up to four individuals from each of the selected household were interviewed.

Each sub-village leader served as a guide in his/her sub-village. The use of sub-village

leaders (and sometimes ten-cell leaders or other respected individuals) as guides helped

with guiding enumerators to households[59] as well as ensuring that local people did not

feel invaded by outsiders (the research team). Sub-village leaders also helped assure local

people that the study was legitimate; that research permits had been issued at national and

local levels, and that village leaders were aware of and supported the study. Furthermore,

being guided by local people ensured security to the research team.

The sub-village leaders were given names of selected households from their sub-

villages a few days before the interview date. This enabled them to notify the selected

household heads and all eligible household members about the interview date and time to

ensure this was convenient for the respondents. In cases where the chosen date did not

work for the respondents, village leaders discussed with them when they would be

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59 Like in most Tanzanian villages, there were no home addresses in the study area.

available. Notifying individuals prior to interview dates minimized the non-response rate.

In a few cases where individuals from selected households were not available for

interview, the interviewer had to return to the house three times or more before the

individual was dropped from the study. However, if all the members of the selected

household were on a trip, and were not returning before the research team completed data

collection in a village, the household was replaced immediately by taking another

household that appeared first on the reserve list determined during the random selection

process.

4.3.   Survey data analysis

To assess the impact of the environmental education project on KAP values,

Eckman (2013) recommends that descriptive statistics which compare pre- and post-test

data be analyzed; that is, percentages and/or mean values from pre- and post-test data can

be analyzed and compared to determine whether there was an increase in any of the KAP

values. Descriptive statistics are recommended especially when dealing with small

sample sizes (e.g., samples below 500). I thus determined proportions of respondents who

reported specific knowledge, attitudes, and practice attributes and compared these

between the two survey periods. In simplest terms, I compared pre- and post-test

proportions. In order to assess the change in cumulative values, I created indices of the

three KAP constructs by adding up attribute variables of each construct and determined

mean values of each. The values of the three constructs were also compared between the

two survey periods to determine if there was any increase in the indices or not.

Additionally, I disaggregated the proportions and means by gender, age (below versus

above 30 years), education (with versus without formal education), distance from ECF (far versus near ECF), and access to EE (accessed EE versus did not). Disaggregation by these factors depended on the sample distribution of the treatment and control groups. I did not analyze by these factors if the sample in one group was much larger than in another; the distribution had to be almost equal. Tables and figures of percentages of participants who mentioned different aspects related to knowledge, attitudes and practices that affect the use and management of ECF were produced.

While descriptive statistics helped me understand whether there was any difference between the pre- and post-test findings, and between various demographic factors, I could not associate any change to the EE project due to several confounding factors. I thus employed inferential statistics in addition to descriptive statistics, despite the small sample size. Specifically, I used the difference in differences model (DID). The DID model determines whether the observed differences between the control and the treatment group are statistically significant. For all the variables whose data were collected before and after the experiments, I used the DID estimator to determine whether the mean values for the treatment and the control groups significantly differed in the follow-up compared to the baseline study. This is a preferred method for evaluating studies because by using both baseline and post-intervention data of the same groups, effects on the output variables that are not due to the treatment are accounted for (Angrist & Pischke, 2008; Dimick & Ryan, 2014). Additionally, because the level of environmental knowledge, for example, was not the same for the treatment and the control group, the DID accounts for those initial differences as well. Finally, multivariate

regression models were used to determine factors that influence engagement in environmentally friendly behaviors and other outcome variables. The specific analysis methods employed are described in detail in Chapters Five to Seven.

Additionally, I employed Logit regression analysis for binary outcome variables to understand whether the environmental education project had any impact on individual attribute variables of the three KAP constructs. The results were also used to confirm whether the observed demographic differences in individual variables were statistically significant or not.

Because the sample design involved up to four people in a single household, the answers provided by respondents from same households might be correlated. I addressed this problem by adjusting standard errors such that they are corrected among members of a household, as well as allow for variances to differ between men and women. These procedures ensured that results reported are more robust household fixed-effects.

4.4.   In-depth interviews

In-depth interviews were conducted during the baseline study to understand how information in Loliondo is transferred between individuals and from local leaders to village members within and between villages. A few individuals considered as *key informants* were purposively selected (Babbie, 1992) and interviewed using a semi-structured questionnaire guide. Key informants are individuals who have specific information about a topic due to their role in their communities. According to Patton (1990), "these are cases from which one can learn a great deal about matters of importance. They are cases worthy of in-depth study" (p. 181). In other words, they are

"information rich" people. In-depth interviews asked questions only related to information access in study villages, and the findings were used to identify communication methods. The identified communication methods were useful in designing the environmental education project.

Selection and interview procedure of key informants. For this study, key informants included village leaders, natural resources committee members,[60] and village elders, because they all play important roles in protecting natural resources. Two people, typically village/sub-village chairpersons or village elders, were interviewed per village. In Loliondo communities, village leaders and elders play critical roles in natural resources protection: they typically understand the history of the natural resources and the values, norms, and cultural beliefs related to forest resources; they also represent their communities. Key informants provided a deeper understanding of information access and sharing of forest-related information which was critical for designing the two experiments.

In-depth interviews were conducted only during the baseline study in 2013. A total of 13 key informants were interviewed. Interviews were used to understand how people access information about local forests and general news to help determine which communication method was suitable in each village. The in-depth interviews were carried out as conversations between the key informant and the researcher. The questions were designed as semi-structured (Rubin & Rubin, 2011); some questions emerged during

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60 Natural resource committee members comprise village council members. They are elected by the village members during village assembly (URT, 1982)

interviews. Semi-structured interviews allowed me to ask follow-up questions to gain a

deeper understanding of information access in the study area. All the interviews were

voice recorded (after seeking permission) during the interviews, and transcribed later.

Most of the interviews lasted for about 30-40 minutes.

Analysis of qualitative interviews. As recommended by Krueger and Casey (2009), key

informant interviews and analyses were conducted concurrently. Therefore, analysis of

in-depth interviews began after conducting the first interview and continued after

completion of each interview. Continuous analysis of key informant data enabled me to

focus on interview questions that were more critical to answering my research questions.

In addition, continuous analysis enabled me to pay attention to emerging themes. NVIVO

software was employed to organize texts into nodes for various themes that came up in

the in-depth interviews. The themes were organized by topic; e.g., themes related to

sources of environmental information, information access preferences, information

sharing strategies, and barriers to learning. A few excerpts from interview transcripts

were used as evidence for the claims made. The observed themes were triangulated with

survey data to create a better understanding of the nuances related to forest information

access and sharing.

4.5. Reflexivity: The effect of identity and positionality on data gathering

Research represents a space shared by the researcher and the participants

(England, 1994). Consequently, "the identities of both researcher and participants have

the potential to impact the research process" (Bourke, 2014, p. 1). Reflexivity, which Van

Maanen (as cited in Pillow, 2010) has also characterized as the "confessional tale", helps us to understand how these identities influence the research process and, consequently, the observed results. It thus "offers an invitation to readers to challenge the accounts offered to them" (Gordon, 2005, p. 281). By raising questions that concern the research process, reflexivity can potentially be used to validate and legitimize the research (Pillow, 2010). Margaret Fonow and Cook (2005) defined reflexivity as the "tendency of feminists [for example] to reflect on, examine critically, and explore analytically the nature of the research process" (p. 2,218). Similarly, Shehata (2006) defines reflexivity as "being self-conscious about fieldwork and the role of the ethnographer (researcher) in the production of knowledge; it is a reflexivity not about writing and textuality (although these concerns are legitimate), but about fieldwork as method and the ethnographer as 'positioned subject'" (p. 246). Reflexivity thus requires that a researcher perform self-scrutiny and be aware of his/her relationship with study participants (Pillow, 2003). Reflexivity allows us to see how critical it is that every researcher remain aware of the impact their own positionalities might bring to their research (Bourke et al., 2009). Reflexivity thus allows us to see our own biases and consequently helps us determine the best way for approaching research, dealing with particular groups, and how, as researchers, we might engage with participants (Bourke, 2014). In essence, some have viewed reflexivity as critical to the extent that research is viewed as incomplete without it, while others, including Okely (1992, as cited in England, 1992), have labelled those who do not practice it as "self-satisfied and arrogant" as they wrongly presume that their presence and relations with research subjects are unproblematic.

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According to Rabinow (1977) and Clifford and Marcus (1986), discussions concerning the use of reflexivity in anthropology that took place in the early 1970s were a response to critiques of ethnocentrism endemic to ethnographic and qualitative research methods. These initial discussions emphasized the role of reflexivity in placing the researcher in a position that ensured that there was not only neutrality but also empathetic and non-exploitative relationships between the researcher and the research subjects. The key issues raised in reflexivity have continued to remain relevant even today (Pillow & Mayo, 2006, as cited in Pillow, 2010). Over time, reflexivity has become an important tool that helps researchers demonstrate that they are aware of the problems that come with conducting research; such problems include "issues of power, voice, researcher and researched subjectivity" (Pillow, 2010, p. 274). Moreover, the different life histories and lived experiences influences us to produce different results (England, 1994), even when social topics and contexts are similar. When doing reflexivity, researchers using feminist methodologies thus focus on understanding the "whole research process—from forming research questions, gaining access and entrée, conducting interviews and observations, research relations, to analyzing data and writing up results" (Pillow, 2010, p. 273). Through reflexivity, researchers have the opportunity to describe in honest and transparent ways the implications of working with a diverse group of people with varied interests, especially in managing and creating knowledge. According to Van Maanen (as cited in Pillow, 2010), reflexivity can focus on issues related to the researcher, subjects, the field environment, or the data.

Reflexivity has become more and more relevant specifically among researchers using qualitative methods such as ethnography and interviews or focus groups (Pillow, 2003). Some qualitative researchers use reflexivity "as a methodological tool to better represent, legitimize, or call into question their data" (Pillow, 2003). Pillow notes, however, that most researchers use reflexivity without making it clear how they are using it. While there are various ways of doing reflexivity, Pillow (2010) argues that the most common type is self-reflexivity.[61] Similarly, Burr (1995, as cited in Pillow, 2003) finds that the most common usage of reflexivity is researchers "analyzing their own writing, reflexively discussing how their own accounts have been constructed" (p. 160). Pillow (2010) urges researchers to move beyond using certain common kinds of "paralyzed reflexivity".

While it is not commonly discussed in my field, reflexivity for me was an attempt to identify, do something about, and acknowledge potential limitations of my research. In a sense, I would argue that I engaged more in what Pillow (2003) refers to as "self-reflexivity," defined as reflexivity that requires a

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[61] Pillow (2010) identifies four types of reflexivity: (1) reflexivity as a recognition of self-reflexivity that aims to recognize the role of the researcher in the research process. According to Pillow (2003), "This use of reflexivity, "imbues the researcher with the ability to be self-reflexive, to recognize an otherness of self and the self of others" (p. 181); (2) Reflexivity that aims to show how well the researcher understands the research subject ("the other") as a way of showing completeness of representing the "other's" views. According to Pillow (2003), this kind of reflexivity is endemic to qualitative research and has been recognized as key to legitimizing and showing validity of the claims made; (3) Reflexivity that seeks to demonstrate that researchers can get it right. This type of reflexivity is especially evident in texts where it is used to authorize our texts or legitimize and validate the findings as truth; (4) reflexivity as transcendence—the idea that "the researcher, through reflexivity, can transcend her own subjectivity and own cultural context in a way that releases her/him from the weight of (mis)representations" (p. 286).

critical consciousness through a personal accounting of how the researcher's self-

location (e.g., across gender, race, class, sexuality, ethnicity, nationality), position

and interests influence all stages of the research process. Self-reflexivity is most

identified with self-disclosure. Self-reflexivity acknowledges the researcher's

role(s) in the construction of the research problem, the research setting and

research findings, and highlights the importance of the researcher becoming

consciously aware of these factors and thinking through the implications of these

factors for her/his research (p. 273).

My reflexivity focused more on how my presence and social and academic

background influenced my approach to research and how these affected my perceived

identity and positionality, and consequently my research results. For me, being reflexive

in doing research was part of being honest and ethically mature in research practice. I was

cognizant of the fact that various approaches have limitations and that my knowledge was

itself limited and changing. I took note of the wide range of literature on environmental

education and sought local support from my enumeration team who were originally from

my research area. I also paid strict attention to the politics, culture, traditions, and local

government structures that seemed critical to the research process.

In the initial stages of my research, very little thought came to my mind about my

personal research identity. As educated, classed, raced, and gendered beings, our

approaches to learning are indeed directly impacted by various positions we are given in

a specific society. As time progressed and as I grappled with how to contextualize the

knowledge I was acquiring, as well as my own contributions to knowledge creation, I had

to ask myself several questions: Who am I as a researcher? How am I perceived by my research subjects? How might my perceived identity shape/influence the research process and the answers I get? How does my presence affect participants' behavior and what can I do to minimize the effect of my presence on my research? As pointed out by Bourke et al. (2009), positionality in a research space may be perceived differently by others and this is true whether one's research is based in one's own home country or not. "Coming to terms with our own privileged identities, be it class, race, gender, nationality or educational background, in peripheral contexts, has demanded a degree of introspection from each of us" (Bourke et al., 2009, p. 96). In my case, my positionality may have been influenced by my social, academic and geographical background. As a female scholar who grew up in two African countries, Zambia and Tanzania, and as someone who had previously conducted research in similar communities, I had become familiar with cultures from various parts of Tanzania, including the Maasai culture, yet I could still easily be distinguished from the locals.

Moreover, the fact that I am not a native of the study area and could not speak Maa language also affected my perceived identity, and consequently my perceived position in the study area. While being the most educated person in the area meant I got respect from men and women of all ages, most also treated me as an outsider with suspicious interests for not being a Maasai. Some people seemed more interested in talking to me about general aspects of life just to learn more about where I come from, my marital status, and why I was in their area, but they were not necessarily interested in subjects related to my research; talking about some forest-related topics seemed to raise

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concern among many. Consequently, my position as a researcher did not make it easier to get honest answers on some matters of forest use and management. Some people (mostly among the Maasai) were afraid of providing honest answers to some questions because they feared that I might use their responses against them (as discussed further in Chapter Six). Understanding their concerns was not an easy task; oftentimes they would conceal their worry and would only say it in their own language knowing I could not understand what they were saying.

My perceived identify was further complicated by the fact that my research was funded by FZS, an international conservation organization which had previously tried to work in the same area but failed due to local politics that had led to false accusations against the organization.[62] This meant that while local people recognized that I was a Tanzanian student conducting research in their area, they also wondered if I was affiliated with FZS in other ways. Some questions raised included: How are you affiliated with FZS? Are you employed by FZS and trying to conceal your identity? Why does FZS's staff work with you if you are doing research only for your graduate studies? Fundamentally, I had to be explicit about my relationship with FZS and how the knowledge gained from the research was going to be used. While I tried to be careful so as not to jeopardize and complicate the fears and worries of local people, the same

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62 FZS had previously (2008) tried to work in the same area; however, they could not continue with a project due to local politics that were going on (not discussed here). False accusations had been made against FZS that it was trying to confiscate the forest from the local people. This led to distrust against FZS among some local people in the area. While these accusations had no logic in them, since that is an impossible act legally, it was brought up throughout the study and thus created doubts toward the study among some participants. I strongly believe that the leaders who brought up this accusation had political motives since the accusations were brought up again during the post-test study which coincided with the 2015 election campaigns.

questions kept resurfacing again and again. While I believe that the fears might have been

complicated by the past land conflict history in the area (as discussed in the context

section), I also had a strong reason to think political leaders used this history and ongoing

land conflicts to help them win political leadership positions in the 2015 elections; local

politicians contributed to instilling fear among local people against FZS in order to win

local people's trust.

At one point, local leaders advised that it would have been easier on me if I worked

without FZS's support and if I worked with local NGOs.[63] Because of the scale of the

project, however, it was impossible to implement the project without FZS's resources. I

thus had to maintain my identity as a Tanzanian, but also as a student funded by FZS.[64]

Because I was quite aware that my relationship with FZS and local politics were going to

influence how participants responded to some questions, I tried to minimize the impact

by implementing various strategies, including ensuring that enumerators were all Maasai

speakers and that baseline findings were reported back to the villages as promised, as

well as to ensure they clearly understood that the focus of my study was not harmful in

any way. Other strategies included holding clarification meetings with leaders and elders

from all four villages that raised concerns to explain the purpose of my study and FZS's

intent working in the area. These efforts were implemented with funding and support

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63 In my view, the local NGOs were also not trustworthy because they had their own politics—they would say one thing in your face, and another when they were amongst themselves.

64 Maintaining my position as a Tanzanian student from the UMN funded by FZS meant that local people in the study area kept questioning my role in the FZS. Some leaders even thought I was probably one of the FZS's staff pretending to be a student. This idea was largely complicated by political leaders who I believe wanted to show to their citizens (mostly among Maasai) that they are there to help them protect their natural resources like forests and land, and thus they should be voted for in the coming elections.

from FZS. Despite all the efforts made, my research was impacted by my identity in one way or another. I believe that local people's perception of my identity (and my positionality) was affected by the relationship I had with FZS, my research funders, although this was fueled by local politicians. Consequently, my perceived identity negatively affected how participants (mostly from the Maasai dominant villages) chose to respond to apparently "sensitive" [65]questions. I describe the impacts in detail in Chapters Five and Six.

5. Impact of Environmental Education (EE) on Loliondo People's Knowledge, Attitudes, and Practices: Comparing Face-to-Face Group Discussion and Mobile Phone Texting Strategies

5.1. Introduction

The goal of this chapter is to assess the impacts of two environmental education strategies, face-to-face group discussions and mobile phone texting, on the Loliondo people's knowledge, attitudes, and practices, and compare the impacts of the two strategies. The two questions addressed in this chapter are (1) "*What is the impact of environmental education on people's knowledge, attitudes, and practices (KAP) related to natural resource use and management among Loliondo people"?* and (2) "*Which*

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65 While in my general view none of the questions seemed to be sensitive, I later learned that native people, specifically the Maasai, were concerned that if they reported that the forest was declining, it might reduce the chances of being given management rights of ECF in future. During the time of my research, the process of converting the Loliondo II forest (referred to by locals as the ECF) to Participatory Forest Management (PFM) had begun in 2012. However, the process was still under observation and would be completed only when the government was satisfied that the surrounding communities were capable of co-managing the forest.

educational strategies have the most impact on Loliondo people as measured by

knowledge, attitudes, and practices?"

Sustainable utilization of natural resources requires the understanding of various

aspects that contribute to its preservation, including how ecosystems function (Cutter-

Mackenzie & Smith, 2003). Environmental behavior models, such as those proposed by

Bamberg and Möser (2007), Clayton and Myers (2009, 2015), Hines, et al. (1987) and

Kollmuss and Agyeman (2002), all show that environmental knowledge is highly

associated with engagement in environmentally friendly behaviors. Assuming all other

factors are held constant, for people to engage in environmentally friendly behaviors,

they must be aware of problems facing the environment, understand which actions can be

undertaken to solve specific problems, and have skills to perform specific

environmentally friendly behaviors. While people normally have some level of

understanding concerning environmental issues and their solutions, often this knowledge

is not enough to deal with current environmental challenges. Consequently, scholars and

practitioners from environmental-related fields advocate for environmental education that

will not only provide information about dealing with environmental issues, but will also

impart the skills necessary to deal with environmental challenges. Environmental

education is one of the most important goals set by the United Nations Educational,

Scientific, and Cultural Organization (UNESCO) during the 1975 workshop on

environmental issues held in Belgrade, Yugoslavia. As stated in the report:

> The goal of environmental education is to develop a world population that is
>
> aware of, and concerned about the environment and its associated problems, and

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which has the knowledge, skills, attitudes, motivations and commitment to work

individually and collectively toward solutions of current problems and the

prevention of new ones (p. 3).

Smyth (1995) also supports the idea of environmental education by stating that

the level at which environmental education goals will be achieved mainly depends on

people's degree of environmental awareness, which starts with environmental

understanding, environmental responsibility, environmental competence, and finally

reaches environmental citizenship. All else constant, it is thus crucial to impart

knowledge to various populations, if these people are to engage in desired environmental

behaviors.

While environmental education may be thought of as a valuable tool for

improving people's' comprehension of environmental issues as well as their ability to

solve these problems, the type of knowledge content, medium of information delivery

and the deliverer all play important roles in determining its impact (Ann Zanetell &

Kanuth, 2004; Clayton & Myers, 2009, 2015). As noted above, the desire of many

conservationists is to have populations with complex environmental knowledge.

Acquiring complex environmental knowledge is a challenge, however, because not only

do people differ in their ability to comprehend new information (Bandura, 1977), but also

because environmental issues and their solutions are numerous. This is especially true

when informal environmental education strategies are employed among non-literate

populations. Consequently, efforts to disseminate environmental information focus on

specific issues depending on one's discipline or specialization, or depending on the specific purpose of the project or vision of the organization funding the project.

In this study, I evaluated an environmental education project implemented in eight villages located in the rural part of Northern Tanzania. The project involved dissemination of environmental information related to a local forest called the Enguerosambu Community Forest (ECF) also officially known as the Loliondo II forest. While previous studies have looked at how some face-to-face environmental education strategies affect knowledge, no such study has been conducted in the Loliondo area. Moreover, most studies conducted in the past were implemented in a developed-world context; as a result, variables used to measure the role of environmental education on knowledge cannot be applied in developing countries in the same way, especially in rural settings. Additionally, most studies that implemented surveys assessed questions that were in a Likert Scale format; in contrast, I used open-ended questions in this study. By using forest-related constructs specific to the local forest, my study contributes to the understanding of not only concepts that are relevant to forest resources use and management, but also to the role of environmental education on environmental knowledge in rural contexts of developing nations.

I separately tested the impact of two environmental education strategies: a group discussion format, the traditional approach, and mobile phone text messaging, the modern approach. While the group discussion format strategy was ideal for the study area as it aligned with traditional ways of communication, testing the impact of implementing environmental education via text messaging was crucial. Like many developing

countries, the Tanzanian government allocates very limited financial and human resources toward natural resources management. Thus, environmental education is rarely provided to people in urban or rural forested areas. People who live close to forests are principle guardians of these natural resources, yet they do not have access to the knowledge and skills necessary for addressing forest resources issues. If effective, text messaging would be an inexpensive strategy for environmental education implementation, and more people in developing nations would consequently have access to environmental information at minimal cost.

5.2. Methodology

This section describes the methodology that was followed in assessing the impacts of the environmental education project reported here. I first provide a summary of baseline findings that were used as part of input information for designing the experiments and for deciding on what information to disseminate to participants. I then describe the two experiments evaluated here, data collection procedures, and analytical methods employed.

5.2.1. Baseline survey findings

The pre-test study served as an informative baseline for comparing post-test to pre-test findings. It served as informative in the sense that it helped me understand what type of environmental knowledge, attitude, and practice attributes existed in the Loliondo area. It helped me determine what people were less knowledgeable about, had negative/positive attitudes toward, and what practices people engaged in with more or

less frequency. Baseline findings helped me design an EE curriculum in a way that

ensured that lesser-known information was included and emphasized to help improve

participants' knowledge, attitudes toward environmentally friendly behaviors and

engagement in desired practices. The baseline study also served as informative in

identifying various communication strategies employed in the Loliondo area. Identifying

communication strategies was critical for determining feasible ways of disseminating

environmental information in specific villages. The following sections provide

information about baseline knowledge, attitudes, and practices related to forest use and

management.

5.2.1.1. *Baseline knowledge, attitudes, and practices*

Baseline data revealed that study participants were knowledgeable about many

aspects of environmental issues, including benefits provided by the forest, causes of

deforestation, negative impacts of deforestation, and possible solutions to environmental

problems faced in Loliondo.[66] While most direct- and indirect-use benefits such as wood

for firewood and construction, rainfall, and water were reported by almost every

participant, other indirect-use benefits such as provides oxygen and stores carbon dioxide

were less reported. Also, while participants demonstrated high awareness of major causes

of deforestation, fewer of them reported behaviors performed by individuals such as

cutting of living trees for firewood or construction or grazing large herds of livestock in

the forest. Finally, participants demonstrated high knowledge of negative impacts of

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66 Tables and figures on baseline knowledge, attitudes, and practices are not provided in this summary section because
   they are shown in comparison figures in Chapter Five.

deforestation, although fewer of them reported impacts such as decline in water and underground water flows. Overall, female participants demonstrated lower knowledge of environmental topics such as benefits of the forest, causes of destruction, and actions and behaviors that would help sustain the forest. With regard to age, younger people aged 18-30 reported more benefits provided by the forest as well as actions that need to be taken to help sustain ECF, but no difference was observed with regard to other knowledge attributes. Higher environmental knowledge observed in the pre-test was not surprising since most native or indigenous people have their own traditional ways of learning about the environment around them and about how to manage it (Berkes, 2012).

With regard to attitudes, every participant was empathetic toward the forest; they all demonstrated a very positive attitude toward its existence. This was expected as people in this area rely on the forest in many ways. While participants demonstrated positive attitudes toward the existence of the forest, many only demonstrated positive attitudes toward a few environmentally friendly behaviors—i.e., they reported only a few environmentally friendly behaviors they are willing to engage in to help sustain the forest. Most of them mentioned community actions such as guarding the forest, restricting cutting down trees, and banning charcoal burning, while about half of them mentioned banning logging for timber and planting trees.

It was clear that respondents understand actions that would help sustain the forest, although none of these actions are implemented effectively, promising no success. Ineffective implementation has been evidenced in various ways; e.g., both charcoal burning and timber logging are not permitted in the ECF, yet these activities take place

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illegally. Corruption among some government officials and limited resources allocated for tackling poaching problems were pointed at as major contributors to the failure to control illegal utilization of the forest. Personal communications with a forest officer and village members revealed that sometimes the district natural resources officials are informed that illegal extraction of wood is happening in the forest, but they often do not go to the scene because there is no fuel or no vehicle. One of the village leaders explained the challenges he sees in managing the ECF as follows:

> *We face challenges when top government officials like security officers from the prison enter the forest and do destruction in the forest. You can't do anything to such people because it is the government. They enter the forest and cut trees for firewood so that prisoners could use for cooking as an excuse.*
>
> [The interviewer asked if they inform the district officials about destructive activities, as a follow up question.] *Yes, they cannot handle even if there is big destruction, and this is a very big weakness they have. We do inform them about the issues of destruction, but they provide excuses like the car has no fuel, so no means of transportation to come and solve the problem, even though there may be an office motorcycle. We have a big forest which needs patriotic people to manage not politicians; otherwise we will lose the fores*t.

Second, while 51.9% of participants mentioned planting trees (forestation) as one of the actions that could help sustain the ECF, only 24.9% mentioned tree planting as an action they would undertake to help sustain the forest. Most of the participants who mentioned tree-planting were from the non-Maasai ethnic group. Finally, while forest-

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guarding is highly perceived as a great strategy to sustain the ECF, its success is questioned. According to village leaders, the village elders and leaders assign forest guarding tasks to young men called *"Moran"* or "Warriors" who are normally also livestock herders. While these Morans are herding livestock, they are also expected to monitor destructive activities taking place in the forest and report to the village elders and/or leaders. Additionally, because they are treated as community warriors, they are expected to stop any person conducting destructive activities in the forest. However, there is no formal guidance for monitoring forest activities and no tools to help them arrest wrongdoers. They readily accept reasons provided by illegal loggers such as "we've been permitted by the district authority." Additionally, the Morans are not compensated for carrying out forest-guard activities; as a result, forest-guarding activities are not conducted regularly, and some of them are easily corrupted by illegal loggers (Personal communication with a former village chairperson).

On the practice of tree planting, baseline findings revealed that out of 414 respondents, a fairly high proportion (60.6%) of them, had planted trees before. Even though men and women mentioned having ever planted a tree, the percentage of women was about 13% lower compared to that of men. People in villages with non-Maasai tribal groups had much higher ever-planted proportions (77.2% to 97.7%) compared to Maasai-dominated villages, whose proportion was less than 50%. The lower participation of Maasai in planting trees may be partly due to their non-farming cultural practices and the lack of exposure of the Maasai groups to forestation projects. As discussed earlier, historically the Maasai were mostly pastoralists and only engaged in agricultural

activities in times of hunger. According to the Ngorongoro District forest officer and the village leaders in the Loliondo village, The Tanzania Social Action Fund (TASAF) initiated a tree nursery project in the Ngorongoro district a few years ago. The project was based in Loliondo village, which is also the headquarters of the district and neighbors the Sakala and Orlkiu A villages. Therefore, Loliondo, Orkiu A, and Sakala villages had the opportunity to participate in tree planting. The project ended a few years ago. There was no statistically significant difference between age groups and men and women who participated in tree planting.

Those who said they had never planted trees, were asked to provide the main reason for not planting trees. Out of 166 who had never planted a tree, most of them (71.1%) said they have no specific reason, and only 12.7% said they do not know how to plant trees. As expected, those who said they had planted trees before also mentioned tree planting as an action they would undertake to help sustain it. A "no reason" answer does not necessarily mean people know how to plant or do not, as there could be a mixture of both.

5.2.1.2.   *Information access and sharing in Loliondo*

Sources of general information. Respondents were asked to mention sources they use to obtain general information. General information included any news on what is happening within the respondents' villages, nearby villages, or in the country. The four most mentioned sources of general information are: family, relatives, or friends (80.0%), mobile phone (67.6%), village meetings (63.8%), and radio (41.6%) (see Figure 5.1). When disaggregated by village, it appears that some villages depend more on some

sources for general information compared to other villages. For example, in the Loliondo and Sakala villages, more people (77.3% and 61.4% respectively) mentioned radios as their main source of general information while more people in Naan (79.6%), Ng'arwa (100%), Orkiu A (76.0%), Orkiu B (96.5%), and Tinaga (85.2%) mentioned family, relatives, or friends as their main source of general information.[67] While the Loliondo and Sakala villages are more urbanized, and thus more people may have access to electronic devices such as radios, the differences observed in access to information via radios may be due to other reasons. For example, Maasai and Sonjo groups are less fluent in Swahili, which is mostly used on radio and television programs. Even if electricity services are available only in the Loliondo and Sakala villages, people—especially males from Maasai and Sonjo tribes—go to charge their cellphones regularly. Additionally, more Maasai and Sonjo report access to general information through cellphones compared to other tribes, although this does not mean that they own more mobile phones compared to other tribes; they may be getting the information through friends and relative's phones.

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67 Only sources mentioned by at least half the sample by at least one village are reported. The cut-off point of half in at least one of the villages was used because the researcher was interested in identifying the most common sources of information used. The aim was to use the results in designing an education program which was going to be based on communication methods identified as feasible.

Figure 5.1. Percentage of participants who reported sources of general information (n=414)
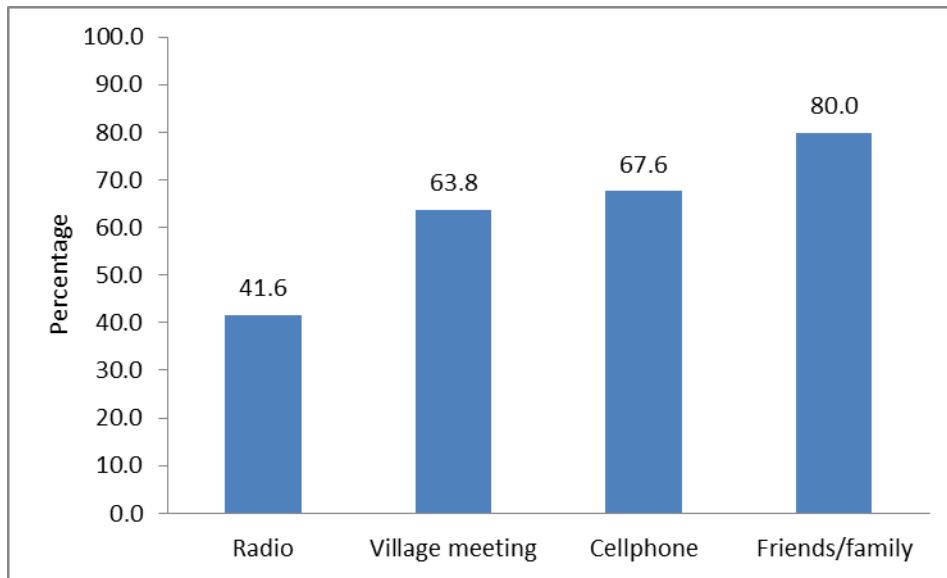
The three main demographic factors that were associated with access to different sources of general information are gender, ethnic groups, and education. With the exception of access to information through family, relatives, or friends and cellphones, fewer women (35.3%) appeared to have access to general information through radios in comparison to men (48.2%). Similarly, fewer women (57.7%) were likely to access general information through village meetings in comparison to men (70.4%). Having some level of formal education seemed to be associated with radio use, but only in villages with tribes other than Maasai and Sonjo. The differences observed in the access to sources of general information may be due to the fact that generally, African women own fewer household assets (Doss, Kovarik, Peterman, Quisumbing, & Bold, 2015; Deere & Doss, 2006; Deere & León, 2003; Quisumbing & Hallman, 2006; Quisumbing & Maluccio, 2003; World Bank, n.d.). Moreover, types of assets owned by men and

women differ (Antonopoulos & Floro, 2005; Talle, 1988); radios are among several assets most likely owned by men. This is especially true among Maasai where women not only barely own anything but are also treated as children who cannot make their own decisions (Galiè, Mulema, Benard, Onzere, & Colverson, 2015; Hodgson, 1999). Moreover, decision makers in most African tribes are men; men not only own most household resources but also decide when to buy those assets and for whom—electronics such as radios or mobile phones are still largely owned only by men (Blumenstock & Eagle, 2010). With respect to attending meetings, women are more responsible for household chores such as taking care of children, cooking, fetching water and collecting firewood, and thus have less free time to attend meetings such as village meetings.

Sources of forest-related information. Respondents were asked a similar question to determine sources used to access information concerning their local forest, the Enguserosambu Community Forest (Loliondo II). Information relating to the forest included current or recent destructive activities taking place in the forest, environmental education components such as conservation strategies employed in the forest, and the impacts of destroying the forest. The four most-mentioned sources of forest-related information were: village leaders through village meetings (82.4%), family, relatives, or friends (51.9%), livestock herders (51.0%), and village elders (35.3%) (see Figure 5.2). When disaggregated by village, it was evident that almost everyone in all the villages relies on village meetings as their main source of forest-related information. With the exception of Tinaga and Loliondo, whose second most-mentioned source of forest-related

information was village elders and livestock herders respectively, the second most-

mentioned source of forest-related information was family, relatives, or friends.

Figure 5.2. Percentage of participants who reported sources of forest-related information (n=414)
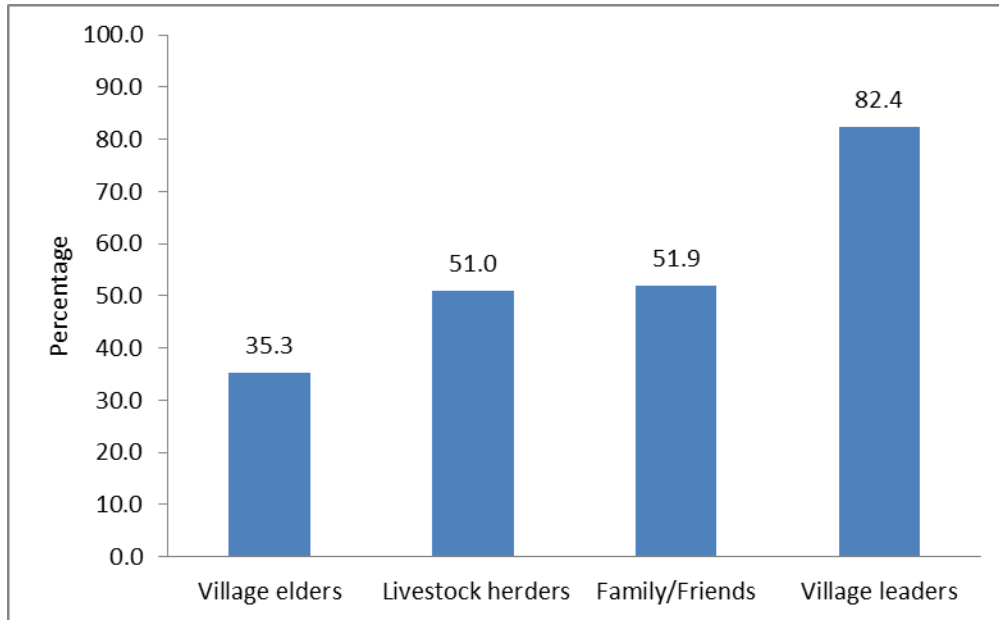
Male and female respondents equally reported access to forest-related information

through village meetings, family, relatives, or friends, livestock herders, and village

elders. Findings also show that, like access to general information, the Maasai (66.4%)

were more likely to access forest-related information through word of mouth from

family, relatives, or friends compared to any other tribe (45.8%). The Maasai are very

social and are more likely to share information through word of mouth, although the

extent of sharing may vary between males and females. Additionally, Maasai households

are very spread out; as a result, most people live far from village centers, where village

offices are located and where village meetings are normally held. This is likely the reason

why fewer Maasai (compared to other tribes), especially women, attend village meetings.

In in-depth interview questions, village leaders/elders were also asked to describe how they access information concerning the ECF. The statements made by most of the leaders show that most access such information through the same means reported in the surveys. Additionally, because of their positions, village leaders seem to have other sources for accessing forest-related information compared to the general public. Additional sources include mobile phones; all twelve leaders interviewed had mobile phones. Village leaders are the focal point for accessing forest-related information, as they are charged with managing village resources. Therefore, any new information has to be reported to the leaders first, so that they can take appropriate actions. As explained by one village elder:

Sometimes when one gives information to sub-village chairperson, the

information reaches the village chairperson or village executive officer, and then

they organize a meeting. The village community decided that if there is any

information of forest destruction, few youths will be selected and sent to the forest

to search for people that are responsible for the destruction; if they catch them,

they should inform the village leaders through phone if there is network.

Another key informant, a village leader described how he gets information as follows:

If there is an ongoing destruction in our forest, we do get information from youth

[Morans] who graze livestock in the forest about people who harvest trees for

timber making, fire disaster/burning and so many things which destroy the forest.

When this occurs, as village chairperson, they have to inform me by making calls.

Also, I can get the information through meeting with youths who are in groups of

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two to three for those who have no mobile phone or if there is no network access

they can send a representative to report the information on what is going on

concerning the forest.

Both surveys and in-depth interviews indicated heavy reliance on word of mouth from family, relatives, or friends for accessing forest-related information. Unlike the general public, village leaders seemed to access the same information through other means such as cellphone due to their positions.

Types of forest-related information accessed. When people were asked to mention types of forest-related information they receive, to determine whether the information they get is adequate, a large proportion (87.9%) mentioned that they get informed about types of destruction taking place in the forest. As shown in Figure 5.3, only a few mentioned other types of information such as ways to conserve ECF (42.7%), causes of deforestation of ECF (39.5%) and the negative impacts of deforestation (26.2%). There were no statistically significant differences between gender, tribes, and age. While it was possible that participants under-reported the types of forest-related information they access, this was not surprising, as the local district has a limited budget for natural resource management of forests, and thus they rarely implement environmental education programs. While school children access environmental education through specific subjects about the environment, most adult environmental education programs are implemented by either local or international NGOs. None were reported in the study area.

Figure 5.3. Percentage of participants who reported types of forest-related information accessed (n=414)
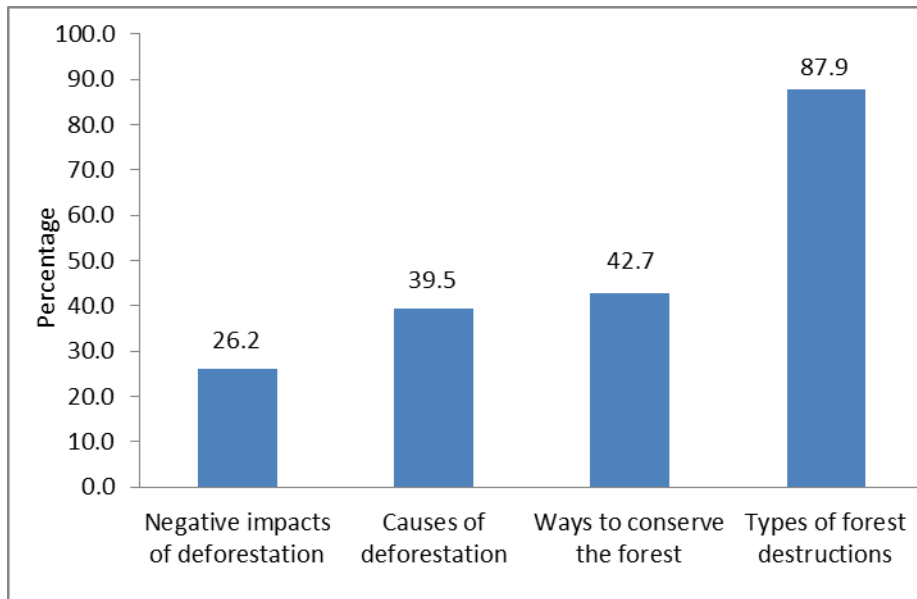
Sharing of forest-related information. In order to understand how forest-related information is shared among village members once accessed, and thus help determine the best way to implement environmental education dissemination, those who reported that they have access to forest-related information were asked whether they share any information concerning the ECF. Out of 405 people who responded to the question, almost every person (97.3%) said they do share. Those who share forest-related information were further asked to say who they mostly share the information with. The largest group (86.5%) said they share with village leaders, while 61.8% said they share with family, relatives, or friends. Only 39.9% reported that they share with village elders

and 32.1% with forest guards[68] (see Figure 5.4). In villages like Tinaga, only a small

proportion (38.9%) of people reported that they share forest-related information with

family, relative, or friends. Women were less likely to share information with village

leaders and forest guards compared to men. The difference can be attributed to

differences in the social interactions between men and women; men share information

with other men while women share information with other women. Since most of the

village leaders and forest guards are men, fewer women are likely to discuss forest-

related information with them, even though both genders are equally likely to share

information with village leaders.[69] The Maasai group are more likely to share forest-

related information with family, relatives, or friends in comparison to other tribes; this

may be due to their nature of social interactions as discussed below.

Based on interviews with village leaders conducted during the baseline study,

people were asked to inform village leaders whenever they heard anything destructive

concerning the forest. For example, if they see someone cutting down trees for either

timber or charcoal, they were instructed to inform their leaders. The leaders would then

take action by either organizing a group of people (usually young men, the "Morans"),

who would follow-up, or would arrange a meeting with village council members to

discuss the problem. This observation was clearly expressed in the statement by one

leader that:

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68 Forest guards here are also the Maasai warriors (Moran), the defenders of Maasai territories. The reason for informing
  Morans may be due to the fact that they are expected to guard areas where destructive activities are taking place as
  well as arrest and inform village leaders about people involved in such unacceptable behaviors.

69 Village leaders are elected by the people and are responsible for ensuring proper management of resources in the
  villages. Every community member is thus obliged to report to them what is going on in the village.

If there is a destruction of our forest we do get information from youth who graze livestock in the forest about people who harvest trees for timber making, fire disaster/burning and so many things which destroy the forest. When this occurs, as village chairperson they have to inform me by making calls. Also, I can get the information through meeting with youth who are in group of two to three for those who have no mobile phone or if there is no network access they can send a representative to report the information on what is going on concerning the forest.

The pattern of information sharing can be linked to the Maasai culture.[70] The Maasai exchange a lot of information through word of mouth. This can also be evidenced in how they exchange greetings. The term used as a greeting exchange is *Lomoni*—a detailed greeting where people ask one another about their health, their families' health, their livestock's health, about the news in the area, and so on. Therefore, it is not surprising that more Maasai also share information related to the ECF, an important resource for their livelihood. Sharing forest-related information with village leaders or elders mainly relates to two aspects: the structural and the cultural aspects of the communities studied here. The structural aspect is that, like in any other part of Tanzania, villages have leaders called village chairpersons who are elected by the respective communities. The village leaders have the responsibility to address the problems reported to them. Therefore, it is not surprising that most people share information concerning the

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70 I say Maasai people because they comprised the majority of the sample, and thus most responses reflect them more than any other tribe in the sample.

forest with their leaders. The cultural aspect relates to the fact that in the Maasai tribal group, it is men who normally make decisions at the family and community levels. As a result, almost every leader in the Maasai communities is a man. For example, all the village leaders who were interviewed were men.

Figure 5.4. Percentage of participants who reported the type of people they share forest-related information with (n=405)
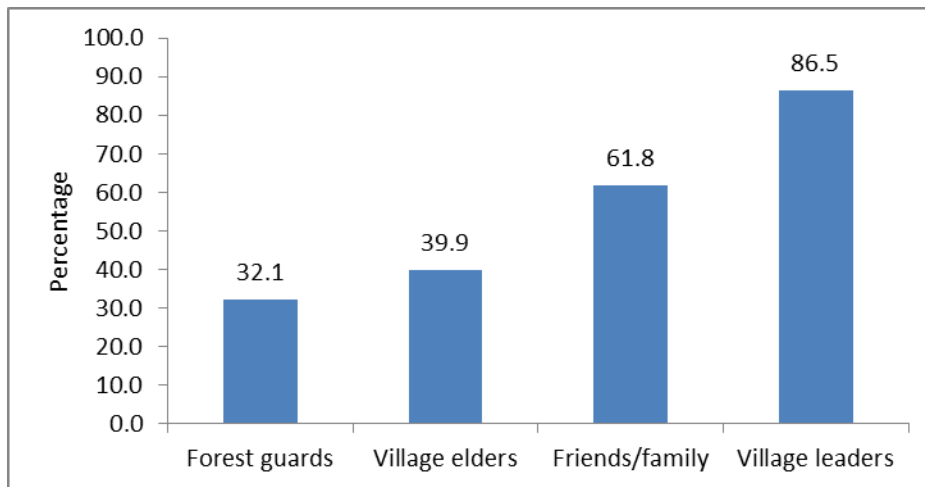
Based on baseline findings, it was determined that the environmental education program was going to focus on knowledge that was less expressed by participants, although it was also going to include highly reported environmental topics. High knowledge of environmental topics does not necessarily translate into action (Clayton & Myers, 2009, 2015), including information already known aimed at reminding people about services provided by the forest and what it would mean for the forest if they do not take action to sustain it. It is also clear from the baseline findings that people in Loliondo relied on word of mouth as a means of communication and information access of general and forest-related information. Thus, the EE strategies that would be employed were going to imitate this means of communication. Since mobile phones were widely reported

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as a means for accessing general information, however, it was going to be used as a second means of EE dissemination so that it could be tested for its effectiveness in comparison to the traditional word-of-mouth-based approach.

5.2.2. EE experiments: Group discussion and mobile phone texting

Group discussion dissemination strategy. The group discussion experiment was implemented in March of 2015, four months before conducting the post-test survey. The meetings were held in various settings—including outside, in village offices, schools and church buildings—depending on what infrastructure existed in the village. The project involved dissemination of environmental information through discussions in groups. Group discussion imitated the traditional way of communication as participants discussed environmental topics face-to-face with their peers. The strategy aimed to facilitate learning in a socially constructed manner, a critical component of social learning theory (Bandura, 1977). To ensure uniformity in the implementation of the experiment in all groups, I created procedural guidelines for the environmental information discussion groups. The guidelines included the process for facilitating the discussions as well as a curriculum of all the environmental information that was to be discussed in each group. Additionally, I trained three facilitators and piloted the experiment in non-study villages before actual implementation.

The environmental education curriculum included information on benefits of the Enguserosambu Community Forest (ECF), causes of ECF destruction, impacts of destroying the ECF, and behaviors and actions that can help sustain the ECF. In line with Frick, Kaiser and Wilson (2004), the environmental topics presented aimed at not only

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increasing system knowledge (knowledge about the functions of the natural forest and knowledge on problems related to degradation), but also at action-related knowledge (i.e., what can be done about these problems) to help save the environment. Such action-related information included how farmers can practice rotational grazing or plant trees around or inside their fields and yards for soil erosion prevention and as future alternative sources of cooking energy.

Participants were divided into groups of up to 12 individuals, with males and females in separate groups. To ensure maximum attendance of study participants from the treatment group, I divided participants such that the meeting place was convenient for them. Individuals from each group agreed on the time and place for the meeting.

Each group started by first listing all the environmental knowledge attributes for all four constructs they knew; the facilitator wrote them on a flip chart. The facilitator also cross-checked the environmental attributes mentioned by the participants with those listed in the environmental education curriculum. Any environmental knowledge attribute that was not mentioned by the participants was added to the list to ensure that all the groups discussed the same type of information. In Figure 5.5 below, knowledge attributes in blue marker were listed by the participants while those in red were added by the facilitator. Because some knowledge attributes were already known to some or most participants, the facilitator asked multiple group members to describe what each of them meant and discussed them with all group members. The facilitator finished the discussion of each construct by either asserting the description of each component variable provided by the participants, clarifying further what each attribute meant, or by providing a correct

description provided in the curriculum. For example, for a forest benefit such as

"provides oxygen", the facilitator described how plants use carbon dioxide to produce its

food and releases oxygen in the process. At the end of discussing all the attributes listed,

the facilitator asked participants to briefly talk about any new attribute they learned

through discussions in order to reinforce what they just learned.

Figure 5.5. Results from face-to-face group discussion

Mobile phone dissemination strategy. The mobile phone experiment was implemented for

three months (February to April of 2015), approximately three months prior to the start of

the post-test study. Unlike most health studies that employed simple text messages to

remind patients to undertake an action or engage in a particular behavior, the cellphone

experiment evaluated here involved sending briefly described forest-related information to every participant in the mobile phone treatment group in Swahili, the medium of learning in public schools. Most messages were fairly long, but also short enough to fit in one phone text character limit (160 characters), such that the messages arrived in the participants' phones as one complete message. A few of them had more than 160 characters so arrived in participants' phones as two separate messages. Keeping the messages long enough was necessary for providing participants with enough content while keeping the text message within the character limit was necessary to avoid sending incomplete environmental messages.

Prior to the experiment, I ensured that the purpose and procedures of the experiment were clearly communicated to participants. This was done in a meeting setting. A clear description of the study was critical for ensuring that participants planned to receive environmental messages for a specific period and on specific days of the week to maximize treatment rate. There was a high potential for participants to think that messages were advertisements sent by phone companies and thus would simply ignore them. Additionally, we showed a sample of messages to some villagers, including leaders during our contact meeting, and assured them that we were going to copy them on every message sent to study participants.[71]

We collected mobile phone numbers from all study participants in the mobile phone treatment group one month before implementation of the project. Participants with

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71 Assuring participants and village leaders that we intended to send environmental messages as promised was necessary since some political leaders had raised concerns that we had other intentions, although their concerns were unfounded. I describe these concerns, their legitimacy and how they affected the study in the discussion section.

no mobile phones provided phone numbers of close relatives/friends who owned a mobile

phone device, from whom they were going to receive environmental messages. At this

stage, it was clear that fewer women owned mobile phones compared to men, as most of

them provided phone numbers of their spouses. We thus emphasized that those who

owned mobile phones should ensure that they share the information with family members

and other people in their respective villages. During a planning meeting, study

participants were asked to identify two days in a week and times of the days which were

convenient for them to receive environmental messages. For some villages, especially

those with limited wireless network, the times suggested as most preferred were those

that coincided with market days; most participants from these villages felt that they were

likely to go to a market place where they normally access the mobile network. Also,

participants and village leaders suggested times that most participants were less likely to

be occupied with economic activities and household chores. For example, in one village,

participants suggested that messages be sent on Thursdays and Saturdays between 1:00

p.m. and 5:00 p.m.

As in the group discussion experiment, the environmental messages' content

focused on the benefits of the ECF, causes of the ECF destruction, impacts of destroying

the ECF, and behaviors and actions that can help sustain ECF. The messages were sent

twice a week for three months (February–April of 2015). To ensure that participants

received and understood the messages, they were asked to reply with a simple text

message or brief phone call. Most households in the area are very poor; therefore,

participants were provided with small mobile phone credit bundles for texting or calling

to encourage them to reply to each message received.

Figure 5.6 shows the location of households that were part of the treatment:

mobile phone (green circles with black dots), group discussion format (red triangles), and

those that were in the control group (black circles). The figure also shows the location of

the households in relation to the Enguserosambu Community Forest.

Figure 5.6. Location of study area, surveyed households, and the Enguserosambu Community Forest (ECF)
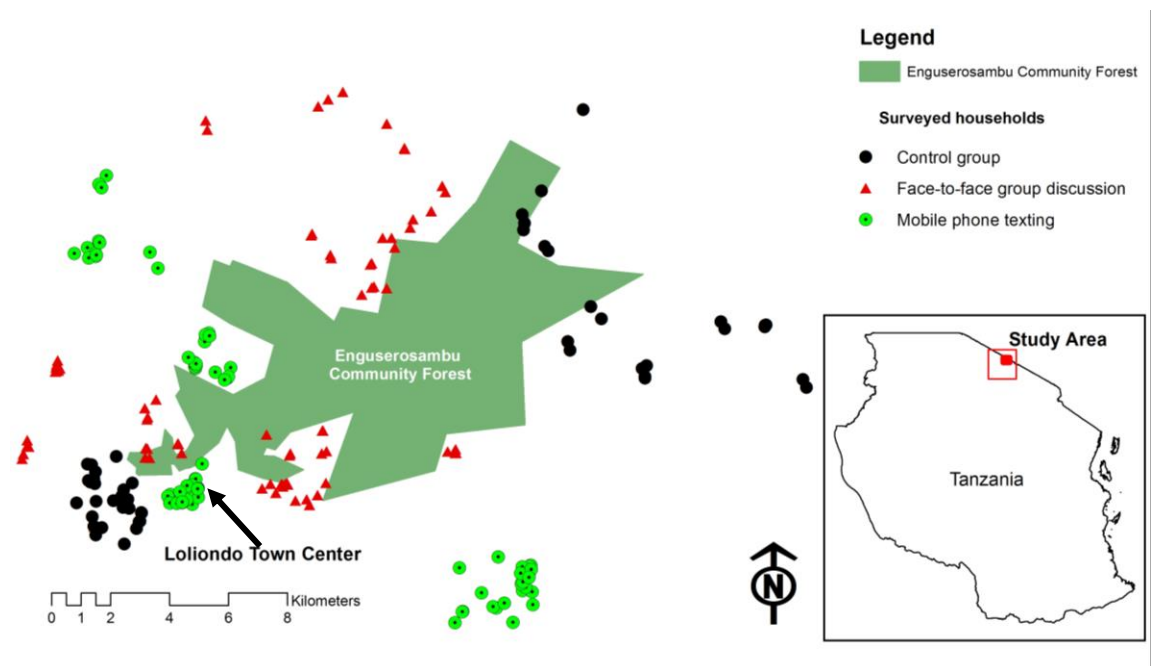
5.2.3. Empirical strategy

People who were exposed to environmental education were expected to

demonstrate higher knowledge in various environmental topics, improved attitudes, and

more engagement in environmentally friendly behaviors, as environmental education is

highly associated with all three constructs (Clayton & Myers, 2009, 2015). With the

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exception of practices, knowledge (of benefits of ECF, behaviors that contribute to

destruction of ECF, negative impacts of destroying ECF, and of behaviors and actions

that can contribute to sustaining ECF) and attitudes were measured before and after

implementation of the group discussion and mobile phone texting experiments. Each of

the three constructs comprised multiple outcome variables, each of which had an implied

"yes" or "no" response. A component attribute was counted as yes when mentioned and

no if it was not mentioned.

For all four environmental knowledge constructs, I created corresponding indices

by adding up respective component attributes: one index for benefits of the ECF, a

second for behaviors that contribute to degradation of the ECF, a third for negative

impacts of destroying the ECF, and the last for behaviors and actions that can help sustain

the ECF. Additionally, I created an overall index for knowledge by summing up

attributes from all four categories of knowledge. Also, I created indices for attitudes

toward EFBs and practices. The indices allowed me to determine whether the participants

in the treatment group demonstrated overall improvement in environmental knowledge,

attitudes and more engagement in environmentally friendly behaviors or not compared to

the control group. The expectation was that per social learning theory (Bandura, 1971,

1977), individuals from the treatment group were more likely to acquire more

environmental knowledge, and thus—due to knowledge gained—their attitudes would be

influenced positively, and they would engage more in sustainable practices. These

individuals would thus report new environmental attributes in the post-test study, and

their average indices would be higher. Those in the control group were expected to report

attributes similar to those observed in the pre-test study, and their average indices were expected to be lower.

Before running any inferential statistics, I conducted descriptive analyses to determine the response and treatment rates which helped me decide whether the data were usable or not. Descriptive analyses also helped me understand the demographic characteristics of the studied population and determine whether disaggregation by demographic factors was feasible.

Eckman (2013) recommends that descriptive statistics of KAP values be performed to determine any changes between pre- and post-test results, especially if sample size is smaller than 500. I measured the proportion of respondents who reported specific knowledge, attitudes, and practice attributes and compared these between the two survey periods to determine whether the difference was positive or not. I also analysed mean values of the indices created for the three constructs and determined if there were any positive changes between pre- and post-test periods. I disaggregated the proportions and means by gender, age (below versus above 30 years), education (with versus without formal education), distance from the ECF (far versus near the ECF), and access to EE (accessed EE versus did not). Tables and figures of proportions of participants who mentioned forest-related attributes of knowledge, attitudes and practices are presented.

In addition to descriptive statistics, I used a difference in differences (DID) estimator to associate any positive change in KAP values to the environmental education project. Despite the small sample size, this was a preferred method for evaluating this study since it included pre- and post-test data. By using pre- and post-test data of the

same groups, effects on the output variables that are not due to the treatment can be accounted for (Angrist & Pischke, 2009; Dimick & Ryan, 2014). Additionally, if the baseline level of environmental knowledge were not the same for the treatment and the control group, the DID estimator accounts for those initial differences as well. For sensitivity analysis, I included covariates such as being a woman, having less than primary school education, and being above the age of 30 to see if the differences observed remained significant. A significant increase in knowledge was reported at the 95% confidence level. The DID model that determined these effects is as shown in equation 1 below. The model below does not contain covariates although I do include them when performing sensitivity analysis.

$$DID = (\bar{Y}T1 - \bar{Y}C1) - (\bar{Y}T0 - \bar{Y}C0) \tag{5.1}$$

Where:

$\bar{Y}T0$ = mean of the dependent variable for the treatment group for pre-test study

$\bar{Y}T1$ = mean of the dependent variable for the treatment group for post-test study

$\bar{Y}C0$ = mean of the dependent variable for the control group for pre-test study

$\bar{Y}C1$ = mean of the dependent variable for the control group for post-test study

A positive and significant result in any of the three constructs would indicate that the environmental education project contributed improved knowledge, attitudes, or practices. Improved KAP values were thus assessed by determining whether any individual knowledge, attitude, or practice attributes significantly increased in the

post-test study and whether the average number of attributes reported in the post-test study were higher than those reported in the pre-test study.

5.3. Results

5.3.1. Response rate, treatment rate, and demographic characteristics

Response rate. Out of 417 respondents who participated in the pre-test, 322 (77.2%) were interviewed in the post-test study. Therefore, the attrition rate was 22.8%. This attrition was mainly contributed by one village which had a 54% rate; all other villages had attrition rates below 20%. The main reason for the high attrition rate in this village was lack of cooperation from village leaders who, I believe, aimed for political gains because the post-test study coincided with primary election campaigns. The leaders in Maasai villages almost denied me permission to carry out the post-test study in their village, even though they were present when I began the study in 2013. I discuss this further in following sections. High response rates in seven other villages were mainly due to the flexibility of enumerators, an interview plan that accommodated respondents' schedules, and high collaboration from village leaders. Some respondents who missed the post-test study had either travelled for long periods or had temporarily migrated to distant parts of the country, and it was impossible to wait for their return before completing the surveys.

While the overall attrition rate in this study may seem high, other studies have reported much higher rates (Fewtrell et al., 2008). For this study, however, I am confident that even a 22.8% attrition rate does not compromise the quality of the study. This is mainly because the high-attrition village was initially part of the other three villages,

before they split in 2011 to form four separate villages. It was expected that findings could be similar to the other three villages; thus, its post-test results could be inferred from other villages. Additionally, the four villages are similar culturally, economically, and in levels of educational attainment. I am, therefore, confident that the results observed are representative of the studied population.

Treatment rate. While the aim of the project was to provide environmental education to randomly selected households in the six treatment villages, not everyone was present during the experiment. Out of 114 individuals selected for the face-to-face discussion group, 71.1% were treated while 28.9% were not. The treatment rate for the mobile phone experiment was much lower compared to that of group discussion. Out of 134 participants from the mobile phone group, only about half of them (52.9%) confirmed that they received environmental information via mobile phones, either directly via their mobile phone or via their friend's or relative's phone. For both treatment groups, I re-assigned individuals who did not receive any environmental education into the control group, whether they were initially part of the control villages or not.

The lower treatment rate among the mobile phone group can be attributed to various factors, including limited mobile phone network, high illiteracy rates, and inexperience in using mobile phones for receiving educational messages (Souter et al., 2005). When respondents from the mobile phone group were asked why they did not receive environmental information, 19.5% said they did not see the messages. Individuals who did not receive the messages are mainly those who did not own mobile devices. Participants with some education were more likely to report having seen the messages

compared to those with no education.

Demographic characteristic of respondents. Individuals who responded to the pre- and post-test survey questions comprised 45.3% male and 54.7% female and their ages were between 18 and 95. While the proportion of female is generally higher compared to the male proportion in the population, the lower proportion of male respondents in this case can be explained by males' higher mobility. More men from selected households were missed during the post-test compared to women. Overall, about 48% had attended at least primary school education while 52.1% had never attended any level of education. When disaggregated by gender, about 39.5% of the male respondents reported that they had never attended school, 46.2% of them had attended primary school, and only 14% had attended secondary school or higher education. For female respondents, 62.3% had never attended any form of education, 29.6% had attended primary school, and only 7.9% had attended secondary school or higher education. The big difference in education levels between male and female respondents is not surprising; research shows that females from the Maasai tribe are still less likely to attend school compared to males due to cultural barriers (Grabe, 2015). Male children are given priority whenever parents can afford to send their child to school, while female children are married off at young ages to get a bridal price. Similar education attainment rates have been observed in the Longido district (SFTZ, 2010), an area occupied mainly by the Maasai ethnic group.

5.3.2. Impact of environmental education on knowledge, attitudes, and practices

To understand whether the environmental education project had a positive impact on the local people in Loliondo, I assessed changes in knowledge, attitudes, and practices by answering three sub-questions: (1) Did people increase their knowledge about benefits provided by the forest, causes of forest destruction, negative impacts of deforestation, and about actions that would help sustain the forest? (2) Did attitudes toward behaviors related to the forest shift in a positive direction? (3) Did people adopt recommended practices, and did they maintain any of them over time? By answering these sub-questions, I intend to answer the first major question: *What is the impact of environmental education on people's knowledge, attitudes, and practices (KAP) related to natural resources use and management among the Loliondo people"?* Since I implemented two independent experiments, face-to-face group discussions and mobile phone texting, I first assess findings separately, and later compare then.

5.3.2.1. *Impact of group discussion environmental education strategy on environmental knowledge*

Knowledge of benefits provided by the ECF. The first aspect of environmental knowledge asked about benefits provided by the ECF. For both pre-and post-test studies, survey results show that benefits most mentioned by participants are those perceived directly. The most commonly perceived direct forest benefits include rainfall, fuel wood, water, construction poles, pasture for livestock, and traditional medicine. More participants in the post-test study, particularly those in the treatment group, mentioned indirect benefits such as how the forest cools down the air, prevents soil erosion, provides clean air, and

provides an environment for recreation, in addition to the direct benefits. Unexpectedly, some benefits were mentioned less in the post-test study compared to the pre-test (benefits such as preserves water, fuel wood, pasture for livestock, traditional medicine, and income source). This was probably a result of the unwillingness of some participants to be interviewed in the post-test study due to politics that emerged (discussed in the discussion and conclusion below). Since additional attributes of benefits of the ECF and the mean value of the benefit index increased significantly in the post-test study, I conclude that individuals reported additional benefits learned through participating in the EE project (see Figure 5.7). Also, disaggregation of the data by gender reveals that male and female participants were equally knowledgeable in most benefits provided by the forest, with few differences observed; these differences may, however, have resulted from a reluctance to talk to the enumerators (during the post-test) and the patience of the enumerator to probe for more answers (see Table 5.1). Note that table 5.1 includes both the experimental and the control groups, so I do not test for significant pre- versus post-differences. That is done below using the difference-in-differences method.

Figure 5.7. Proportion of reported benefits provided by the ECF disaggregated by pre- and post-test data (n = 211)
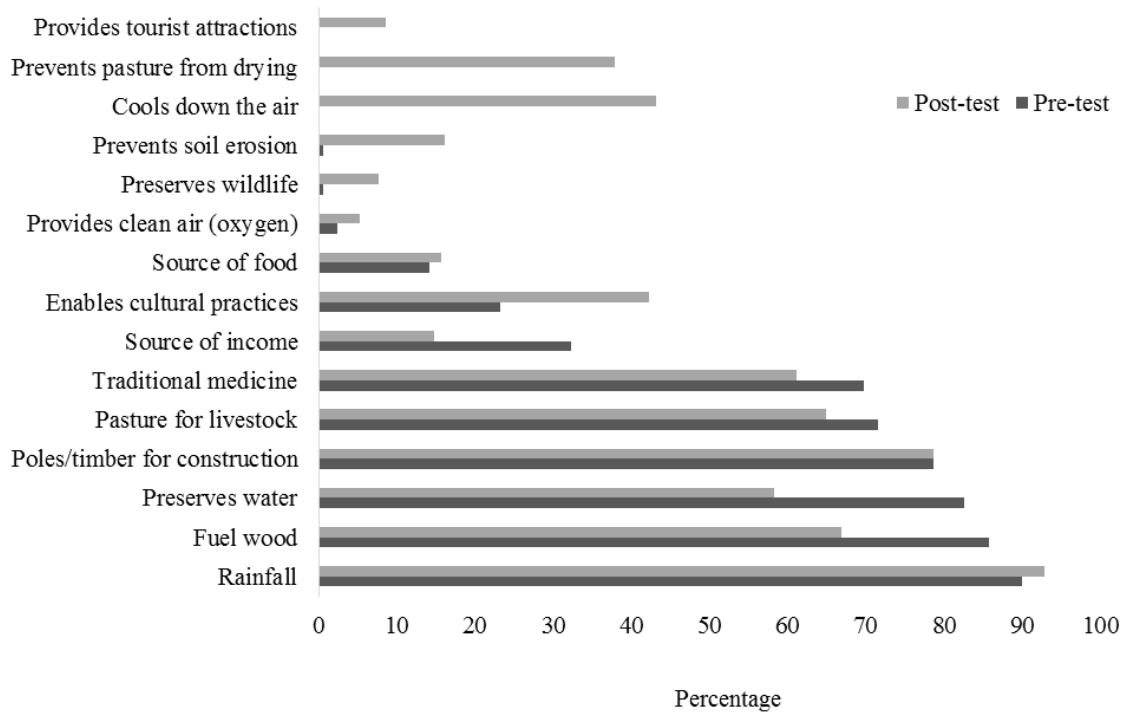
Table 5.1. Proportion of benefits provided by the ECF disaggregated by pre- and post-test studies and gender

Perceived benefits provided by ECF	Pre-test %		Post-test %	
	Male	Female	Male	Female
Rainfall	89.7	90.4	92.4	93.2
Poles/timber for construction	81.4	76.3	78.3	78.6
Fuel wood	82.5	88.6	51.1	78.6***
Preserves water	78.4	86.0	67.4**	50.4
Pasture for livestock	76.3	67.5	67.4	62.4
Medicine (traditional medicine)	75.3	64.9	53.3	67.5**
Cools down the air	0.0	0.0	48.9	38.5
Enables cultural practices	25.8	21.1	41.3	41.9
Food to people	15.5	13.2	17.4	14.5
Income source	35.1	29.8	8.7	19.7**
Prevents soil erosion	0.0	0.9	14.1	17.1
Preserves wildlife	1.0	0.0	6.5	8.5
Provides tourist attractions	0.0	0.0	5.4	11.1
Provides clean air (oxygen)	3.1	1.8	6.5	4.3

Note: Male (n = 97), Female (n = 114). The asterisks indicate statistical significance between male and female percentages at the 1% (***) and 5% (**) levels.

Knowledge of behaviors that contribute to degradation of the ECF. The second aspect of

environmental knowledge asked about what behaviors contribute to the deforestation of

the ECF. Behaviors that were highly mentioned during both pre-and post-test studies as

attributes of degradation of the ECF include the following: cutting of living trees for

cooking or home construction, charcoal burning, illegal logging, and farming and settling

inside the forest. While less than half the sample mentioned these behaviors during pre-

test study, more than 50% of the same participants point out these behaviors after the

environmental education project. Overgrazing by livestock, burning for honey harvesting,

and cutting of trees for livestock fodder were mainly mentioned after the environmental

education project (see Figure 5.8). Both male and female respondents were likely to

mention the most destructive behaviors, although some behaviors were more likely to be

reported by one gender. For example, female respondents were more likely to report the cutting of living trees for firewood as a destructive behavior compared to male respondents, and vice versa for overgrazing by livestock (see Table 5.2). The gender differences in the perceptions about destructive behaviors may be due to different roles played by Maasai men and women in the study area; for example, women collect firewood while it is mainly the men's job to take care of livestock, although sometimes women help with small calves and goats.

Figure 5.8. Proportion of perceived causes of ECF destruction disaggregated by pre- and post-test data (n = 211)
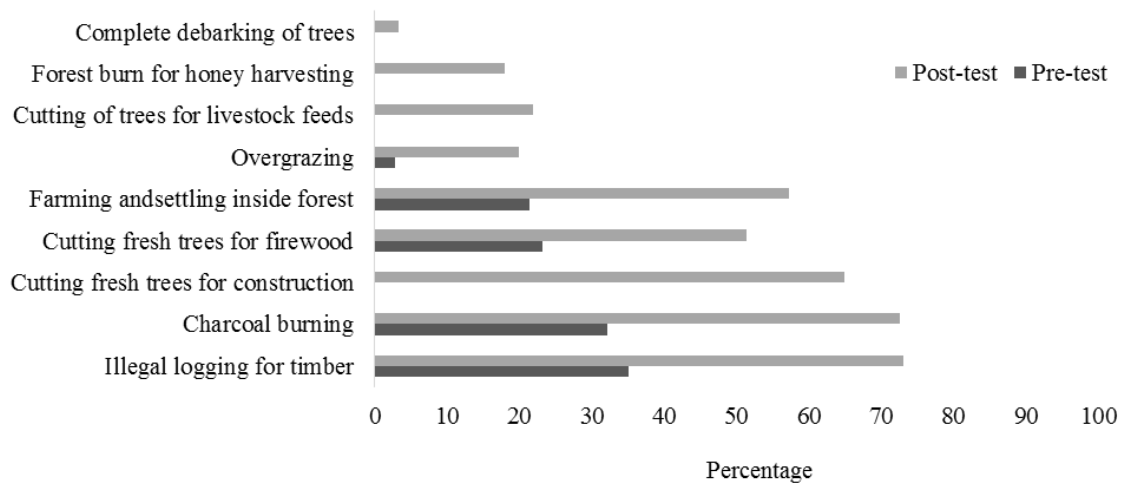
Table 5.2. Proportion of perceived causes of ECF destruction disaggregated by pre- and post-test studies and gender

Perceived cause of ECF deforestation	Pre-test %		Post-test %	
	Male	**Female**	**Male**	**Female**
Tree cutting for firewood	23.7	22.8	71.7	83.8**
Illegal logging for timber	40.2	30.7	68.5	76.9
Tree cutting for construction	35.1	22.8	64.1	65.8
Charcoal burning	38.1	27.2	73.9	70.1
Agricultural expansion inside forest	25.8	17.5	55.4	54.7
Settling inside the forest	0.0	0.0	30.4	33.3
Overgrazing	2.1	3.5	22.8	17.9
Tree cutting for livestock feeds	0.0	0.0	21.7	22.2
Tree debarking	0.0	0.0	1.1	5.1

Note: Male (n = 97), Female (n = 114). The asterisks indicate statistical significance between male and female percentages at the 1% (***) and 5% (**) levels.

Knowledge of negative impacts of destroying the ECF. The third aspect of environmental

knowledge asked about negative impacts of destroying the ECF. The negative impacts

that were most mentioned by participants in both the pre- and post-test studies include no

rainfall, no wood for home construction, no medicinal plants/trees, no fuelwood, and no

pasture for livestock. Unlike in the pre-test study, additional negative impacts such as

increased soil erosion, reduced air quality, and increased temperatures around the forest

were reported in the post-test study (see Figure 5.9). While fewer female participants

(compared to male participants) reported negative impacts of forest destruction in both

the pre- and post-test studies, there were no statistically significant differences between

answers provided by the two groups, except for "won't have source of wood for

construction" and "no fuel wood". As shown in Table 5.3, female participants were more

likely to report these two negative impacts during the post-test study compared to male

participants. As previously argued, the differences observed may be due to gendered

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roles; Maasai women are responsible for firewood collection and construction of their

huts.

Figure 5.9. Proportions of perceived causes of the ECF destruction disaggregated by pre- and post-test data (n = 211)
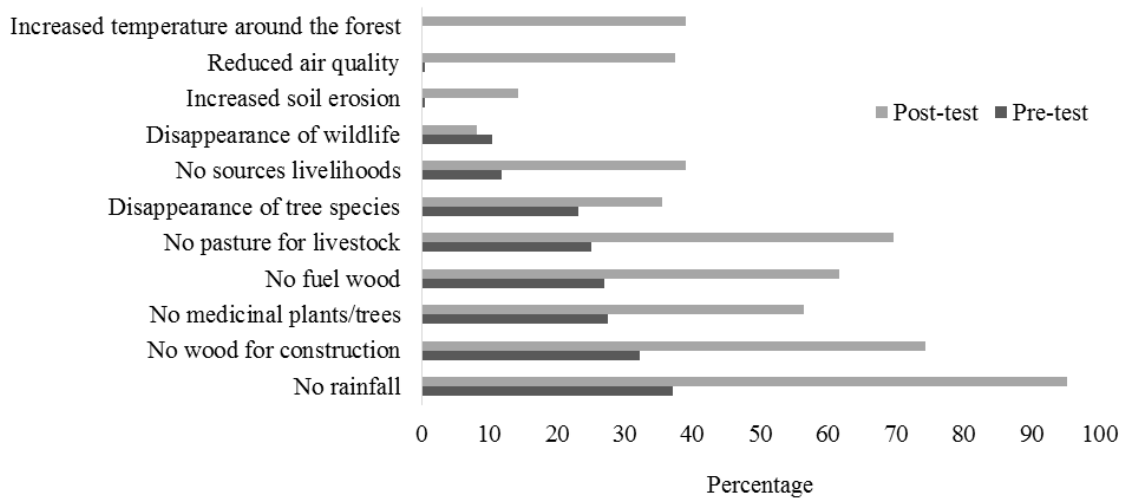
Table 5.3. Proportion of perceived impacts of destroying the ECF disaggregated by pre- and post-test studies and gender

Perceived impacts of destroying the ECF	Pre-test %		Post-test %	
	Male	Female	Male	Female
Won't get rainfall	43.3	31.6	97.8	93.2
Won't have source of wood for construction	37.1	28.1	64.1	82.1***
Rivers and springs will dry	32.0	21.9	71.7	64.1
Won't have pasture for livestock	29.9	21.1	64.1	74.4
No fuel wood	25.8	28.1	44.6	74.4***
Won't have medicinal plants/trees	32.0	23.7	58.7	53.8
Air quality will decline	0.0	0.0	40.2	35.9
Increased temperature around the forest	0.0	0.0	44.6	34.2
Disappearance of some tree species	26.8	20.2	32.6	37.6
Won't have sources livelihoods	16.5	7.9	40.2	38.5
Increased soil erosion	0.0	0.0	16.3	12.8
Disappearance of wildlife	13.4	7.9	7.6	8.5

Note: Male (n = 97), Female (n = 114). The asterisks indicate statistical significance between male and female percentages at the 1% (***) and 5% (**) levels.

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Knowledge of actions and behaviors that can help sustain ECF. The final component of

environmental knowledge asked about actions and behaviors that would help sustain the

ECF. Behaviors that were highly reported include guard the forest, restrict cutting trees,

ban charcoal burning, plant trees, and ban logging for timber. Actions and behaviors

observed mostly after the implementation of environmental education via group

discussion include the following: report illegal activities to village leaders, collect only

dry wood for firewood, collect only dry wood for home construction, participate in

establishing and abiding by forest bylaws, conserve more forested areas, practice

rotational grazing, and restrict livestock from entering the forest (see Figure 5.9). With

the exception of "report illegal activities" and "collect only dry wood for firewood", both

before and after treatment, male and female participants demonstrated equal knowledge

of actions and behaviors that would help sustain the ECF (see Table 5.4).

Figure 5.10. Proportions of perceived causes of the ECF destruction disaggregated by pre- and post-test data (n = 211)
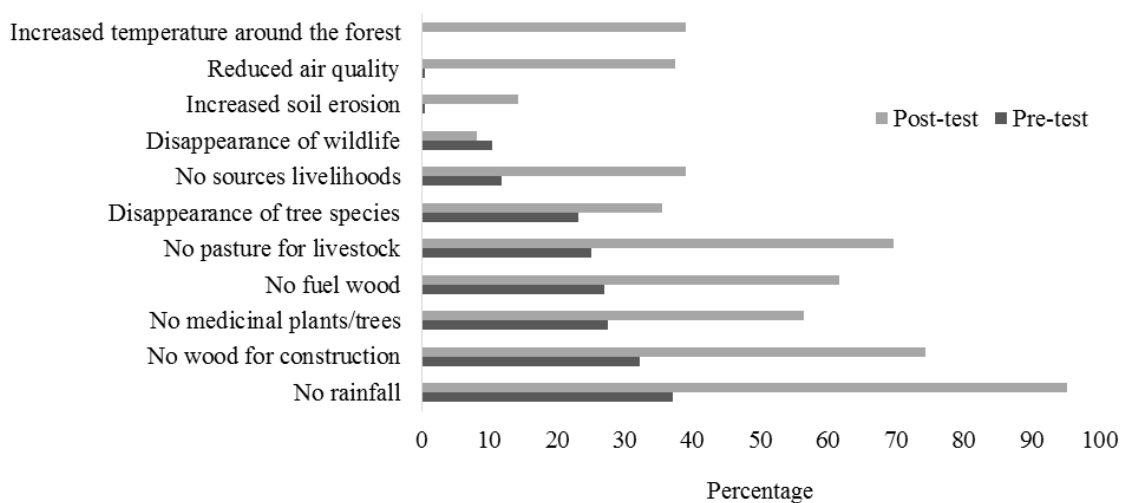
Table 5.4. Proportions of environmentally-friendly behaviors disaggregated by pre- and post-test studies and gender

Perceived actions and behaviors that would help sustain ECF	Pre-test %		Post-test %	
	Male	**Female**	**Male**	**Female**
Forest guarding by communities	90.7	89.5	91.3	86.3
Restrict cutting trees	84.5	86.0	59.8	74.4**
Plant trees	54.6	58.8	47.8	44.4
Ban logging for timber	53.6	50.0	43.5	53.8
Ban charcoal burning	75.3	72.8	45.7	48.7
Provide conservation education	29.9	20.2	38.0	29.9
Rotational grazing	22.7	14.0	30.4	36.8
Exclusion of livestock	22.7	14.0	27.2	32.5
Report illegal activities	0.0	0.0	18.5	34.2**
Collect only dry wood for firewood	0.0	0.0	15.2	34.2***
Collect only dry wood for construction	0.0	0.0	17.4	27.4
Stop farming/settling inside forest	0.0	0.0	31.5	24.8
Establish and abide to forest bylaws	0.0	0.0	16.3	17.1
Conserve more forested areas	0.0	0.0	8.7	12.8
Practice sustainable agriculture	0.0	0.0	6.5	6.8

Note: Male (n = 97), Female (n = 114). The asterisks indicate statistical significance between male and female percentages at the 1% (***) and 5% (**) levels.

In order to associate observed differences to participation in the EE project, I compared the mean differences of the control and the treatment groups for the two survey periods for all four environmental knowledge constructs. Except for one construct, the results showed that the mean was higher in the treatment group compared to the control group after implementation of the environmental education project; as a result, the difference of the means [(mean of treatment – mean of control in post-test) – (mean of treatment – mean of control in pre-test)] was positive.

Overall, there was evidence that the group discussion treatment contributed to increased knowledge in almost all four categories of environmental knowledge assessed in this study. With the exception of knowledge of benefits provided by the ECF, the mean

differences of the indices of factors that contribute to degradation of the ECF, impacts of

destroying the ECF, and actions and behaviors that would help sustain the ECF, all

increased significantly after implementation of the EE project. Table 5.5 shows the

differences in the averages between environmental knowledge reported in the treatment

(group discussion treatment) and the control groups before and after CREATE's EE

project. The difference between the two differences are reported in the last column. As

shown in the last column of Table 5.5, the positive means show that this increase mainly

occurred in the treatment villages. The observed results remain significant even after

accounting for gender, age, and education, even though results also show that women and

individuals (both male and female) aged 30 and below demonstrated less knowledge in

benefits provided by the ECF and in actions and behaviors that can help sustain the ECF,

after accounting for various demographic factors.

**Table 5.5. Mean differences between the control and the face-to-face discussion
treatment group (n=211)**

Environmental knowledge questions	Mean difference before treatment	Mean difference after treatment	Difference in differences
What are the benefits of ECF?	0.06	0.979**	0.919
	(0.259)	(0.289)	(0.389)
What behaviors contribute to decline of ECF?	2.419**	3.574**	1.156**
	(0.243)	(0.271)	(0.364)
What are the negative impacts of destroying ECF?	3.085**	4.606**	1.521**
	(0.361)	(0.403)	(0.541)
What actions and behaviors would help sustain ECF?	0.513	1.84**	1.328**
	(0.300)	(0.335)	(0.449)

Note: Standard errors are in parenthesis; *** significant at 1%, ** significant at 5%. This model controls
for gender, age, education, participation in an EE program, and location of households in relation to the
forest (i.e., far versus near Enguserosambu Community Forest).

5.3.2.2.   *Impact of group discussion strategy on people's attitudes*

The first question in the KAP study also answers a question about whether the EE project had any impact on participants' attitudes toward environmentally friendly behaviors. With increased environmental knowledge, it was expected that attitudes toward environmentally friendly behaviors would also change positively, as the two have been shown to have a positive relationship (Hines et al., 1987). As shown in Figure 5.11, participants reported more behaviors they would be willing to engage in to help sustain ECF in the post-test compared to the pre-test study. When disaggregated by gender, male participants seem to demonstrate a more positive attitude compared to female participants during both pre- and post-test studies. On the one hand, male participants reported more behaviors such as educating the community about forest conservation, volunteering to guard the forest, planting trees, and practicing rotational grazing, as behaviors they would be willing to engage to help sustain the ECF. On the other hand, female participants demonstrated a more positive attitude toward reporting illegal activities taking place in the forest (during pre-test) and collecting only dry wood for firewood (during post-test; see Table 5.6).

As discussed earlier, the differences observed between male and female participants may be due to embedded cultural differences between the two groups; men and women in Maasai societies (and many African societies) tend to have gender-differentiated access and ownership rights to resources, decision-making power, and responsibilities at both household and community level. Knowledge, attitudes and behaviors expressed are thus likely to follow imbedded differences between gender.

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Figure 5.11. Proportion of expressed attitudes toward environmentally friendly behaviors disaggregated by pre- and post-test periods (n=211)
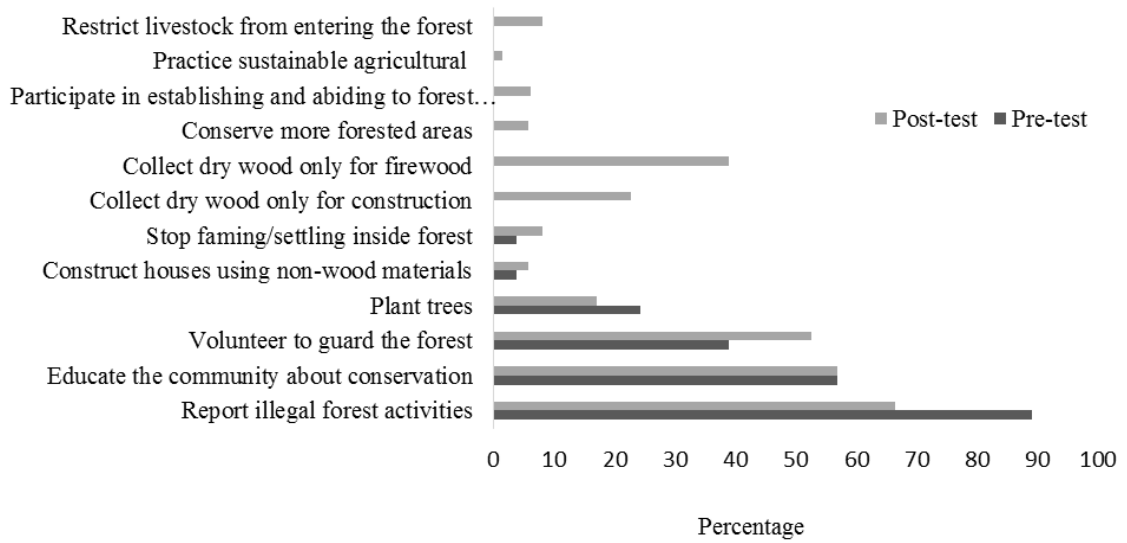
Table 5.6. Pre- and post-test attitudes toward environmentally friendly behaviors disaggregated by gender

Attitudes toward environmentally responsible behaviors	Pre-test %				Post-test %		
	Male		Female		Male		Female
Report illegal forest activities	82.5		94.7		60.9	***	70.1
Educate the community about conservation	64.9	**	50.0		59.8		54.7
Volunteer to guard the forest	54.6	***	25.4		76.1	***	34.2
Sensitize people to guard the forest	17.5		13.2		42.4		43.6
Restrict cutting trees	0.0		0.0		44.6		33.3
Collect only dry wood for firewood	0.0		0.0		19.6	***	53.8
Collect only dry wood for construction	0.0		0.0		20.7		23.9
Plant trees	29.9	**	19.3		27.2	***	9.4
Ban charcoal burning	0.0		0.0		23.9		12
Prevent livestock from entering the forest	0.0		0.0		10.9		6
Stop faming/settling inside forest	5.2		2.6		8.7		7.7
Participate in establishing and abiding to forest bylaws	0.0		0.0		9.8		3.4
Conserve forested areas that are outside protected forest	0.0		0.0		6.5		5.1
Practice rotational grazing	0.0		0.0		5.4	**	0.9
Practice sustainable agricultural	0.0		0.0		5.4		2.6

Note: Control: Male (n=97), Female (n=114); Treatment: Male (n=92), Female (n=117). The asterisks indicate statistical significance between male and female percentages at the 1% (***) and 5% (**) levels.

To associate any positive change in attitudes to the EE project I again ran the difference-in-differences model. The positive values of the differences between the means of the treatment and the control groups between the two survey periods suggest that the attitudes toward individual attributes of EFBs increased. However, since the observed differences for most attitude attributes (with the exception of volunteering to guard the forest) were not significant at the 95% confidence interval, I could not attribute with certainty this change to the EE project implemented in the treatment villages. Similarly, the change in the overall attitude (i.e., the attitude index) toward EFBs was

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positive but was only significant at the 90% confidence interval. This finding thus suggests that while environmental knowledge increased significantly post-EE project, it did not lead to improved attitudes toward most EFBs (see Table 5.7)

Table 5.7. Attitudes toward specific environmentally friendly behaviors

Attitude toward specific EFBs	Mean difference before treatment	Mean difference after treatment	Difference in differences
Report illegal activities to village leaders	-0.222***	-0.234***	-0.012
	(0.053)	(0.059)	(0.079)
Volunteer to guard the forest	0.034	0.266***	0.232**
	(0.064)	(0.072)	(0.096)
Construct houses using other materials	-0.000	0.043	0.043
such as cement bricks	(0.028)	(0.031)	0.042
Provide environmental awareness to	-0.043	0.053	0.096
people	(0.065)	(0.072)	(0.097)
Stop expanding farms/settlements toward	0.034	0.053	0.019
forests	(0.031)	(0.034)	(0.046)
Plant trees	-0.120**	-0.011	0.109
	(0.053)	0.059	(0.079)
Restrict livestock entering the forest	0.051**	0.117***	0.066*
	(0.025)	(0.028)	(0.038)
Collect only dry wood for firewood	0.376***	0.404***	0.028
	(0.045)	(0.050)	(0.068)
Collect only dry wood for construction	0.188***	0.277***	0.089
	(0.039)	(0.043)	(0.058)
Participate in establishing and abiding to	0.077***	0.043*	-0.034
forest bylaws	(0.022)	(0.025)	(0.033)
Conserve forested areas that are outside	0.051**	0.064***	0.013
protected forest	0.022	0.024	0.032
Practice sustainable agricultural – e.g.,	0.026**	-0.000	-0.026
create contours in hilly areas	(0.011)	(0.012)	(0.016)
Restrict people from cutting trees	0.376***	0.394***	0.018
	(0.045)	(0.050)	(0.068)

Note: Standard errors are in parenthesis; *** significant at 1%, ** significant at 5%, * significant at 10%

5.3.2.3. *Impact of group discussion strategy on participants' engagement in environmentally friendly behaviors*

The goal of disseminating environmental information is to influence behaviors in a positive manner (Clayton & Myers 2009, 2015; Roth, 1973; UNESCO, 1975). The first question in the KAP study reported here also answered a question about whether the behaviors of participants changed positively after participating in the EE program. That is, did participants in the treatment group (compared to those in the control group) report engagement in more EFBs during the post-test study compared to the pre-test period? Since this question was not asked in the pre-test study, however, I use only post-test data to compare the differences between the treatment and the control groups.[72] As shown in Table 5.8, individuals in the treatment group seemed to report engagement in more EFBs compared to those in the control group; the differences were not statistically significant, with the exception of two EFBs. Individuals in the treatment group appear to report more engagement in collecting dry wood for construction compared to individuals in the control group; while the results for tree planting were reversed.

When disaggregated by control/treatment and by gender, there appear to be no statistically significant differences between male and female participants in the treatment group, with the exception of collecting only dry wood for firewood (see Table 5.9). In the control group, however, there appear to be gender-differences in the reported EFBs. As in the treatment group, more women were likely to report having engaged in collecting dry

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72 Erroneously, this question was left out in the baseline study, as a result, I have missing data for this question in the pre-test study.

wood for firewood. On the contrary, more male participants were likely to report engaging in volunteering to guard the forest, reporting illegal activities, restricting grazing livestock in the forest, practicing rotational grazing and participating in establishing and abiding by forest bylaws. The differences observed between men and women all follow the pattern of gender differences in household decision making and distribution of household responsibilities in the Maasai and most African cultures.

Despite the increased participation in most EFBs, however, I could not associate this increase with the EE project since baseline information to compare to was missing for this question. Changes in reported EFBs must be compared for the two time periods to be able to assume causation (Angrist & Pischke, 2008; Dimick & Ryan, 2014).

Table 5.8. Self-reported actions and behaviors engaged in disaggregated by control/treatment

Actions and behaviors engaged in to help sustain ECF	Control %	Treatment %
Provided conservation education to other people	34.1	41.5
Sensitized other people about guarding the forest	27.9	34.2
Collected only dry wood for firewood	24.0	35.4
Volunteered to guard the forest	23.3	30.5
Reported illegal activities	17.8	24.4
Collect only dry wood for construction	10.9	22.0**
Restricted grazing livestock in the forest	10.9	15.9
Planted trees	14.0**	4.9
Practiced rotational grazing	9.3	9.8
Conserved forested areas that are outside protected forest	5.4	6.1
Stopped expanding farms/settlements toward forests	7.8	3.7
participated in establishing and abiding to forest bylaws	4.7	4.9
Practiced sustainable agriculture	5.4	1.2

Note: Control (n=129), Treatment (n=82). The asterisks indicate statistical significance between the control and the treatment group percentages at the 1% (***) and 5% (**) levels.

Table 5.9. Self-reported actions and behaviors engaged in disaggregated by control/treatment and gender

Actions and behaviors engaged in to help sustain ECF	Control % Male	Control % Female	Treatment % Male	Treatment % Female
Provided conservation education to other people	41.4	28.6	50.0	36.2
Sensitized other people about guarding the forest	34.5	22.9	35.3	34.0
Collected only dry wood for firewood	10.3	35.7***	17.6	48.9***
Volunteered to guard the forest	43.1***	7.1	38.2	25.5
Reported illegal activities	25.9**	11.4	17.6	29.8
Collect only dry wood for construction	13.8	8.6	20.6	23.4
Restricted grazing livestock in the forest	20.7***	2.9	20.6	12.8
Planted trees	19.0	10.0	8.8	2.1
Practiced rotational grazing	17.2**	2.9	11.8	8.5
Conserved forested areas that are outside protected forest	6.9	4.3	8.8	4.3
Stopped expanding farms/settlements toward forests	15.5***	1.4	0.0	6.4
Participated in establishing and abiding to forest bylaws	10.3**	0.0	2.9	6.4
Practiced sustainable agriculture	8.6	2.9	0	2.1

Note: Control - Male (n=58), Female (n=70); Treatment - Male (n=34), Female (n=47). The asterisks indicate statistical significance between male and female percentages in the control and the treatment groups at the 1% (***) and 5% (**) levels.

5.3.3. Impact of mobile phone texting strategy on environmental knowledge

The mobile phone experiment was not as successful as the group discussion strategy. Fewer participants received EE messages than expected. Within three villages that were part of the treatment group, about half of the group (77 out of 134) reported that they received environmental information. These respondents received environmental information either directly via their mobile phones or via their friend's or relative's phone. When the treatment group is combined with the control group, only 32.5% of 231

persons received environmental information via mobile phones. Of the 77 individuals who reported that they accessed EE messages via mobile phone texts, only 42.2% (30) of them were female. Also, out of 30 women who reported that they received EE messages via mobile phone, only 70% used their mobile phone compared to 92.7% male. The remaining 30% of female participants who received EE messages used other people's (friend's or relative's) phone (see Figure 5.12 below).

These results show that while access to EE via mobile phones was generally lower than expected, since baseline findings indicated that there is higher reliance on mobile phones for general information, the women had much lower access. Low access by women may be due to the fact that they generally own fewer assets than men (World Bank, n.d.). Ownership of mobile phones was, however, not the only determinant for accessing EE messages. The individual could own a mobile phone yet could possibly not read the message especially if they are non-literate, have no access to the network, or were not interested in the subjects presented to them. Nevertheless, ownership of a mobile phone was an important factor since no devices were provided to participants by the study.

Figure 5.12. Proportion of male and female participants who received EE messages via their mobile phones versus other people's phones
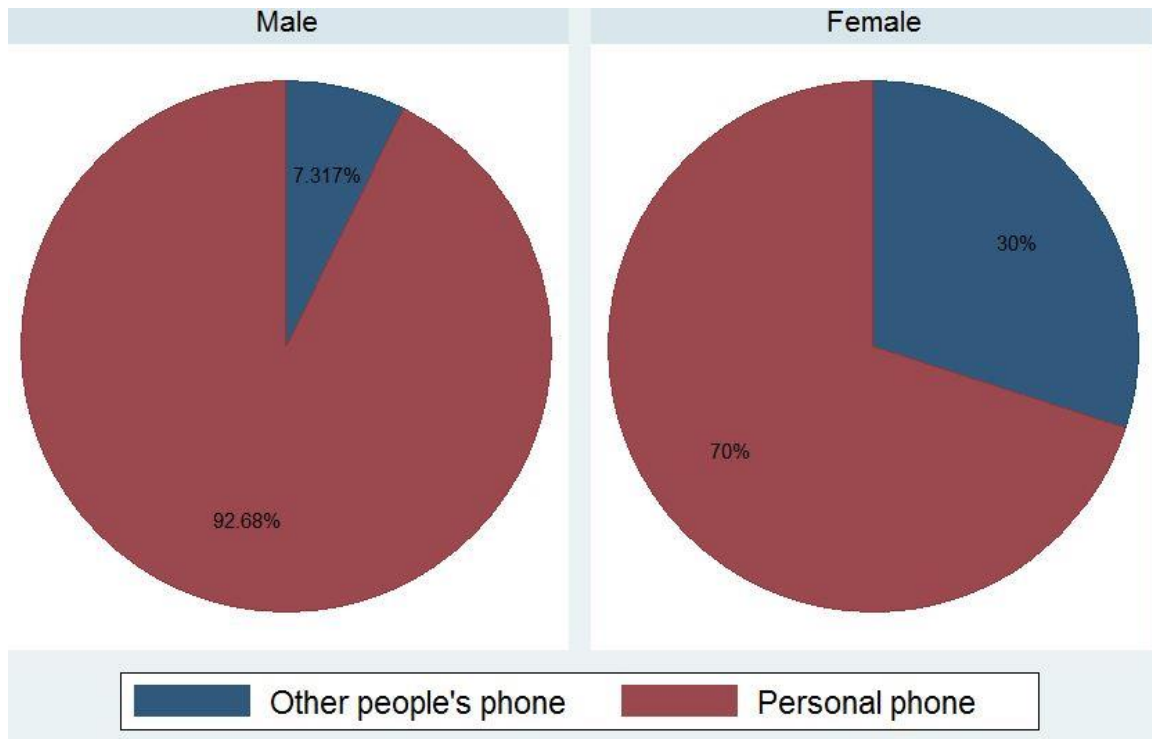
Impact of mobile phone texting on knowledge. The reported environmental constructs

for all four knowledge categories were like those observed in the group discussion

treatment. Unlike the group discussion treatment, however, I observed significant change

in only one knowledge category—benefits provided by the ECF—at the 90% confidence

level. The other four knowledge constructs, including factors that contribute to forest

degradation, negative impacts of destroying a forest, and behaviors and actions that

would help sustain the forest increased after the experiment, but the increase was not

statistically significant (see the last column in Table 5.11). The positive numbers in the

last column show that this increase mainly occurred in the treatment group. Since the

observed changes were not significant, however, there is not enough evidence that mobile

phone texting environmental education contributed to the increased knowledge in

environmental topics.

Since there were no significant changes in environmental knowledge constructs, I

did not assess changes in attitudes and practices post-EE implementation.

Table 5.11. Mean differences between the control and the mobile phone treatment group (n=231)

Aggregated environmental knowledge (Indices)	Mean difference before treatment	Mean difference after treatment	Difference in differences
Benefits provided by the ECF	0.359 (0.237)	1.120*** (0.342)	0.761* (0.416)
Causes of the ECF destruction	2.410*** (0.202)	2.973*** (0.292)	0.563 (0.355)
Negative impacts of the ECF degradation	3.006*** (0.298)	3.2*** (0.43)	0.194 (0.523)
Actions that can help sustain the ECF	0.551** (0.235)	1.093*** (0.339)	0.542 (0.413)

Note: Standard errors are in parenthesis; *** significant at 1%, ** significant at 5%. This model controls for gender, age, education, participation in an EE program, and location of households in relation to the forest (i.e., far versus near Enguserosambu Community Forest).

5.4. Discussion and conclusion

Studies have shown that environmental education is positively associated with

high environmental literacy (Clayton & Myers 2009, 2015; Hines et al., 1987; Roth,

1973). Furthermore, research shows that environmental knowledge is also associated with

attitudes toward EFBs, which in turn is associated with engagement in environmentally

friendly behaviors (Clayton & Myers, 2009, 2015; Hines et al., 1987). Implementation of

environmental education thus aimed at improving local people's awareness of various

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environmental topics, including environmental issues and their solutions, with the expectation that this knowledge would be converted to positive attitudes, and consequently to engagement in EFBs. As expected, the proportion of participants who reported environmental knowledge attributes increased significantly after implementation of the EE. The increase was largely observed in the group discussion treatment group compared to the control group. Similarly, there was a significant improvement in participants' attitudes toward EFBs but not in their self-reported engagement in EFBs. Most increased engagement in EFBs (in the treatment group) were not statistically significant. As in other studies (Bizerril at al., 2011; Hsu, 2004), the results observed here show that dissemination of environmental information is necessary to create populations not only knowledgeable about various environmental topics but also with positive attitudes toward EFBs.

While it was expected that participation in the EE project would also lead to increased engagement in EFBs, that was not the case for most behaviors. Results show that despite a significant increase in participant knowledge and improved attitudes toward most behaviors, individuals in the treatment and the control group equally engaged in EFBs. These findings suggest that information dissemination alone was not enough to translate knowledge into actions. Various scholars acknowledge that the relationship between knowledge, attitudes, and practices is not a simple one; access to information alone does not guarantee engagement in EFBs because many other factors, including skills in specific behaviors, socioeconomics, upbringing, cultural background, and personality factors can either facilitate or counteract the effect of knowledge gained on

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engagement in EFBs (see Clayton & Myers, 2009, 2015; Hines et al., 1987). In some

cases, live modeling of desired environmentally friendly behaviors such as tree planting,

rotational grazing, and sustainable agriculture may have to be implemented so that people

acquire skills to perform such behaviors, instead of oral instruction which provides

information only (as in the EE project). Live modeling may also improve mastering of

the process for implementing a behavior, and thus the behavior may easily be recalled

(Bandura, 1977). Studies have shown that individuals who received information and

hands-on training on cognitive skills were more likely to engage in environmentally

friendly behaviors compared to those who received only information (Klingler, 1980;

Ramsey, 1979). Furthermore, some behaviors would also require that an individual has

access to resources. In the case of tree planting, for example, one may need funds for

buying nursery trees as well as a plot of land. This implies that if a person is financially

poor, he/she may not be able to afford to buy and plant trees. Similarly, individuals need

access to enough land with pasture to implement behaviors like rotational grazing. In the

case of sustainable agriculture, one may need not only to have access to fertile land but

one must also be able to access organic fertilizer and afford to pay for extra labor since

this practice can be very demanding in terms of manual labor. Nevertheless, the failure to

engage more in tree-planting, rotational grazing, and sustainable agriculture was likely

due to low cognition in these behaviors rather than to socioeconomic factors. Cultural

factors, more than economic, may have influenced low engagement in most behaviors. It

was not surprising that an individual who is used to cutting down a specific tree for

constructing either his/her *boma* continued to do so even after understanding the

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consequences of this behavior. This is especially true if there are no alternative sources of forest products, but it may also be due to the cultural meaning of the activity. In other cases, behaviors may have not been practiced because the opportunity to engage in that behavior did not present itself. For example, people could provide conservation education to other people only if they saw a person cutting down a fresh, living tree or if they were asked to speak about conservation at a meeting.

The impact of the mobile phone texting strategy was much lower compared to that of group discussion—the observed increase in knowledge, for example, was not statistically significant.[73] This finding was not surprising, however; while mobile phones are widely used for communication, their use has not extended widely to information seeking (Souter et al., 2005) especially among non-literate adults in rural areas. Therefore, the impact observed may be due to the rural nature of the study area. Previous studies also found rural areas in developing countries to rely less on mobile phones for information seeking compared to urban communities (Souter et al., 2005). Moreover, while some studies have shown that mobile phones can be used for information access, the types of information disseminated are mainly short and specific, and the need to seek information may be driven by expected benefits. For example, a pregnant mother may call a health worker to seek health information because the baby's or her own health is at risk. The low impact observed may have also been due to factors such as limited mobile

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73 Since knowledge did not change in the mobile phone strategy, I did not assess attitudes and practices, as knowledge is a prerequisite for both.

phone ownership, illiteracy and limited skills in technology use, unreliable mobile

network, and the political climate. I briefly discuss these challenges below.

Limited mobile phones ownership. Not every study participant owned a mobile phone.

Even with low mobile phone ownership among male participants, female participants

ownership rates were lower still. Women's ownership was about half the number of male

owners, and much fewer (about half of male owners) female participants owned mobile

phones compared to male participants. Moreover, because people carry their mobile

phones everywhere, there is substantial risk of losing phones via theft or misplacement.

People are most likely to lose their mobile phones in crowded places such as at weekly or

monthly markets, or after encountering thieves. Due to their low incomes, when

individuals lose their mobile phones, most cannot afford to buy a new device

immediately. Moreover, even after they purchase new mobile phones, some of them tend

to purchase new phone numbers as well instead of renewing the old one. It is likely that

losing of phones and purchasing of new mobile phone chips (SIM cards) reduced the

chances of ensuring that all the environmental messages were delivered to all the

participants.

Illiteracy and limited skills in technology use. Despite the rapid adoption of mobile

phones in Africa, many people above the age of 18 are non-literate; this is especially true

among rural populations. As my data show, 70% of women and 50% of men from the

mobile phone treatment group had never attended primary school. Illiteracy limits the

extent to which people can use mobile devices; non-literate individuals tend to use

mobile phones for voice calling rather than for texting. While, it was possible for

participants to ask their family members or friends to read the messages for them, this might have happened only if they perceived the information sent to them was important or if they perceived any benefits that could be gained by reading. As findings show, of all the people who reported having received environmental text messages, almost everyone read for themselves. This suggests that most people who did not read the messages were likely to be non-literate.

Unreliable mobile phone network. While it is true that mobile network coverage across the world has rapidly increased in the last decade (Pew Research Center, 2015), the coverage is still sparse in many rural parts of developing countries. Out of the three villages that received environmental education via mobile phones, only one had full network coverage. In the two other treatment group villages, the network was available sparsely in specific locations. While it was agreed that the messages would be sent on particular times and days, so that people could easily access the messages when they went to the weekly market where the network was available, it is possible that not every participant went to the market every week; these individuals were less likely to access all the environmental education messages. Moreover, it is possible that some messages were never delivered whenever the phone owner did not access the network for seven days.

Political issues. Political issues in the Loliondo area are numerous due to various natural resource conflicts between local people and investors or the government. Political issues were observed during the baseline study, but were only heightened in the post-test study due to election campaigns. At one point during the baseline study, we were almost denied access to the household roster in one village because "they've been told not to give out

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any of their names as they may be used against them to show that they agreed to something."[74] This issue was easily resolved after clarifying that we needed names only for preparing sampling frames and we would not include them in any report. The village leaders understood and gave us permission to continue with our research plans.

The final phase of my study coincided with the country's primary election campaigns. Some political leaders in the study area who were campaigning for various positions tried to deny us from continuing with final data collection due to unfounded reasons. In one village, political leaders convinced villagers that my research process was not transparent enough—that the messages sent via their mobile phones had hidden intentions and that the FZS, the funding organization, wanted to confiscate their forest. This claim had no logic in it because leaders who made these allegations were present when the project was first initiated in 2013 and during implementation of the environmental education program in 2015. Moreover, we (the author and assistants) clearly described all phases of the study to the village council, village elders, and other representative village members. These arguments were due to anticipated political gains; these leaders must have reasoned that if they convinced their people that they can protect them from invaders of their land, then they would be elected in the coming elections. It is possible, therefore, that worry expressed by the village leaders prevented some participants from paying attention to the environmental education messages. The document in Appendix B presents unfounded allegations made by the then

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74 As discussed in the context section, some local NGOs were suspected of fueling distrust among local people (specifically among the Maasai in the Enguserosambu Ward) against national or international NGOs whose work did not seem to align well with theirs.

Enguserosambu ward councillor in collaboration with some village leaders and the ECF board of trustees.

Text message character limit. Mobile phones have a character limit of 160. This implies that beyond 160 characters, a message cannot be sent as a single text; instead, it is broken down into chunks and sent as multiple texts. This may have been a challenge in villages with unreliable networks and with non-literate populations because some messages comprised about 320 characters, and thus were received by participants as two separate texts. Since some environmental messages could be sent only in two chunks, it was possible that some individuals in villages with poor network received only the first part for those few longer messages; consequently, they may have failed to understand the information. This may have been the case especially for non-literate participants. Some experts from the marketing field have suggested that due to the character limit, when SMS is used to implement any campaign, it should be supplemented with other media (Dickinger et al., 2004). This was not the case, however; mobile phone texting was implemented on its own because I wanted to understand its effectiveness in knowledge transfer among the Loliondo people, and thus I did not implement additional strategies which could have led to confounding of the findings. Also, marketing experts suggest that the message be very short and concise; however, I decided that very short messages would have not made much sense in my experiment. Longer descriptive messages were preferred to ensure that the messages were as close to the information received in the group discussion treatment, so that the two groups are comparable.

Conclusion. Based on the findings presented, the EE program contributed to improved

environmental knowledge and attitudes, but this mainly occurred in the group discussion treatment. The increase observed in the mobile phone texting group was much lower compared to the group discussion. As discussed above, various factors may have impeded the success of the mobile phone texting messaging strategy, including limited mobile phone ownership, unreliable mobile network, high illiteracy and limited skills in technology use, and the political climate at the time of the experiment and the post-test study. Despite the improvement in knowledge and attitudes in the group discussion villages, individuals in the treatment and the control groups equally reported every EFB they engaged in. Low engagement in EFBs may be due to cultural and socioeconomic factors which may act as barriers. Nevertheless, these findings show the importance of an environmental education project on managing forest resources. The findings also reveal the need for more funding to ensure that EE programs are implemented more rigorously.

Study limitations. While this study provides some insights into the impact of The environmental education project on knowledge, attitudes, and engagement in environmentally friendly behaviors, there were some data limitations that beg the readers' caution when interpreting findings. Limitations that relate to data include relatively smaller sample size, open-endedness of survey questions, and self-reported behaviors.

Due to budget constraints, the sample included only 30 households from each village, although there were multiple individuals from each of the selected households. While the aim was to have equal samples from each village, it also meant highly populated villages were less represented. Also, while a sample size of 417 was enough for some analyses, it was a limitation for others. The sample size was a limitation in

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terms both of representation (in some villages) and of types of analysis that could be performed on the sample to draw generalizable conclusions. For example, running logits on individual behaviors were impossible as much fewer people reported having engaged in individual attributes of behavior—logits require much larger sample sizes. As argued by Long (1997), "it is risky to use ML with samples smaller than 100, while samples over 500 seem adequate," and that "these values should be raised depending on characteristics of the model and the data" (54).[75] Due to the relatively smaller sample size, it was also challenging to run fixed-effects models at the village level, specifically on the individual component attributes of the behavior construct. Moreover, it was impossible to disaggregate data by various demographic factors for individual component attributes that were reported only a few times. Future research should thus consider including more households in the sample (and oversample more populated villages) to obtain a more representative sample of the study area and to allow for complex analyses.

The second data limitation is that this study relies on self-reported behaviors. It was possible that some individuals reported certain behaviors only to impress the researcher or to conform to socially desirable behaviors, as it may be considered shameful for one not to engage in behaviors viewed as "preferred behaviors" or those perceived as norms. This has been found to be the case in some contexts (Stern & Oskamp, 1987, as cited in Kormos & Gifford, 2014; 1987; Tarrant & Cordell, 1997), although Milfront (2009) observes that social desirability had a weak direct effect on

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75 ML is the Maximum Likelihood estimator used in the logistic models to estimate the coefficients or the odds ratios of the independent variables.

environmental attitudes and no effect on self-reported behaviors ecological behavior. With time and money, this limitation could be overcome by conducting prolonged field observations to physically monitor forest-related community behaviors and triangulate findings from this method with survey responses. Eckman (2013) proposes that observing individual efforts for longer periods of time (e.g., using methods such as participant observation) might provide a better understanding of the extent to which participants adopted new behaviors or enforced desirable behaviors and rules and regulations. Behaviors to monitor might include visiting different parts of the forest to determine types of destructive activities carried out in the forest and what groups of people are responsible (male/female or villagers/outsiders). Additionally, performing physical examination of land use changes between two periods, before and after the EE project completion, may help determine if the knowledge acquired was translated into actions, and whether desired behaviors diffused to other groups of people in the community (i.e., individuals who did not participate in the EE project). Physical examination of land use changes should be conducted preferably a few years after project completion to be able to detect any changes (improvement or decline) in land cover. Nevertheless, the significant difference observed between the control group and the group-discussion treatment group provide enough evidence that the EE project contributed to improved environmental knowledge and attitudes.

Another data-related limitation concerns the nature of the questions. Open-ended questions meant that individuals could report only as many attributes as they could recall during the interview. The number of component variables reported by participants

depended on various factors, including the patience of the survey administrator (the more the interviewer prompted for more answers, the more attributes were recorded), the ability of the participant to recall what they already knew or learned (whether or not the survey administrator was patient), and whether the respondent had enough time to respond to the questionnaire. In this case, it was assumed that the shorter the time the respondent had, the fewer responses they provided. While open-ended questions provided conservative findings, it also meant that there may have been knowledge or attitude attributes that were not reported even when the participant was knowledgeable about it or had a positive attitude toward that behavior. This was, however, not expected to lead to biased responses because each component variable was assumed to have had an equal chance of being reported; thus, one variable could be reported by one respondent while another variable could be reported by another respondent; eventually most known attributes or practiced behaviors would be reported more. I am thus confident that this study provides conservative estimates of how knowledge, attitudes, and personal responsibility are positively related to more engagement in environmentally friendly behaviors in the three wards of the Ngorongoro district. To overcome this challenge, future studies might consider using a carefully designed closed-ended questionnaire instead or simply ensuring that enumerators understand the need for being patient during interviews.

Another data constraint relates to the fact that local politics in the area interfered with this study. While my position as a non-native student affiliated with FZS might have played as a disadvantage in the study area (as discussed above), I believe that local

politics surfaced during the onset of the post-test study because of the ongoing election campaigns were due to issues of distrust and fear (Nkhoma, 2015). As discussed in previous chapters, the politics were only heightened during the post-test study. Consequently, some participants from the Maasai majority villages dropped out of the study before the post-test study was conducted, leading to a much higher attrition rate than anticipated. Also, participants from Maasai villages were less willing to talk during the post-test study (compared to the pre-test study); thus, some variables that were highly reported in the pre-test were less reported in the post-test. Addressing this challenge in the future would require paying attention to the local politics and ensure that this type of study is conducted at a time when chances of awakening such conflicts are minimal. Future studies may also implement a similar study in a less politicized environment to get more cooperation from participants and community leaders to avoid responses from being confounded with politics.

Finally, while there are many behaviors an individual can engage in to help sustain the forest, it may be challenging to assess all the possible behaviors as done here; promoting and assessing one or a few behaviors may lead to greater effectiveness in implementation of the training as well as in assessing its outcomes and impacts at later times.

6. A Mixed Methods Approach to Understanding the Impact of Participatory Photo-Mapping on Knowledge about Health Status of a Local Forest in Northern Tanzania

6.1. Introduction

In this chapter, I address the third research question, "*What is the impact of participation in participatory photo-mapping (PPM) on the Loliondo people's perception about health conditions of the ECF?*" This question is answered by doing two types of analysis: quantitative data from a survey questionnaire and analysis of satellite imagery using GIS and remote sensing techniques. I compare survey responses with land use and land cover results obtained from GIS analysis and determine whether participation in PPM had any impact on participants' understanding of forest health conditions.

Participatory photo-mapping is a participation-based development tool initiated in the early 2000s. It was first reported by Müller and Wode in 2002 in their Vietnam trainer guide titled "Manual on Participatory Village Mapping Using Photomaps" Müller and Wode (2002) defined participatory photo-mapping (PPM) as the process that engages local community members in identifying earth features on an aerial or satellite photo. The idea is similar to other forms of GIS-based participatory mapping processes such as the 3-D landscape modelling described in Di Gessa, Poole, and Bending (2008) and Rambaldi, Muchemi, Crawhall, and Monaci (2007). The idea of mapping earth features using satellite or aerial photos in collaboration with local communities is linked to participatory mapping in which rural people use the ground, floor, or paper to map social, demographic, health, and natural resources (Chambers, 1994). The participatory photo-

mapping procedure uses photo maps, which are basically printouts of geometrically corrected (rectified) aerial/satellite photographs placed in a map coordinate system (Müller & Wode, 2002).

Müller and Wode (2002) point out that while the purpose of participatory photo-mapping is to identify land features in areas of interest, discussion of other related aspects may be introduced. The discussion may include causes of the current state of the land and how it has changed over time. Participatory photo-mapping can thus allow identification of environmental problems as well as create a common understanding about the spatial distribution and status of natural resources among local people. Additionally, as with the traditional participatory approach, participatory photo-mapping can provide a starting point for participatory problem analysis as well as future land use planning. Similarly, Di Gessa et al. (2008) and Rambaldi et al. (2007) concur with this idea by arguing that photo-mapping can lead to increased understanding of space, aid in knowledge transfer among local people, and improve natural resources management. In this study, the purpose of engaging participants in marking earth features found inside the Enguserosambu Community Forest was to increase understanding about the health conditions of a local forest among local people. It was expected that increased understanding of the forest condition by a wide range of local people (i.e., not just leaders) would stimulate them to take more conservation measures, especially at the village level, to ensure that the forest is utilized in a sustainable manner. The use of photo-mapping for educational purposes is relatively new; at the time of this study, it had never been employed among people in the Loliondo Division of Tanzania. Moreover,

unlike studies that used photo-mapping for land-use planning purposes, this study

exclusively used photo-mapping for increasing local understanding about forest health

conditions.

Participatory mapping applications. Participatory mapping (e.g., Participatory Rural

Appraisal) as a development tool has been used widely since the late 1980s. Participatory

mapping was a useful tool because it allowed for better exchange of information between

communities and outsiders (e.g., researcher, government, or donor) during the design and

implementation of development projects (Di Gessa et al., 2008). Today, participatory

mapping can be used to "help secure access to land and natural resources, to facilitate the

management of these resources and to support community advocacy on land-related

issues" (Di Gessa et al., 2008). Di Gessa et al. add that "mapping is increasingly playing

a role in the empowerment of people and communities" (p. 1).

Various methodologies and technologies have been employed in participatory

mapping, including sketch mapping, which is based on observations rather than actual

measurements of earth features of an area. Sketch mapping has long been used in

Participatory Rural Appraisals, but it is limited in that it lacks a map scale. The resulting

map cannot, therefore, be georeferenced for further use. Other methods are more current

and utilize GIS and remote sensing technologies. For example, GPS-based Field Mapping

is a simple method which allows teams of local people to map local knowledge and

resources over their territories. Another method, the 3-D landscape modelling, uses large-

scale 3-D physical maps; this has been used to engage communities in mapping their

traditional lands. Mapped 3-Ds can later be converted to digital maps. The image map,

also referred to as a photomap, utilizes satellite imagery or aerial photos to engage communities in mapping their land. Other participatory methods and technologies for mapping are described in Di Gessa et al. (2008).

As proposed by Di Gessa et al. (2008), mapping can be applied to fulfill various purposes, including, facilitating community cohesion and collective action, helping resolve land issues and expedite land rights registrations, helping improve land-use planning and management, and forming a basis for planning of territories and the integration of socioeconomic activities. When people acquire more understanding about the history of their land and what it comprises, they are equipped with information necessary for claiming not only their territory but also for demanding justice over their land and resources. As stated in Di Gessa et al. (2008), rural maps have proved to increase "user's capacity to advocate, lobby, plan, manage and monitor territorial and land–related issues within the mapped area" (p. 10).

While the main purpose of implementing participatory photo-mapping is to assist in land use planning (Muller & Wode, 2002; Mundia, 2016), local people may perceive other purposes as well. In the case of the Ogiek people in Kenya, participants perceived the photo-mapping process as a way for not only marking out their territory physically and culturally but also as a convenient method for knowledge transfer from the older generation to the younger generation. As stated by Rambaldi et al. (2007) in the lessons learned, "for the Ogiek people, the priority purpose of the exercise was to transfer knowledge and hopefully wisdom and values from the oldest generation to the youngest" (p. 123). They further add that "the 3D map-making proved to be an excellent process for

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allowing people of all ages to engage with their landscape and heritage in an inspiring

and motivating collegial environment" (p. 11). Similarly, the photo-mapping activity

reported here aimed to allow knowledge transfer from knowledgeable individuals to

those less knowledgeable, with the expectation that more familiarity with forest

conditions would lead to increased efforts in protecting the local forest.

Why employ photo-mapping in learning about forest in Loliondo? Dunn (2002)

recommends that when designing teaching and learning activities, we need to consider

principles of learning and that we need to "think about individual differences among

learners and to work towards including activities that have variety and interest for all the

learners in educational programs" (p. 3). Implementation of participatory photo-mapping

imitated documented successes of learning strategies that utilize visual senses in learning.

Scholars assert that knowledge transfer through visual tools is a powerful way to enhance

learning among individuals, children and adults alike. As stated by Dunn, "By

stimulating the senses, especially the visual senses, learning can be enhanced". Laird's

(1985) analysis of research that tested various ways of learning found that most (75%) of

knowledge held by adults is learned through seeing compared to only about 13% of

knowledge gained through hearing. In the sensory stimulation theory, Laird (1985)

acknowledges that learning is more effective if multiple senses are stimulated, and thus

the use of multiple techniques and media should be encouraged. In this study, the use of

the photo-map and discussions of the changes aimed at stimulating both the visual and

hearing senses, with the expectation that maximum learning about the forest conditions

would happen among participants.

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Can politics interfere with results in environmental projects? Political interests can interfere with natural resources management projects when local people choose to provide answers that align with their political goals rather than with conservation goals. In the current natural resources management paradigm, communities are being integrated in various natural resource management activities, including in monitoring activities that aim to ensure that natural resource management projects are yielding the expected impacts, such as reduction in illegal killing of wildlife or timber extraction. While the involvement of communities is desirable because it creates a sense of ownership of natural resources, it is challenged by various factors, including local people's inability to perform skilled work and lack of trust among community members which sometimes can lead to corruption. These factors often lead to misreporting of observed activities and thus incorrect records. As demonstrated by Nielsen and Lund (2012), numbers of wildlife reported by locally-based monitoring systems, for example, contradicted physical observations of wildlife and observed human disturbances. Village natural resources councils seemed to report information about wildlife that aligned well with conservation objectives, so that higher authorities can perceive them as capable of managing and monitoring wildlife trends successfully. Due to the observed contradictions, Nielsen and Lund caution that information produced under the locally based monitoring system should be taken as complementary methods because they may be "shaped by the incentives and power struggles surrounding the particular context within which the system is based and therefore cannot be taken at face value" (p. 1). Instead, scholars propose that locally-based monitoring systems should be supplemented with reliable methods such as remote

sensing to help develop social capital, enhance the local ownership of natural resources management efforts and contribute to local accountability, transparency, and benefit sharing (Danielsen et al., 2011; Skutsch, Van Laake, Zahabu, Karky, & Phartiyal, 2009).

In this study, I assessed whether local people who participated in a participatory photo-mapping process better understood the health status of a local forest, the Enguserosambu Community Forest (ECF), compared to individuals in the control group. I hypothesized a positive relationship between participation in PPM and correct perception of forest conditions. For triangulation purposes, and considering the possibility that study participants might provide biased answers, I assessed the reliability of the responses by analyzing participants' qualitative responses and change in land use land cover results.

6.2. Methodology

In this section, I describe the procedures employed in participatory photo-mapping, including how satellite imagery data were acquired, how photo-maps were prepared using ArcGIS, and how these were used for knowledge transfer among participants. The second part of this section describes how the satellite imagery used for land use and cover classification were acquired, pre-processed and analyzed, and how accuracy assessment was performed for quality control. Finally, I describe survey data used and how they were analyzed.

6.2.1. The participatory photo-mapping (PPM) experiment

The experiment involved participants marking geographic features on a satellite photo-

map. To ensure uniformity in implementation of the intervention, I created procedural guidelines and trained three facilitators. To determine feasibility of the experiment, I first tested the experiment in a nearby community that had participants similar to those in my study villages. The pilot village was located far enough from the study villages to avoid confounding of findings. Since the intervention was planned to be implemented by field researchers from the Frankfurt Zoological Society (FZS), the funding organization, I trained them on all aspects of the experiment. The field researchers were native speakers of local languages and were fluent in English. Training involved discussing the intervention process as described in the guidelines as well as providing explanations of relevant concepts. I first demonstrated the implementation procedures by acting as the facilitator while the trainees served as my participants. The field researchers practiced facilitation of the whole participatory photo-mapping process under my observation. This process ensured visual learning for the FZS trainees, thus ensuring effective comprehension (Schnotz, 2002). Implementation of the pilot was carried out by FZS researchers while I observed and occasionally prompted. At the end of the pilot, we discussed areas for improvement and how to resolve issues that might arise during the process. I also revised the intervention guidelines accordingly with inputs from FZS researchers.

Satellite imagery acquisition and photomap preparation. I acquired one-meter spatial resolution satellite images that covered the ECF and a few surrounding areas through an

application to DigitalGlobe. The image strips[76] used to create photo-maps were acquired at different times (between 2001 and 2014). As a result, some land cover changes that had taken place between the two periods were not visible on the images. Nevertheless, these images were still suitable for the experiment because participants used their knowledge of the forest landscape to discuss any changes and their causes. Even in areas where forest clearance was not visible, other participants could identify the changes. Participants who were more knowledgeable about where the changes had taken place shared their knowledge with those who were less knowledgeable.

To create a photo-map of the Enguerosambu Community Forest, I clipped two of the three tiles[77] format images such that there was little overlap with the third image. I was not using the one-meter resolution images for analysis, so I did not need to mosaic them. The purpose of clipping the images was to reduce the size of the images, and thus improve processing speed in ArcGIS software. Apart from understanding participants' knowledge about forest cover changes, I was interested in understanding whether participants also knew the location of official boundaries of the forest as this is one of the basic requirements for natural resources management. I then overlaid the satellite tile imagery with a vector file of the official boundaries[78] of the ECF and ensured that its lines were very thin and faint such that participants could hardly see them. Making the

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76 In remote sensing, a strip is an area of a specific width and length on the earth that is imaged by a remote sensing scanner system.

77 In remote sensing, a tile is a collection of image files of a specific location. A number of satellite images are mosaicked to cover a certain size of an area.

78 The official boundaries of the ECF (officially known as the Loliondo II Forest Catchment Reserve) were marked by the Ministry of Natural Resources in 2011.

vector boundaries less visible was intended to help participants freely mark the forest

boundaries according to their understanding without fearing that they would be reported

to authorities. It was also used to understand whether the boundaries they perceived

aligned with official boundaries. I exported the map to pdf on 110 inch by 85 inch paper

and printed two copies on two tiles[79] each, such that one tile was about 55 inches wide

and 43 inches long. This ensured that the sizes were manageable during transportation on

airplanes. All tiles were laminated so that they would withstand footsteps and all weather;

thus, they could then be used by all groups that engaged in the participatory photo-

mapping process.

Participatory photo-mapping process. Participants from three participatory photo-mapping

treatment villages participated in marking forest boundaries and other geographic

features. In each village, participants were divided in groups of up to 12 individuals. To

ensure maximum attendance of study participants from the treatment group, I divided

them such that meeting places were convenient for them, using household GPS

coordinates to identify their locations. Participants from each group agreed on times and

places for meetings for the participatory photo-mapping activities. For the Maasai ethnic

group, men and women were assigned to separate groups to allow women to voice their

opinions, as they often fail to do so in the presence of men. This was not feasible for all

cases, however; some groups were comprised of both genders. Two groups participated

in the participatory photo-mapping process each day, one male group and one female

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79 A tile here is understood from a photography perspective since a map was printed as a photo. A tile is thus a portion of
the photo-map. Since the maps were very large, they had to be split into half (tiles) to be able to fit in overhead lockers
of aircrafts.

group. A total of 12 group discussions were held for the three villages.

As shown in Figure 6.1, each group was presented with a photo-map showing the Enguserosambu Community Forest plus some of its surrounding areas and were asked to separately mark geographic features of interest on the map. The groups started by first marking boundaries of the forest and finished by marking agricultural fields and/or houses, water springs/dams/rivers, roads, and other cleared areas that existed inside the forest. Participants were also asked to reflect on what the forest looked like 10-15 years ago compared to conditions at the time of the PPM, and to cross out any houses/agricultural fields that did not exist 10-15 years ago or water sources that existed 10-15 years ago, but no longer exist. Additionally, each group discussed causes of forest-cover changes observed on the photo-map. The purpose of crossing out any geographic features that either existed at the time of the experiment but did not exist before or those that existed previously but no longer exist was to help less knowledgeable individuals understand better how much the forest had changed between the two time periods (2000 and 2015).

After each pair of groups had completed marking all the features, they met and discussed the two marked maps to correct any wrongly marked areas based on consensus. The purpose of meeting and discussing the two marked maps was to again increase

Figure 6.1. Participatory Photo-Mapping in progress

Source: Author's photo, March 15, 2015

6.2.2. Land use land cover change: Data and analysis

The overall objective of imagery analysis was to determine land use land cover

classes found in the ECF and determine whether they changed during the past 10-15

years. I used both Erdas Imagine and ArcGIS 10.3.1 software to perform the analysis.

The process is described below.

Data acquisition and quality assessments. I acquired two separate Landsat 7 imageries for

each sample year (2003 and 2014) from the USGS earth explorer website.[80] Also, the

time difference coincided well with the time frame used in the survey question since

results for the PPM analysis were being compared to survey findings. The two images for

2003 were collected on February 4th and March 8th; the 2014 images were collected on

February 26th and June 2nd. All the images had seven bands.[81]

The images were already projected using "WGS_1984_UTM_Zone_36N", so I

did not need to do any Georeferencing. Additionally, I examined the images in Erdas

Imagine software to check for radiometric issues such as line or column drop-outs by

looking at image statistics such as minimum, maximum, and mean brightness values.

From the statistics, I did not notice any radiometric issues, and thus I did not perform any

radiometric corrections. The forest portion of the imagery did not have any haze or cloud

cover. I also acquired Global Positioning System (GPS) coordinates of the official

boundaries of the ECF from the Forest Division of the Ministry of Natural Resources and

Tourism of Tanzania. The GPS coordinates were essential for creating a vector boundary

file of the forest. Other data included one-meter resolution imagery from the

DigitalGlobe, and the Google Earth online imagery; these images were used as reference

data.

Preprocessing of Landsat data. Preprocessing involved three steps; first, using a layer

stack tool in Erdas Imagine, I combined the two images from the same years to get

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80 Both 2003 and 2014 Landsat 7 images were the most appropriate years for my study area because they had negligible
   atmospheric effects such as cloud cover in comparison to more recent images acquired by sensors such as Landsat 8.

81 A band is a "wavelength interval in the electromagnetic spectrum. For example, in Landsat images the bands
   designate specific wavelength intervals at which images are acquired." – See
   http://www.ldeo.columbia.edu/res/fac/rsvlab/glossary.html

composite images; the resultant composite images had a total of 14 layers (2 images x 7 bands). Combining two images collected at two different times of the year was important for increasing contrast between earth features since the spectral radiometric characteristics of earth features vary with time of year. Second, I clipped out the ECF using the vector boundary file of the forest. Third, using the stacked image tool, I transformed the image into nine principal components. The purpose for transforming the image into principal components was to reduce the number of layers while maintaining the original data, as well as to maximize spectral radiometric differences between spectral classes (i.e., between earth features or land cover classes).

Classification and accuracy assessment. To ensure accurate classification, I employed a Supervised Classification technique on both the 2003 and the 2014 images. Using Google Earth and high-resolution imagery from DigitalGlobe as reference data, I created 20 training polygons for each class and ran the supervised classification using a maximum likelihood algorithm. Due to the small sizes of houses (*bomas*), homes being spread out, and farms often located close to people's homes, I assigned residential and cropland into one class. Other classes delineated included: dense forest, shrubland and grasses. Because the size of the imagery was relatively small (only 78 square kilometers), after running the supervised classification tool, I manually reclassified some cells to ensure the classes were more accurate.

To assess whether the results observed were reliable, I performed "visual" accuracy assessment on the classified imagery. The main reason for not following the traditional way of accuracy assessment—i.e., using high accuracy images collected

within the same year as the imagery being analyzed was collected, use of statistical

methods for sample size determination, and use of an error matrix to present results—was

unavailability of high resolution images and reliable thematic maps for the Loliondo area

at the time of this analysis. Visual interpretation of the features using google earth images

as reference data was key to accurate assignment of classified features. Image

interpretation was made easy by the fact that I had visited the study area multiple times

before performing land cover analysis.

Land use land cover change detection. Following classification of the 2003 and 2014

images, I used the field calculator tool in ArcMap to generate the number of pixels for

each land cover class and determined the equivalent proportions. The land cover

categories of 2003 were subtracted from those of 2015 to determine how much each class

had changed between the two periods. The proportion of each class and land cover

changes is recorded in Table 6.1 below.

**Table 6.1. The Enguserosambu Community Forest's land-cover percentage change
between 2003 and 2014**

| Land Cover Class | 2003 | | 2014 | | % change | |
	Pixel Count	%	Pixel Count	%	Pixel Count	%
Cropland or residential	312	0.36	1309	1.48	997	1.12
Dense Forest	46312	52.94	34745	39.23	-11567	-13.71
Grassland	19880	22.72	14828	16.74	-5052	-5.98
Shrubland	20984	23.99	37692	42.55	16708	18.57

6.2.3. Survey data and analysis

Participants from all eight villages[82] were surveyed before and after the
participatory photo-mapping experiment in 2013 and 2015 respectively. To understand if
people in the Loliondo area know to what extent Enguserosambu Community Forest had
degraded or declined, they were asked *"When you compare the current conditions of the
Loliondo II (Enguserosambu) forest to 10-15 years ago, do you think it has improved,
stayed the same, or gotten worse?"* Individuals could say whether they thought the forest
had been the same, declined, or improved over the past 10-15 years. The answers to this
question were compared for the two study periods (before and after participatory photo-
mapping experiment), for both the control and treatment groups to determine whether
there was improved understanding about the forest conditions after participating in
participatory photo-mapping activity. Also, the answers to this question were compared
with results obtained from land use land cover analysis, to determine whether local
people had a correct understanding of the health status of their forest. Survey findings
were compared with those from land use land cover analysis because analysis of satellite
imagery provided more accurate results of the forest cover change.

Other questions that helped understand whether participants' knowledge increased
after participating in participatory photo-mapping are *"Did participating in marking earth
features on Loliondo II forest map improve your understanding of the Loliondo II forest"*
and *"If understanding improved: Ask; which knowledge increased."* Qualitative answers
to these questions were critical for understanding what types of knowledge were gained

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82 Three of the eight villages were from the participatory photo-mapping group while five were control villages for this
particular question. Mobile phone villages acted as control villages for this question.

by participating in participatory photo-mapping and whether the type of knowledge gained was valuable to management of the Enguserosambu Community Forest.

The post-test study was planned such that there was a waiting period of at least three months after implementation of the participatory photo-mapping experiment. While most environmental studies have conducted post-test surveys immediately after intervention implementation (see Knapp & Poff, 2001; Legault & Pelletier, 2000), others have measured long-term effects (see Farmer, Knapp, & Benton, 2007; Kuhar et al. 2010). Literature in health studies show a waiting period of 3-6 months for studies that involved behavior change, although the environmental literature is inconclusive about timing of post-intervention studies. Eckman (2013) suggests a waiting period of two years for projects that involve natural resources-related behavior change. This waiting period is long enough to see effects of people's change in behaviors on outcome variables such as water quality, although landcover change detection may require a much longer waiting time, specifically if a researcher uses satellite imagery with lower spatial resolution, to detect land use land cover change.

6.3. Findings

6.3.1. Treatment rate and demographic characteristics

While I aimed at ensuring that all randomly selected adults from the treatment villages participated in the participatory photo-mapping activities, not everyone was present during the experiment, either because they arrived at the meeting center late or because they had other responsibilities and thus failed to attend the meetings. Out of 114 individuals from the participatory photo-mapping treatment group, only 46% reported

that they participated in marking geographic features on the photomap. The low treatment

rate was possibly also caused by widespread *bomas;* due to long distance walks to the

center of the village, most people miss important village meetings or arrive at meetings

very late. Due to low sample size, individuals who did not participate in participatory

photo-mapping activity were treated as controls during the analysis. Participants from the

participatory photo-mapping and the control groups were largely composed of the Maasai

tribe: 95% were Maasai and only 5% other tribes.

Individuals who participated in the participatory photo-mapping activity

comprised 46% male and 54% female and their ages were between 18 and 95. The

differences in the male and female participation are mainly due to a higher proportion of

women in the general population (URT, 2013) as well as higher mobility of Maasai men

compared to Maasai women (Ojalammi, 2006). Most Maasai men who were missed

during the pre- or post-test studies had either traveled for long periods of time as they

tend to temporarily migrate to other parts of the district to graze their livestock. About

half of male respondents (51%) had never attended school, 34% had attended primary

school, and only 15% had attended secondary school or higher education. For female

respondents, 71% had never attended any form of education, 20% had attended primary

school, and only 9% had attended secondary school or higher education. While generally

the Maasai populations are less educated compared to several other tribes in Northern

Tanzania, the women are much less educated compared to men. The big difference in

educational attainment between male and female respondents is similar to what has been

observed in other studies (e. g., SFTZ, 2010). Both Grabe (2015) and Gimbo et al. (2015)

attribute lower education attainments by women from the Maasai tribe (when compared to Maasai men) to cultural barriers. Nevertheless, female children stand much lower chances of being educated whenever a family is willing to educate their children, as most of them are married off at very young ages to get the bridal price. Despite government efforts to ensure that every school-aged child is enrolled in school, there has been high resistance against the move by the pastoral Maasai because they want to maintain their culture (Gimbo, 2015). Maasai elders worry that the more educated their children are the less chance their traditions will be sustained (Sirima, 2015).

6.3.2. Knowledge about forest health conditions before and after PPM

To understand how people perceived the health conditions of the ECF, participants were asked, "*When you compare the current conditions of the Loliondo II (Enguserosambu) forest to 10-15 years ago, do you think it has improved, stayed the same, or gotten worse?*" This question was asked before and after implementation of the PPM experiment. Out of 92 participants from the treatment group who responded to this question during baseline study, 28% perceived the forest as getting better, 39% did not perceive any changes, and 32% correctly perceived the forest health conditions as declining (see Figure 6.2). The proportions in all three categories of answers did not significantly differ between the treatment and the control group during the baseline study. There was, however, a significant difference between the control and the treatment group in their reported perception of forest health conditions after implementation of the PPM, although not in the expected direction. While the percentage of participants from the control group who correctly perceived the forest health conditions as declining did not

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significantly change between the baseline and post-test study, 16% fewer participants from the treatment group correctly perceived the forest as declining (see Figure 6.3). Additionally, in the post-test study, while the percentage of participants who did not perceive any change in the forest health conditions dropped dramatically in both the treatment and the control group, that of participants who perceived the forest as improving increased significantly (see Figures 6.2 and 6.3 below).

When disaggregated by gender, the same pattern is seen. Individuals who said the forest's health condition was getting better compared to 10-15 years ago increased significantly for both male and female participants in the control and the treatment groups, although the increase is much higher among individuals who participated in the PPM. The proportion of male and female participants from the treatment group who said the forest health conditions have declined significantly dropped between pre- and post-test studies, although the decline among female participants was larger. There is a similar pattern among male participants in the control group, but no change among female participants in this group. A significant decline in proportion was also observed for those who said the forest health status has remained the same between the two time periods among both genders and in both the treatment and the control groups (see Table 6.2). It appears that individuals who initially perceived the forest as the same or declining later reported that the forest health was getting better. This was contrary to what was hypothesized, as it was expected that participation in the PPM activity would lead to better understanding of previous and current conditions of the forest, and thus more people in Loliondo would correctly perceive the forest health conditions as declining

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compared to 10-15 years ago. I believe that politics may have influenced findings in the

particular question answered in this paper. I discuss further possible reasons to

unexpected findings in the discussion section.

Figure 6.2. Pre-test perceptions toward forest health status (n=205)
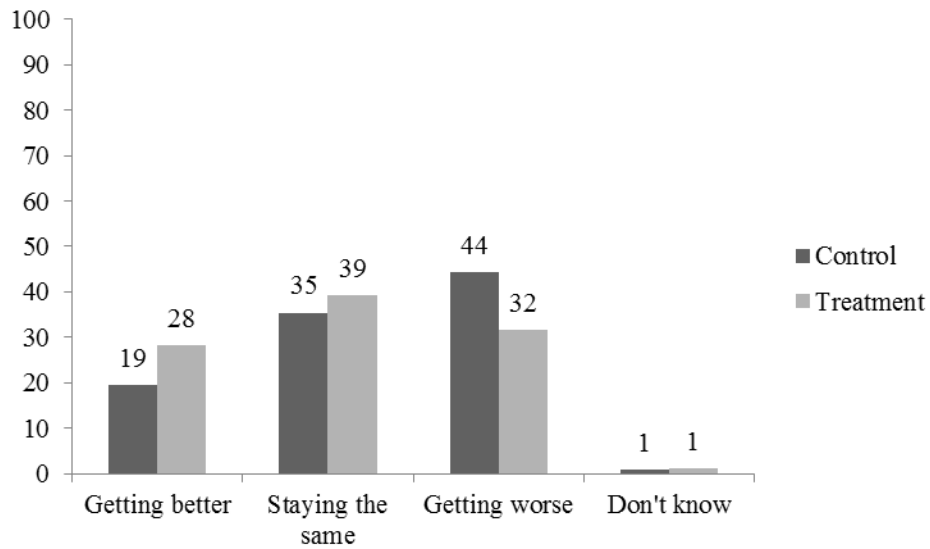
Figure 6.3. Post-test perceptions toward forest health status (n=197)
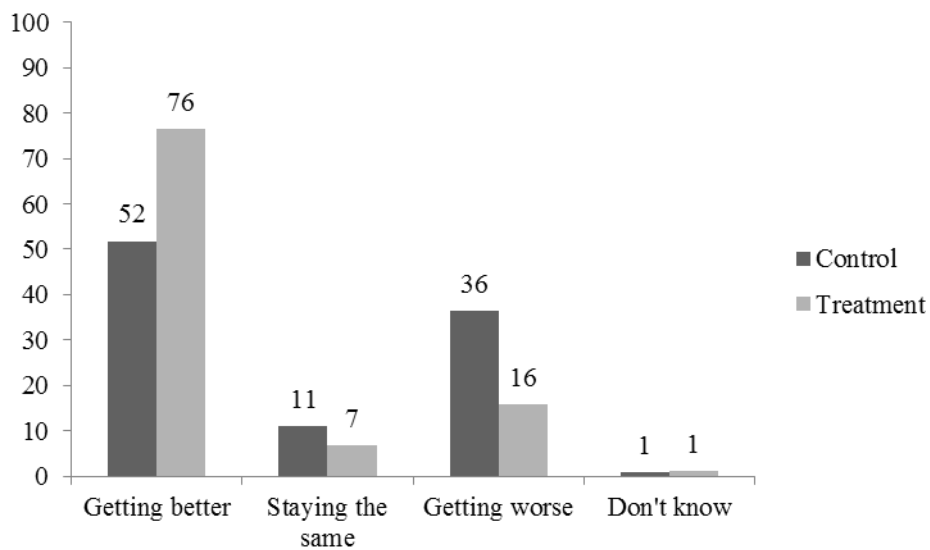
Table 6.2. Pre- and post-test proportion of participants who reported their perceptions toward forest health conditions disaggregated by gender

| | Pre-test data | | | |
| | Male (n = 93) | | Female (n = 112) | |
Perceptions	Control	Treatment	Control	Treatment
Getting better	18.87	32.50	20.00	25.00
Staying the same	24.53	35.00	45.00	42.31
Getting worse	56.60	32.50	33.33	30.77
Don't know	0.00	0.00	1.67	1.92

| | Post-test data | | | |
| | Male (n = 89) | | Female (n = 108) | |
Perceptions	Control	Treatment	Control	Treatment
Getting better	54.17	75.61	49.18	76.60
Staying the same	6.25	2.44	14.75	10.64
Getting worse	39.58	21.95	34.43	10.64
Don't know	0.00	0.00	1.64	2.13

6.3.3. Evidence for improved knowledge about forest health conditions after participation in the PPM activity

While participants' knowledge about forest health conditions did not seem to have improved as a result of participation in the PPM activity, other questions revealed that most participants gained a better understanding about the status of the forest. For example, out of 68 participants who confirmed that they participated in marking geographic features, more than half of them said that their understanding of the forest increased. The reported types of understanding gained include increased knowledge about boundaries of the forest (80%), location of fields and houses inside the forest (52%), location of water springs and rivers inside the forest (60%), and location of roads inside the forest (22%) (see Figure 6.4 below). Moreover, a zoomed portion of the labeled photo-map in Figure 6.5 below, also shows features such as agricultural fields identified by participants which did not exist 10-15 years ago. This implies that

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individuals who participated in the PPM activity became more aware of the destructive

activities that took place inside the forest (e.g., cultivation inside the forest or dried

streams) and thus were expected to correctly perceive the forest as declining when

compared to 10-15 years ago, because they learned that some farms were identified as

relatively new. While one could argue that participants might have misunderstood the

question, I have strong reason to believe their responses during the post-test were more

politicized, since the same question was asked in the pre-test study.

**Figure 6.4. Proportion of participants who reported types of new knowledge gained
through participating in the participatory photo-mapping activity (n=69)**
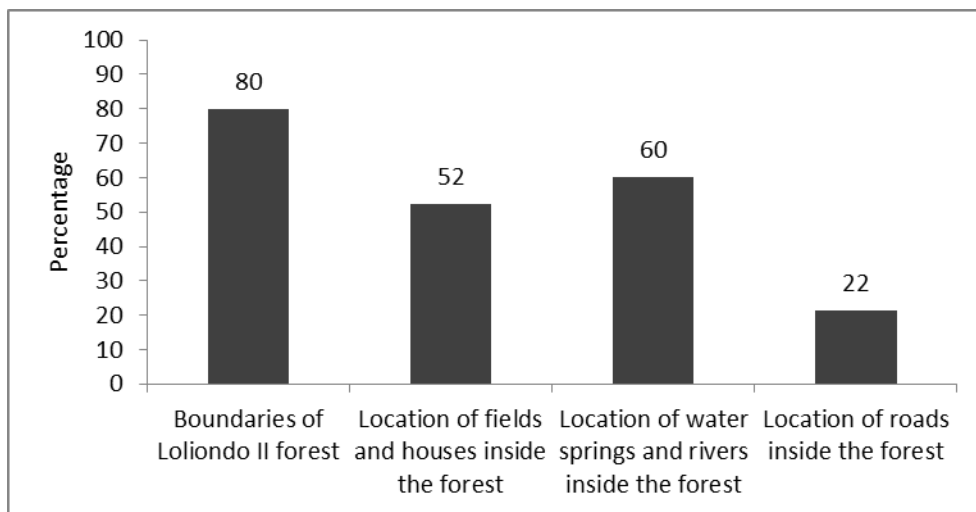
Figure 6.5. A portion of photo-map showing identified forest boundaries and other geographic features found within Enguserosambu Community Forest
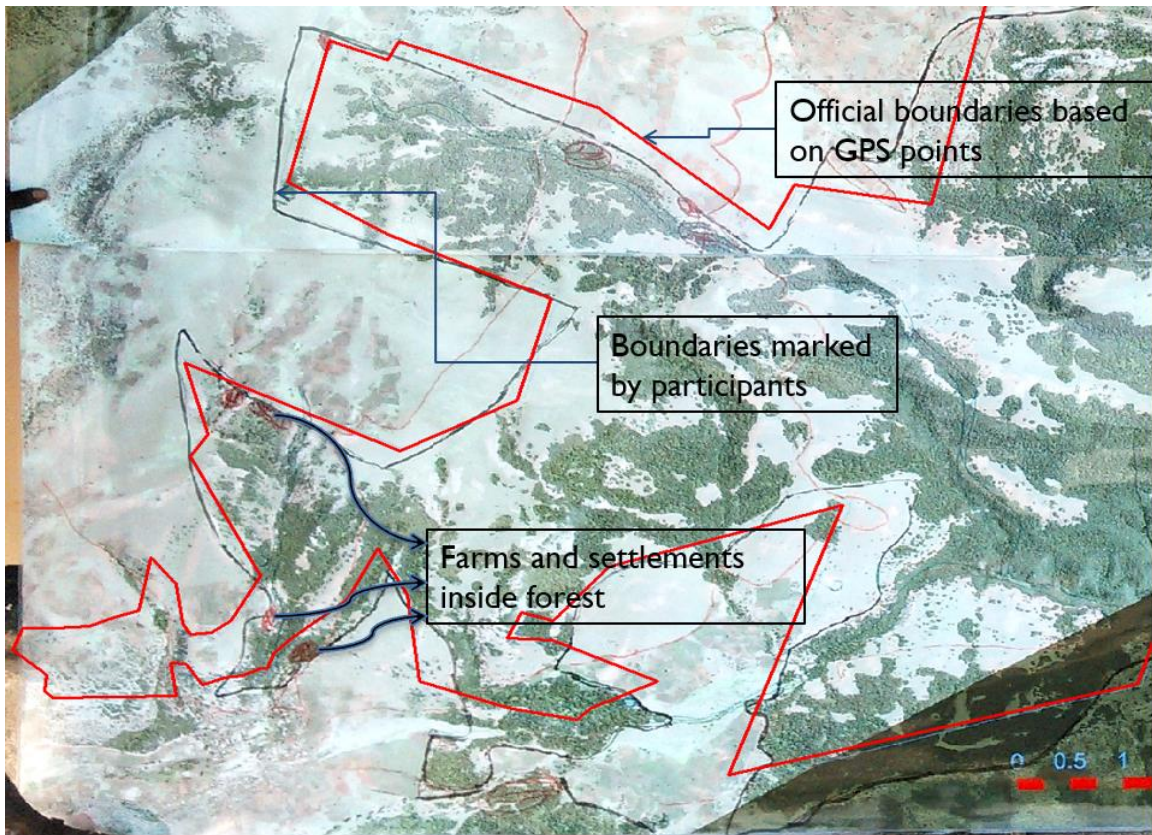
6.3.4. **Land use land cover change detection: Results from GIS analysis**

Accuracy assessment results: While some classes may have been misclassified, visually, almost all four classes seem to be accurately classified. This high accuracy of classes may have resulted because I manually corrected some classes that were initially misclassified, as the size of the area was manageable.

Land cover changes and possible contributing factors. As shown in Table 6.1 and Figure 6.6 below, the proportion of most land cover categories changed significantly between 2003 and 2014. Densely forested areas declined by almost 14%, bushes/shrubs increased by 19%, grassland declined by 6%, and crop fields and settlement areas increased by 1%.

The changes observed are not surprising and align with qualitative responses observed from survey findings. While there were already some fields inside the ECF in 2003, most were created or extended in the later years. While doing field work in Loliondo, I also observed that grassed patches and densely forested areas (not included in the analysis) were being converted to agricultural fields. When village leaders were asked informally why they let people cultivate inside the forest, they said people who engaged in such activities disobeyed them as they were aware that it is illegal to conduct such activities inside the forest. Also, some densely forested areas may have been converted to bushes/shrub-land due to high extraction of wood poles for home/cowshed construction as well as illegal logging of timber. Cultivation and tree cutting, whether illegal or legal, were expected to be the major cause of decline in the forest cover of the ECF.

Figure 6.6. The Enguserosambu Community Forest land cover: 2003 and 2014

2003   2014

Agricultural and settlement areas inside
the forest increased from 0.36% to 1.12%
between 2003 and 2014

Land Cover Classes
- Cropland or residential
- Dense forest
- Grassland
- Shrubland
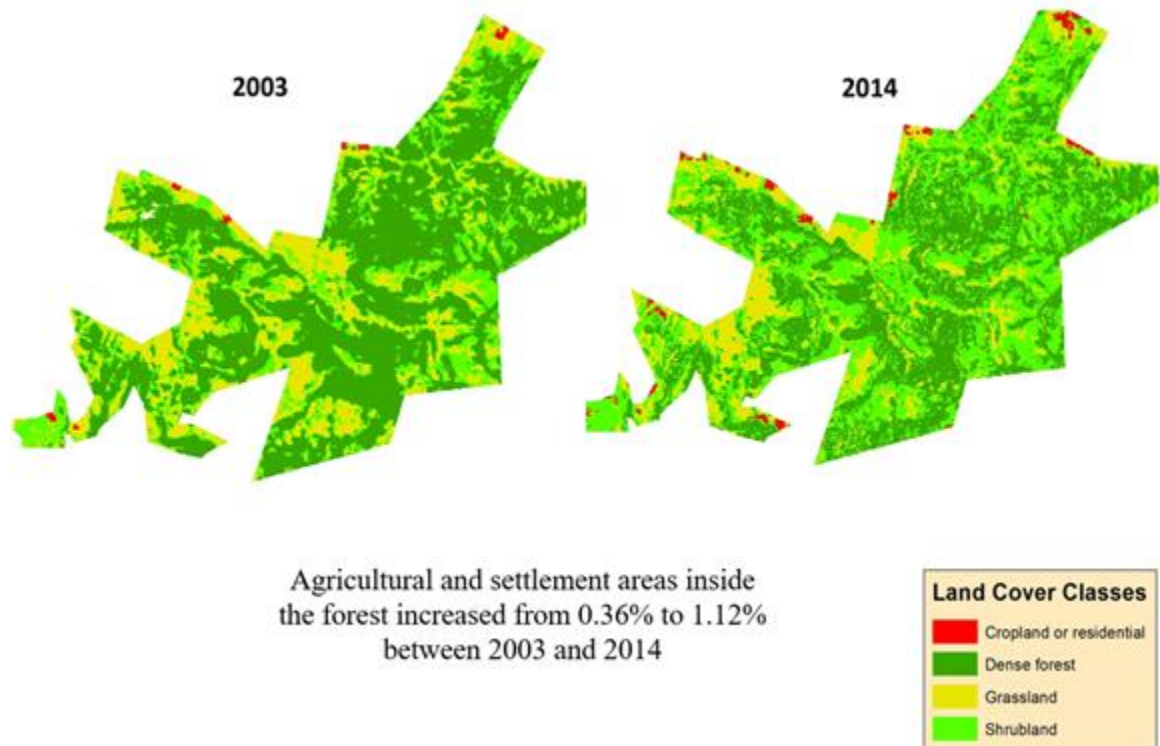
6.4. Discussion and conclusion

Implementation of participatory photo-mapping was aimed at increasing participants' understanding of health conditions of the Enguserosambu Community Forest, their local forest. I theorized that through participating in marking geographic features found inside Enguserosambu Community Forest, people would visually witness areas within the forest that have been cleared, thus they would be more aware of various destructive activities taking place in the forest and of forest cover changes that have taken place over the last 10-15 years. Individuals who participated in the PPM activity would thus have a better understanding of the health conditions of the Enguserosambu

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Community Forest and would correctly perceive the forest as declining compared to those who did not participate in the PPM activity. The results observed are contrary to what I previously hypothesized. Unexpectedly, many fewer participants in the treatment group correctly perceived the forest as declining while the percentage of participants who incorrectly perceived the forest as improving increased significantly, both in the treatment and the control groups, after implementation of the PPM. On the other hand, qualitative questions (marked in Figure 6.5 above) revealed an increase in awareness about ECF's health status. For example, individuals who participated in the PPM activity reported increased understanding of the crop fields and settlement areas found inside the forest which did not exist 10-15 years ago. Additionally, most participants in the PPM activity identified water sources that existed 10-15 years ago, but no longer exist. Identification of crop fields and settlements that did not exist 10-15 years ago and water sources that existed in the past but are not longer there provide evidence that participants do acknowledge that the forest has declined over time. This knowledge only increased after the treatment, even though this was not revealed in the health status question.

One might argue that poor implementation of the participatory photo-mapping activity attributed to increased incorrect perceptions of forest conditions in the post-test study. This was unlikely as responses would then have remained relatively the same as those observed in the pre-test study. Also, while one could contend that participants might have misunderstood the question during the post-test study, this was also unlikely since the same people were asked the same question during the pre-test. I argue that the increased incorrect perception of the forest health status after PPM treatment was

possibly due to deliberate misreporting due to political interests raised by local political leaders. Conversations with village leaders and representatives of the Enguserosambu Community Forest Board of Trustees, in a formal meeting held on June 25, 2015, suggest that participants deliberately did not indicate that the forest is declining despite their knowledge of its declining status, as this may lead to revocation of their management rights. The certificate of forest ownership shown in Appendix A shows that in 2013 the government transferred management rights of the Loliondo II Forest to adjacent villages but their management capabilities would be monitored. To avoid revocation of their ownership and management rights, they would have to abide by regulations on managing community forests as stated in the Forest Act of 2002.

During the post-test study, participants from PPM villages raised concerns that if they reported that the forest had declined, their management rights might be revoked by the government. Similar concerns were raised during meetings with village leaders who specifically pointed out that they were worried that I would give the report to the government and that the report might be used against them. While it is likely that local people felt that their management rights were threatened by my study, these concerns were largely expressed by individuals with leadership roles. I thus believe that the village leaders influenced the answers provided by study participants by convincing them to provide answers that would help them retain management rights to the forest. Consequently, most participants from the treatment and the control groups provided answers that they thought would not impact their management rights. Since participants reported the types of information they learned by participating in the participatory photo-

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mapping activity, I argue that PPM contributed to increased understanding of the local forest health conditions despite the contradiction observed in their responses.

While I conclusively argue that participating in marking earth features on photo-maps contributed to increased knowledge of the ECF's health status among participants, I could not determine the extent of the contribution. This is largely due to the limited nature of the responses obtained. Answers to the forest health status question seem to have been politicized and thus I could rely only on answers to the descriptive questions. The limited nature of the responses obtained thus restricted me from assessing the impact using more complex analytical methods. Politicization of responses is not new, however. Other scholars warn of how responses can be twisted to serve respondent interests. In a study conducted to determine the effectiveness of community monitors in wildlife management, Nielsen and Lund (2002) found inconsistencies between records provided by community monitors and actual wildlife populations. In Nielsen and Lund's study, the community monitors elevated the number of wildlife so that the government would continue to entrust management rights of a wildlife area to them. These findings suggest that in the context of political interests, it may not be possible for researchers to obtain unbiased answers even to straightforward questions. Future studies could minimize this shortcoming by conducting a similar study in less politicized regions and ensure that they employ additional data collection methods, such as interviews/focus groups, to gain a deeper understanding of the impact of the project. Additionally, with larger sample sizes and unbiased data, more complex analytical methods could also be employed to determine the levels of association or causal links.

Other limitations are observed in analysis of the satellite imagery. With respect to land use land cover classification, it was a challenge to classify small features such as houses (*bomas*) due to the low spatial resolution of the Landsat satellite data. However, most Maasai *bomas* comprise multiple *bomas* plus livestock enclosures in one area—the combined features can cover a much larger area, an area often larger than the 30m pixel size; low imagery resolution was thus not problematic. This problem could, however, be eliminated by purchasing new higher spatial resolution imagery if budget is not a constraint. This can mainly be done for the current year or in certain areas where historic high spatial resolution images are available. Nevertheless, the 30m Landsat data were adequate for analysis and provided adequate accuracy. The final data limitation in this study was the low (46%) treatment rate due to low attendance of participants in the PPM meetings. Future studies could address this problem by ensuring that they plan to have more PPM meeting days so that individuals from different parts of the communities have more options. Also, one may ensure that this kind of project is implemented during times when fewer Maasai are likely to migrate their livestock to distant seasonal grazing areas.

7. Determinants of Self-Reported Forest-Related Environmentally Friendly Behaviors in Loliondo area, Northern Tanzania.

7.1. Introduction

The goal of this chapter is to explore factors associated with engagement in actions and behaviors that have a positive impact on forest use and management in the Loliondo area, by using an existing (but modified) framework for environmental behaviors. This chapter thus addresses my last research question, "*What factors are associated with engagement in forest-related environmentally friendly behaviors among people in the Loliondo area?*"

Efforts to understand factors that influence engagement in environmentally friendly behaviors started in the 1960s. During this period, most frameworks were based on linear progression relationships (Kollmuss & Agyeman, 2002). It was thought that environmental knowledge leads to environmental concerns (positive attitudes toward the environment and its conditions), and consequently to engagement in environmentally friendly behaviors. Early environmental educators thus assumed that merely providing environmental education would lead to participation in environmentally friendly behaviors. Linear progression models were later proved to be of limited use, although most NGOs and governments continued to base their assumptions on this simplistic model (Kollmuss & Agyeman, 2002; Owens, 2000). More robust models, such as one developed by Hines et al. (1987) were proposed. Apart from environmental behavior models, other theories have also been employed to understand factors that influence

environmental behaviors. It is, however, important to note that most environmental behavior models stem from Bandura's (1977) social learning theory, which emphasizes the role played by societies not only in the learning process but also in the selection of behaviors to engage in.

One model that has been widely applied in predicting environmental behaviors is the theory of planned behavior, developed by Ajzen (1991). While the theory of planned behavior was not specifically developed for modeling environmental behaviors, it has received substantial attention among environmental scholars. Some examples of application of the theory of planned behavior are reported in studies on recycling behaviors (Boldero, 1995; Cheung, Chan, & Wong, 1999; Mannetti, Pierro, & Livi, 2004; Rise, Thompson, & Verplanken, 2003), water use behaviors (Harland, Staats, & Wilke, 1999; Lam, 2006; Trumbo & O'Keefe, 2001), green consumer behaviors (Chan & Lau, 2002), private car-use behaviors (Bamberg & Schmidt, 2001; Harland et al., 1999), adoption of conservation technology (Lynne et al. 1995), and use of energy-saving light bulbs (Harland et al., 1999). While the theory of planned behavior has been applied successfully in many of the aforementioned research topics, Kaiser, Hübner, and Bogner (2005) note that the model has been exclusively applied to individual behaviors rather than a group of behaviors, a factor that might explain its higher predictive power (Chao, 2012).

Another model that has been fairly widely tested for its predictive power is Hines et al.'s (1987) responsible environmental behaviors (REB) model, which was specifically developed for predicting environmental behaviors. This model is based on a meta-

analysis that used 128 empirical studies conducted between 1973 and 1986. In 2007, Bamberg and Möser extended Hines et al.'s model by carrying out a meta-analysis using more and newer studies. Bamberg and Möser retained all the variables proposed by Hines et al., but added a few more psycho-social variables. While the two models are a little different, analysis of the models shows no significant difference between them in terms of predictive power (Kollmuss & Agyeman, 2002). Some scholars, including Bamberg and Möser (2007), have argued that Hines et al.'s model is limited because it was conceptually developed from insufficient empirical studies, while others have argued in support of the model. In fact, scholars like Chao (2012) recommend that it should be used in predicting environmental behaviors. As revealed in some studies, Hines et al.'s model can fairly explain the variance observed in environmental behavior predictions. For example, Hsu, Shih-Jang, and Roth (1998) applied Hines et al.'s model and reported that 39% of variance was explained while Cottrell's (2003) model (adapted from Hines et al.'s model) had an explained variance of 23%.

Since my data do not include any psycho-social variables proposed by Bamberg and Möser, I use the simpler model proposed by Hines et al., and modify it further to suit my study area. While Hines et al.'s model is relevant to my study, the studies used to model environmental behaviors included only Western behaviors, including recycling, transportation, water use, and/or energy use behaviors, most of which are not relevant to rural areas of developing countries. I have yet to come across a model that is based on studies related to forest-related behaviors in developing countries. Nevertheless, the concepts were applied consistently, with adherence to context and topic of interest.

The objective of this study was to explore factors that influence engagement in forest-related behaviors using a simplified version of Hines et al.'s (1987) model. Specifically, I explore the impacts of forest-related knowledge, attitudes, and personal responsibility on engagement in actions and behaviors that can help sustain forests in the Loliondo area, Northern Tanzania, by answering the question *"What factors are associated with engagement in forest-related environmentally friendly behaviors among people in the Loliondo area?* While several studies have in the past assessed the effects of knowledge, attitudes, and personal responsibility on environmental behaviors, most studies focused on contexts in developed countries. Consequently, most explanatory and outcome variables evaluated in these studies cannot be applied in the same way in developing countries, especially in rural contexts. By using forest-related questions specific to Loliondo area, my study hopes to contribute to the understanding of factors that can help predict engagement in environmentally friendly behaviors suitable for the Loliondo area. Identification of influential factors is key to directing efforts toward actions that will contribute to conservation goals.

7.2. Conceptual framework

According to Hines et al.'s (1987) model, environmentally friendly behaviors[83] are directly related to people's intentions to act; however, these intentions are influenced by other factors such as personal and cognitive attributes. Hines et al. define intentions to act as expressions of commitment to act in an environmentally friendly manner; these can

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83 Hines et al (1987) use the term "Responsible Environmental Behavior" in place of Environmentally Friendly Behavior. Others use "Pro-environmental behavior."

be expressed orally or written. When individuals express that they will undertake an action, they are more likely to engage in that particular action in the future than if they do not express such intention. This implies that if, for example, people express the intention to plant trees to help preserve the environment, they are more likely to do so than individuals who do not express a commitment to tree planting. One may argue that individuals who express such intention already possess a particular personality, have adequate or a certain level of knowledge about the intended act, and are aware of the facilitating factors that might enable them to engage in an intended behavior. Capturing intention to act thus becomes a redundant act. Hines et al. (1987) argue that intentions to act are a mere consequence of cognitive characteristics (i.e., knowledge and skills already possessed by the actor), and thus they propose that knowledge of environmental issues and their solutions, as well as possession of skills for solving environmental problems, are basic prerequisites for engagement in environmentally friendly behaviors.

Hines et al.'s model shows that for people to engage in environmentally friendly behaviors, it is not sufficient for them to be knowledgeable about environmental problems and solutions or to possess necessary skills. On the contrary, people's personality characteristics and situational factors must align with the environmentally friendly behaviors being measured.

Cognitive factors. Hines et al. (1987) identify knowledge of environmental problems and their solutions, and possession of needed skills, as cognitive factors that positively contribute to engagement in environmentally friendly behaviors. Environmental knowledge further includes understanding of alternative solutions for dealing with

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environmental problems (Asch and Shore, 1975; Klingler 1980; Ramsey 1979). This implies that when a person perceives an environmental problem, understands strategies required to solve the problem, and has skills to solve that problem, he/she is more likely to engage in an environmentally friendly behavior, assuming there are no situational (e.g., economic or social) factors to counteract the effect. To capture cognitive level, questions about factors that contribute to deforestation and about actions and behaviors that might help sustain the ECF, the local forest, were asked. While it was important to determine whether participants possessed skills to perform desired behaviors, it was not necessary in this case. Most behaviors did not require special skills to perform them as they are already known by most people through previous similar EE programs, local NGOs, village and district government trainings, and lifelong experiences (i.e., through indigenous knowledge transfer mechanisms). Variation of skills among most respondents was thus not expected. A few behaviors that were determined as relatively new to most participants (and thus requiring skills to perform them), including tree planting, rotational grazing, and sustainable agricultural practices, were reported by only a few; these behaviors did not provide enough data to assess how possession of relevant skills might affect engagement in these behaviors.

Personality factors. Personality factors, also understood as psycho-social factors, include attitudes toward environmentally friendly behaviors, locus of control (self-efficacy), and personal responsibility. *Attitudes* can be defined as positive or negative feelings toward the environment or toward actions related to the environment (Hines et al., 1987). Attitudes can be toward the existence or non-existence of an environmental condition, or

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can be toward actions and behaviors that aim to protect or destroy the environment. Hines et al.'s definition is consistent with one provided by Clayton and Myers (2009) who define attitudes as "evaluative reactions to objects or behaviors based on beliefs about those objects or behaviors" (p. 15). According to Hines et al., individuals with positive attitudes toward either a positive environmental action or environmental condition are more likely to engage in environmentally friendly behaviors and vice versa.

In this study, attitudes toward environmentally friendly behaviors were identified as positive when individuals mentioned at least one specific environmentally friendly behavior they would be willing to engage in to help sustain the local forest. Respondents could report as many environmentally friendly behaviors as they would engage in. Respondents were considered to possess a more positive general attitude toward environmentally friendly behaviors if they reported more behaviors they would engage in and vice versa. Another question assessed attitude toward the existence of a local forest, the Enguserosambu Community Forest (ECF). Respondents were asked to say how they would feel if the ECF disappeared. Expression of sadness was considered a positive attitude toward the forest while happiness and neutral expressions were considered as negative attitude. This question is, however, not included in modeling environmental behavior as there was little variation in participants' responses.

Hines et al. (1987) define *locus of control* as an individual's perception of himself or herself as someone who can (or cannot) bring about change through his/her own actions. Interpretation of locus of control also includes individuals' "efficacy perception"; that is, whether an individual perceives his/her behavior as effective in bringing about

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positive change (Clayton & Myers, 2009). Individuals who perceive themselves as capable of bringing about change are viewed as having internal locus of control while those who see others (e.g., parents, leaders, God) as more powerful and able to bring about change, compared to themselves, are viewed as having external locus of control. It is believed that people with external locus of control tend to avoid taking actions because they feel that change can be brought only by those more powerful than they. Individuals with internal locus of control are more likely to engage in environmentally friendly behaviors compared to those with external locus of control. Locus of control was captured by asking participants to say whom they felt was more responsible for ensuring that the local forest was protected/conserved. Participants who mentioned "everyone" were considered to have an internal locus of control while those who mentioned others were considered to have an external locus of control. Participants with external locus of control mentioned village leaders/elders, government, NGOs or others as groups responsible for ensuring conservation of the local forest.

Personal responsibility represents an individual's sense of responsibility toward protecting something or taking an action (Hines et al., 1987). Personal responsibility can be expressed toward the environment overall or toward just one environmental concern (e.g., feeling the responsibility to reduce forest degradation). Individuals who feel that it is their responsibility (whether partial or total responsibility) are more likely to engage in environmentally friendly behaviors compared to those who do not feel that responsibility. In this study, personal responsibility was captured in the same variable as locus of control because of a lack of difference in the two concepts in the context of Loliondo. I therefore

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collapsed the two constructs into one and include only personal responsibility in assessing behavior.

Situational factors. Hines et al. (1987) consider "economic constraints, social pressures and opportunities to choose different actions" as situational factors. Situational factors are what are referred to as environmental factors in Bandura's (1977) social learning theory and in Clayton and Myers (2009, 2015). Per Hines et al., situational factors have a direct relationship with environmental behavior and may either counteract or strengthen personality and cognitive factors. This implies that while an individual may be knowledgeable about environmental issues and their solutions, and his/her personality characteristics may align with conservation goals, he/she may still fail to engage in environmentally friendly behaviors because of having low income. For example, one cannot purchase a hybrid car unless one can afford the cost. Moreover, individuals might engage in environmentally friendly behaviors when they perceive some personal and financial benefit even when their personality characteristics do not align with conservation goals. One may engage in guarding the forest in order to be paid (a financial benefit) even when the person's attitude toward the forest condition does not necessarily align with conservation goals. Therefore, situational factors can either facilitate or inhibit individuals' engagement in environmentally friendly behaviors. Since these factors were not expected to vary significantly among respondents, they were not included in the data collection process. Figure 7.1 graphically shows how the various factors described above are related to engagement in environmentally friendly behaviors.

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Figure 7.1. Conceptual model for factors related to engagement in environmentally friendly behaviors
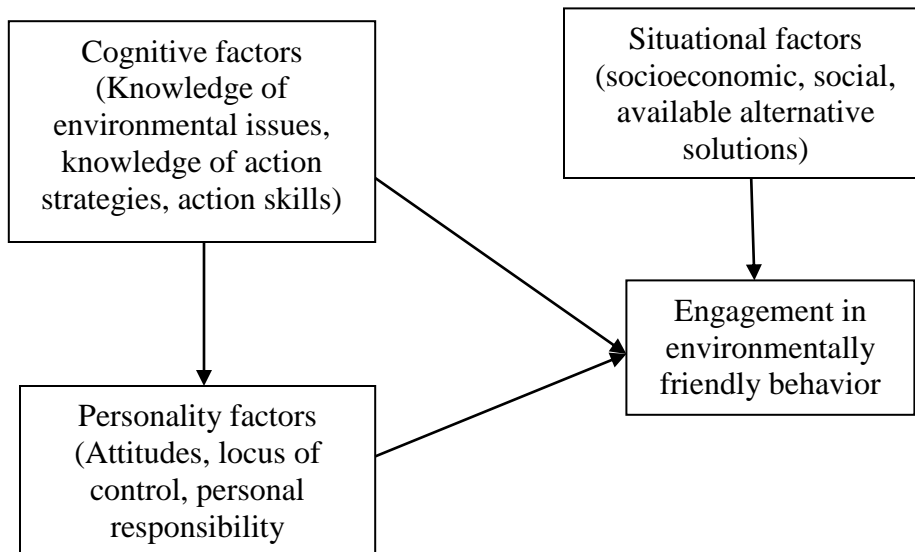
Adapted from Hines et al.'s (1987) Responsible Environmental Behavior model

Hypothesis. Following Hines et al.'s (1987) model, I hypothesized that if all other factors are held constant, each of the two major explanatory factors, cognitive (knowledge of environmental problems and their solutions) and personality (i.e., attitude and personal responsibility) has a positive association with engagement in forest-related environmentally friendly behaviors.

7.3. Data

Data used in this analysis were collected in the Loliondo area, Northern Tanzania, between summer and fall of 2015. The 2015 survey data were collected as part of the post-test study for the environmental education project started in 2013, as described in Chapters Four to Six. In this analysis, I included post-test data only because the outcome variable (engagement in environmentally friendly behavior) was not captured in the pre-

test study. Approximately 30 households were randomly sampled from each village to obtain a total of about 240 households from eight villages. Up to four individuals, two males and two females, 18 years and above were interviewed from each household. In cases where no balanced gender could be found in the household, up to four individuals of any gender were included in the sample; the ratio within the household could be 1 male to 3 females or vice versa. The total sample included 358 individuals, 162 males and 196 females. Inclusion of up to four individuals from selected households was aimed at increasing sample size and equalizing the sex ratio, as well as minimizing survey costs. It was appropriate to include multiple members from each household because responses to various questions were expected to differ even within households. Additionally, a larger sample size allowed for disaggregation of outcomes by various demographic factors and implementation of more complex analyses.

Per Hines et al.'s (1987) environmental behavior model, three major categories of constructs were included in this analysis: (1) a cognitive construct that included knowledge about behaviors that contribute to forest degradation and knowledge of actions and behaviors that can help sustain the forest; (2) a personality construct that included attitudes toward environmentally friendly behaviors and a sense of personal responsibility; and (3) actual actions or environmentally friendly behaviors engaged in to help sustain the forest—the outcome variable. Due to the differences in the personality variables, one discrete (attitude index) and another categorical (personal responsibility), I did not combine the two variables to create a personality construct; instead, I assessed their effect separately. As stated in the conceptual framework, cognitive questions about

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action skills were not included because most behaviors did not require specific skills; it was also expected that levels of required skills for most practiced behaviors were not expected to vary between individuals. For the few behaviors that required skills, they were scarcely reported, so skills for these behaviors were assumed to have a negligible effect. Similarly, the fourth major construct, situational factors, was not collected because there was no expected variation among respondents with respect to the outcome variable.

Except for a few questions which were closed-ended, questions were open-ended; answers to questions were assigned to pre-defined categories of expected responses. Responses that did not fall in any of the pre-defined categories were assigned to "other" and were later coded to either new or existing categories. The format of the questions was thus unlike many studies which used the Likert Scale to measure knowledge, attitudes, or behaviors related to environmental topics (see studies reported by Chao, 2012; Pe'er et al., 2007; Sah & Heinen, 2001; Van der Ploeg et al., 2011). All questions were asked in either Swahili or Maasai. Interview questions included in this analysis (in English) are included in Appendix C.

7.4. Empirical strategy

Since constructs used to model behavior were composite measures, I had to create indices to include all component attributes of a construct. The first step in the analysis thus involved transforming variables by creating indices for environmental knowledge and attitudes, the explanatory variables, and self-reported EFBs—the outcome variable. The indices were created by adding up the values of corresponding attributes of each construct. Since each reported attribute was given a value of one (and zero if not

reported), the size of each index depended on how many respective attributes were reported. The EFB index, for example, had a minimum index of zero if an individual did not engage in any EFB, and nine, if an individual reported having engaged in nine different EFBs. The environmental knowledge index comprised all factors perceived by study participants as causes of deforestation as well as actions and behaviors considered as solutions that can help sustain the forest. The attitude index included all reported actions and behaviors that respondents would be willing to engage in to help sustain the forest. I assumed that the higher the number of reported environmentally friendly behaviors the individual was willing to engage in, the more positive their general attitude would be toward environmentally friendly behaviors and vice versa. Likewise, the larger the value of the knowledge index, the more knowledgeable the individual was perceived to be. Finally, a larger value for the self-reported EFBs index represented more engagement in EFBs and vice versa. Additionally, I converted sense of personal responsibility and all the control variables to binary "yes/no" variables.

In the second step, I obtained summary statistics (including mean, median, minimum, maximum, and standard deviation) for the indices of environmental knowledge, attitudes, and self-reported EFBs. The summary statistics were useful for understanding how many attributes of knowledge (a cognitive construct), for example, were reported by participants on average, since the questions were open-ended and allowed for multiple responses. The expectation was that knowledgeable individuals would report more attributes compared to individuals with less environmental awareness. In addition to summary statistics of the overall attitude toward environmentally friendly

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behavior (the index), I assessed the proportion of individuals' attitudes toward the existence of the ECF (a second attitude question) to understand if local people in Loliondo had a positive attitude toward the existence of the forest. Moreover, I performed descriptive analysis for the sense of personal responsibility variable to obtain the proportion of participants who expressed that it is their responsibility to help protect the ECF. Descriptive results for personal responsibility were useful for determining whether there was an equal distribution between individuals who expressed that it is their responsibility versus those who expressed that it is other people's responsibility to protect the forest; this equal distribution was necessary for comparing the EFBs of the two groups.

In the third step of the analysis I ran three separate linear regression models to estimate the effects of knowledge, attitudes and sense of personal responsibility—the explanatory variables—on engagement in EFBs—the dependent variable. I used transformed variables created in the first step. Since the dependent variable was comprised of discrete values, I measured the effects by assessing how much it changed for any one unit increase or decrease in the number of reported attributes of knowledge or attitude, when all other factors were held constant. The effects of the explanatory variables on engagement in EFBs were also measured by assessing how much the index increased or decreased when an individual possessed a sense of personal responsibility versus otherwise. For all three estimates, I ran multivariate models that included control variables. Regressing engagement in EFBs on individual factors of the behavior model before including them all in the final model was necessary for determining whether these

dimensions had the expected relationships.

In equations 7.1, 7.2, and 7.3 below, E_i is the outcome variable for an individual, i, with respect to individual explanatory variables, knowledge (K), attitude (A), and sense of personal responsibility (PR) respectively. The dependent variable, E_i, measures the number of self-reported desired behaviors (EFBs) an individual engaged in six months prior to this study. The regression coefficient of interest (β_1) in each equation thus estimates the independent effects of knowledge, attitudes, and sense of personal responsibility on engagement in EFBs. For example, in the case of knowledge, for each additional attribute of knowledge, the estimated β_1 represents the number of additional EFBs in which an individual will engage in on average. X_i accounts for dummy individual-level control variables (gender, age, education, and participation in an EE program) while X_h accounts for a household-level control variable (household location in relation the ECF). For gender, 0 is male and 1 is female; for age, 0 is 30 years and below and 1 is above 30 years; for education, 0 is no formal education and 1 is some formal education (attended standard one or higher level of education); for participation in EE, 0 is control and 1 is treatment; for household location, 0 is far from the ECF and 1 is near the ECF. The error term ε_i in each equation contains unobservable variables that might have an influence on the number of EFBs an individual engaged in. While it is possible that the unobserved variables in the error term may be correlated with an individual's ability or decision to engage in EFBs, their effects are assumed to be very small and negligible.

$$E_i = \beta_0 + \beta_1 K_i + \beta_2 X_i + \beta_3 X_h + \varepsilon_i \qquad (7.1)$$

$$E_i = \beta_0 + \beta_1 A_i + \beta_2 X_i + \beta_3 X_h + \varepsilon_i \tag{7.2}$$

$$E_i = \beta_0 + \beta_1 PR_i + \beta_2 X_i + \beta_3 X_h + \varepsilon_i \tag{7.3}$$

In the final step, I estimated the effects of knowledge, attitudes and sense of personal responsibility on engagement in EFBs using a multivariate linear regression model. While the three predictors of interest have independent effects on engagement in environmentally friendly behaviors, Hines et al.'s (1987) and other models show that the explanatory power is larger and more reliable when these factors are modeled together. The final model specification that estimates effects of each dimension is a simplified version of Hines et al.'s (1987) environmental behavior model. As with individual factor models described above, this model assumes a linear relationship between the dependent variable and each of the explanatory variables. In this model, engagement in EFB is influenced not by individual factors alone, but by a combination of these factors.

Based on Hines et al.'s model, knowledge of causes of forest degradation and actions and behaviors that can help sustain the forest, attitudes toward EFBs and the general environmental conditions, a person's sense of personal responsibility, and situational factors,[84] collectively influence an individual's decision to engage in EFBs. The effects of explanatory variables may vary between different groups of people (e.g., between male and female); as such, demographic and geographic factors were included in the model to account for any differences in the outcome variable between different groups of people. The model specification is as shown below.

$$E_i = \beta_0 + \beta_1 K_i + \beta_2 A_i + \beta_3 PR_i + \beta_4 SF_i + \beta_5 X_i + \beta_6 X_h + \varepsilon_i \tag{7.4}$$

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84 Situational factors include having or not having alternative sources of wood for fuel and construction.

In equation 7.4, E_i is the outcome variable, self-reported engagement in EFBs for an individual, i. Coefficients of interest include β_1 for environmental knowledge (K_i). As noted above, action skills are excluded from this knowledge construct because most EFBs did not require special skills to engage in them and the few behaviors that required skills were scarcely reported. Skills for these behaviors were assumed to have a negligible effect; β_2 for attitude toward EFBs (A_i); and β_3 for sense of personal responsibility (PR_i). While it would be ideal to also have the coefficients of situational factors (SF_i), data on these factors were not collected because they were not expected to lead to variation in the effects on the outcome variable; as with action skills, they were assumed to be constant for all individuals. The explanatory variables X_i and X_h include individual-level (gender, age, education, and participation in an EE program) and household-level control variables. The error term (ε_i) includes all factors that have not been accounted for, including situational factors and action skills. Equation 7.4 is thus simplified to equation 7.5 below.

$$E_i = \beta_0 + \beta_1 K_i + \beta_2 A_i + \beta_3 PR_i + \beta_5 X_i + \beta_6 X_h + \varepsilon_i \qquad (7.5)$$

7.5. Results

The findings are organized in three sub-sections. The first part reports descriptive statistics of the four constructs included in the regressions models. The second part reports linear single factor predictor model estimates; that is, model estimates of individual relationships between environmental knowledge, attitudes, and personal responsibility to engage in environmentally friendly behaviors. The final part reports estimations of the environmental behavior model when all key explanatory variables are

included.

7.5.1. Reported knowledge, attitudes, personal responsibility, and EFBs

Environmental knowledge. Overall, participants demonstrated high levels of knowledge of various environmental issues and their solutions. The few most-reported forest-related environmental issues include tree-cutting for firewood, illegal logging for timber, tree-cutting for construction, charcoal burning and agricultural expansion inside the forest. With respect to knowledge about solutions to forest problems, most reported solutions include forest guarding by communities, restrict tree-cutting, tree-planting, ban logging for timber, ban charcoal burning, and provision of conservation education to local people. When disaggregated by gender, both male and female respondents demonstrated high cognition in environmental issues and their solutions. While most knowledge attributes were equally reported by male and female participants, a few of them were reported more often by one gender compared to the other. For example, more female participants (compared to male participants) reported "tree-cutting for firewood" as a major contributor to current forest-related issues in the area and "restrict cutting trees" and "collect only dry wood for firewood" as solutions. This difference may be due to the fact that women are responsible for collecting firewood and thus are more likely to witness fellow women cutting down live trees for firewood; consequently, they may have a better understanding to what extent live trees are cut for firewood. Since these women are more responsible for collecting firewood (and wood for construction in the Maasai communities), they are more likely to feel the burden of the lack of these resources if they were depleted, and thus they may be more likely to seek solutions to end the

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problem. The burden of getting firewood resources may already be felt by communities

such as the Loliondo and Sakala villages which are located far from the ECF and other

denser forests. When the reported number of knowledge attributes are averaged, the

differences between male and female participants were not statistically significant,

however, implying that both groups were equally likely to report various attributes of

forest-related issues and their solutions (see Tables 7.1 and 7.2).

Table 7.1. Knowledge of causes of ECF deforestation disaggregated by gender (n=358)

Perceived causes of ECF deforestation	Male % (n = 162)		Female % (n = 196)
Tree cutting for firewood	73.5	**	83.2
Illegal logging for timber	75.3		75.0
Tree cutting for construction	69.1		66.8
Charcoal burning	69.8		64.3
Agricultural expansion inside forest	51.2		48.5
Settling inside the forest	32.1		29.1
Overgrazing	25.3		21.4
Tree cutting for livestock feeds	24.1		24.5
Tree debarking	1.2		3.1

The asterisks indicate statistical significance between male and female percentages at the 1% (***) and 5% (**) levels.

Table 7.2. Knowledge of solutions to ECF deforestation disaggregated by gender (n=358)

Perceived actions and behaviors that would help sustain ECF	Male % (n = 162)		Female % (n = 196)
Forest guarding by communities	90.7		84.2
Restrict cutting trees	61.1	**	72.4
Plant trees	50.6		43.4
Ban logging for timber	43.2		48
Ban charcoal burning	43.8		46.4
Provide conservation education	40.1		31.1
Rotational grazing	32.1		35.7
Exclusion of livestock	29.0		31.1
Report illegal activities	25.3		30.1
Collect only dry wood for firewood	21.0	**	31.6
Collect only dry wood for construction	20.4		26.5
Stop farming/settling inside forest	23.5		23.5
Establish and abide to forest bylaws	17.3		14.8
Conserve more forested areas	11.7		8.2
Practice sustainable agriculture	4.9		5.1

The asterisks indicate statistical significance between male and female percentages at the 1% (***) and 5% (**) levels.

Participants' attitude toward the existence of the ECF. When participants were asked how they would feel if the forests were depleted, almost everyone (98.9%) expressed emotions of sadness. Reasons provided by respondents for their sad emotions included *"binadamu na mifugo watakufa"*; meaning, "both human beings and livestock will die." Or as stated by another respondent that, *"hali ya maisha itakuwa mbaya kweli; maji, mvua, kuni, vyote vitakosekana,"* meaning, "our standard of living will deteriorate badly; there will be no water, rains, and firewood." The sad emotions expressed by respondents were not surprising since people in this area rely on the local forest in various ways, including for forest products and climate regulation.

Attitudes toward forest-related environmentally friendly behaviors. To gauge participants'

attitudes toward various environmentally friendly behaviors, participants were asked to mention any actions and behaviors they felt they would engage in to help sustain the ECF. As expected, most participants expressed willingness to engage in various forest-related environmentally friendly behaviors, as shown in Table 7.3. Participants could mention as many as 15 different actions and behaviors they would engage in. The most reported behaviors include: reporting illegal forest activities, educating others about conservation, volunteering to guard the forest, sensitizing other people to guard the forest, and restricting cutting trees. Apart from a few behaviors, male participants seemed to express positive attitudes toward more behaviors compared to female participants. Female participants expressed more positive attitudes than men toward collecting only dry wood for firewood. The differences in attitudes between male and female participants do not necessarily mean that men care more about the forest than women. It is likely that Maasai men were just more expressive compared to women, possibly due to the patriarchal nature of Maasai societies. As discussed earlier, men make more decisions in these societies. This may be the case especially since the questions were open-ended.[85]

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[85] While one may argue that it is likely that women were simply impatient so they could attend to other household chores, this is unlikely because Maasai people are generally friendly and patient unless they do not want to talk to you for reasons such as feeling insecure about the topic. Also, the survey questionnaire was relatively short (it took about 15-20 minutes of interview without interruptions).

Table 7.3. Attitudes toward specific environmentally friendly behaviors disaggregated by gender (n=358)

Attitudes toward environmentally responsible behaviors	Male % (n = 162)		Female % (n = 196)
Report illegal forest activities	68.5		70.9
Educate the community about conservation	64.2	**	51.0
Volunteer to guard the forest	74.7	***	31.6
Sensitize people to guard the forest	48.8		40.3
Restrict cutting trees	43.2	***	28.6
Collect only dry wood for firewood	17.9	***	46.9
Collect only dry wood for construction	19.8		23.0
Plant trees	26.5	***	11.2
Ban charcoal burning	19.8	**	9.7
Prevent livestock from entering the forest	14.2	**	7.1
Stop farming/settling inside forest	10.5		6.6
Participate in establishing and abiding to forest bylaws	8.0	**	3.1
Conserved forested areas that are outside protected forest	6.2		3.6
Practice rotational grazing	6.8	***	1.0
Practice sustainable agricultural	3.1		0.5

The asterisks indicate statistical significance between male and female percentages at the 1% (***) and 5% (**) levels.

Sense of personal responsibility. Out of 358 participants, about 60% said it is everyone's responsibility to protect the ECF while about 40% said it is other people's (e.g., village leaders, elders, NGOs, and district-level local government authorities) responsibility. Since "everyone" included the respondents themselves, those who provided this answer are perceived to have a sense of personal responsibility toward protecting the ECF. On the other hand, respondents who said others are responsible for protecting ECF are said to have no sense of personal responsibility toward protecting the ECF.

Table 7.4 shows that when disaggregated by gender, male respondents seemed to possess a greater sense of responsibility compared to female respondents. Individuals with at least primary school education, whether male or female, were more likely to

report a sense of personal responsibility compared to participants with no education at all. Also, participants who previously accessed environmental information through The environmental education project were also more likely to show a sense of personal responsibility compared to participants who did not access any environmental information. This was true only among female participants. No difference was observed between individuals aged 18 to 30 years and those above 30 years nor between those who live close to the forest versus those who live far from it. The differences observed between male and female may be as explained with attitudes; Maasai men make more decisions both within the household and at the community level, and thus are more likely to feel responsible to protect the local forest compared to women. The differences between individuals with some education and those without any might be related to social status and power-relations within these communities; educated individuals tend to have more power in communities and participate more in decision making compared to uneducated individuals. They may feel more responsible to protect the forest since it involves decision making. Finally, females who participated in the EE were likely to have acquired more environmental awareness about various environmental topics (including about consequences of destroying the forest) compared to those who were not part of the treatment group. As a result, such individuals were likely to develop more concern for the forest as well as feel empowered to take part in protecting it compared to women who did not receive any environmental education.

Table 7.4. Participants' sense of personal responsibility (PR) disaggregated by gender, age, education status, distance from the forest, and access to environmental information (N=358)

Level of analysis	% of participants with sense of PR	% of participants with no sense of PR
Gender		
Male	30.86+	69.14
Female	47.45+	52.55
Age		
18-30	39.58	60.42
31 and above	40.00	60.00
Education status		
No education	51.93+	48.07
At least primary education	27.53+	72.47
Near versus far from the ECF		
Far from ECF	40.86	59.14
Near ECF	38.86	61.14

+ indicates a pair of numbers that are statistically different at the 1% level.

Self-reported environmentally friendly behaviors engaged in. Respondents were asked to report any environmentally friendly behaviors (actions and behaviors) they engaged in six months prior to the study. While some participants reported engaging more in some environmentally friendly behaviors than others, very few of them reported engaging in most behaviors. Behaviors that were engaged in follow a similar pattern to reported attitudes toward those behaviors. Participants had already expressed positive attitudes toward most behaviors they engaged in. Out of about 13 possible behaviors an individual could engage in, only a few behaviors were reported by up to 40% of the sample. Most reported behaviors include: providing conservation education to other people, sensitizing other people to guard the forest, collecting only dry wood for firewood, and reporting

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illegal activities. Less than 20% of surveyed participants reported engaging in other environmentally friendly behaviors. As with attitudes, male participants reported more behaviors they engaged in than female participants (see Table 7.5 below). Since most Maasai and other ethnic groups are patriarchal in nature, as with other resources, most decisions related to forest resources management are made by men. In the study area, all traditional leaders (who are also major decision makers) among the Maasai and Sonjo are men while among the Maasai, the Morans (Warriors) are given responsibilities to guard Maasai territories (including forest and grazing resources). Higher levels of engagement in EFBs reported by men may thus be due to their role in natural resources management in these communities. While women can take part in only some forest-related actions, reporting more behaviors by male participants does not necessarily imply that they care more about the forest compared to female participants; on the contrary, it is likely that women care more since they would bear the greatest burden if these resources were depleted.

Table 7.5. Proportions of participants who engaged in specific EFBs disaggregated by gender

Actions and behaviors engaged in to help sustain ECF (n=361)	Male % (n = 162)		Female % (n = 196)
Provided conservation education to other people	46.9	***	27.0
Sensitized other people about guarding the forest	39.5	***	23.5
Collected only dry wood for firewood	13.0	***	36.7
Volunteered to guard the forest	41.4	***	13.8
Reported illegal activities	26.5	**	15.3
Collect only dry wood for construction	17.3		13.8
Restricted grazing livestock in the forest	19.8	**	9.7
Planted trees	16.0	**	8.7
Practiced rotational grazing	15.4	**	7.1
Conserved forested areas that are outside protected forest	9.3	**	3.1
Stopped expanding farms/settlements toward forests	7.4	**	2.6
participated in establishing and abiding to forest bylaws	6.2	**	1.5
Practiced sustainable agriculture	3.1		1.5

The asterisks indicate statistical significance between male and female percentages at the 1% (***) and 5% (**) levels.

Analysis of individual attributes of self-reported EFBs revealed differences in responses between different groups of people. For example, individuals with some primary level education were more likely to engage in tree planting compared to those who had never attended school. This was not surprising since tree-planting was largely observed among non-Maasai (who are also more educated compared to Maasai) villages who have historically been farmers and have in the past planted trees on their yards for boundary demarcation. Also, individuals with no education were more likely to collect only dry wood (versus "green" growing wood) for firewood and construction poles, possibly because dry wood is more readily available to them than for those who live far from the forest, where firewood may be scarce. Also, except for tree planting and reporting of illegal forest activities, individuals who live close to the forest (compared to

those who live farther from the forest) were more likely to report engagement in most EFBs, possibly because they feel that it is their forest and thus their responsibility to protect it. Individuals who lived close to the ECF were less likely to engage in tree planting compared to those who live far from ECF. This difference may be because those who live far from the forest are also non-Maasai and more familiar with agricultural practices compared to the Maasai who live close to the forest. No difference was observed in engagement in reporting illegal forest activities. Finally, with the exception of tree planting and collecting dry wood for firewood, individuals who participated in an environmental education project were more likely to report engaging in most EFBs compared to those who did not, possibly because they were reminded of the need to protect the forest and thus took more action. Since behaviors were self-reported, however, the reader needs to interpret the findings cautiously.

Summary results of knowledge, attitudes, and self-reported EFBs. On average, each participant reported about 12 out of 36 possible environmental knowledge attributes (SD=1.71), although most of them mentioned only about 11 (see Table 7.6). The least knowledgeable individuals reported only one knowledge attribute while the most knowledgeable people reported as many as 36 attributes. For the attitude construct, most participants scored about three points on average (SD = 2). Individuals with the least positive attitudes scored zero points while those with most positive attitudes scored about 13 points; zero points means that an individual did not report any behavior he/she was willing to engage in to help sustain the forest. Individuals who lived close to the forest appeared to possess more positive attitudes toward environmentally friendly behaviors

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compared to those who lived far from the forest. Finally, for the EFBs index, representing self-reported behaviors engaged in, the average score was one (SD = 2), and the median was zero. Individuals who engaged least in EFBs scored no points while those who engaged most scored 14 out of a possible 14 points. A median of zero implies that most individuals did not engage in any EFB and only a few of them engaged in more than one EFB. As expected, despite demonstrated knowledge in forest-related problems and their solutions (and positive attitudes), both men and women engaged in only a few desired behaviors. As will be discussed further, knowledge alone does not translate into action; other factors, as shown in various environmental behavior models, affect an individual's decisions to engage in EFBs.

Table 7.6. Summary statistics of environmental knowledge, attitudes, and self-reported EFBs

Statistics	Environmental knowledge	Attitudes toward EFBs	EFBs engaged in
	Household located far from the ECF (n=186)		
Mean	10	2	1
Median	11	2	0
SD	5	1	2
Minimum	1	0	0
Maximum	22	7	9
	Household located near the ECF (n=175)		
Mean	12	3	2
Median	11	3	0
SD	9	2	3
Minimum	1	0	0
Maximum	36	13	14
	All households (n=361)		
Mean	11	3	1
Median	11	3	0
SD	7	2	2
Minimum	1	0	0
Maximum	36	13	14

Notes: "Near the ECF" implies that the participant lives in a village whose land is part of the forest. "Far from the ECF" implies that the participant lives in a village whose land is not part of the forest.

Table 7.7 below shows differences (of the average number of attributes of knowledge, attitudes, and self-reported EFBs) between various demographic and geographic characteristics. Male participants demonstrated more positive attitudes and reported more EFBs they engage in. A significant difference was also observed between individuals with some education versus those without any education. Educated individuals demonstrated more environmental knowledge and positive attitudes than the uneducated, although both groups equally reported EFBs they engaged in. Differences were also observed between individuals who live near the ECF (versus those who live far from the ECF); individuals near the ECF demonstrated higher knowledge, positive

attitudes, and reported engagement in more EFBs compared to those who live far from

the ECF. Similar differences were observed between those who accessed environmental

information via the EE project versus those who did not. No differences were observed in

the three constructs between age groups. Reasons for the observed differences are as

suggested in previous sections.

Table 7.7. Summary statistics disaggregated by gender, age, education, distance from the forest, and access to EE (n=358)

Level of analysis	Average knowledge	Average attitude	Average self-reported EFBs
Gender			
Male	15.52	3.69***	3.15***
	(SD = 5.93)	(SD = 2.19)	(SD = 3.24)
Female	15.19	2.97	2.12
	(SD = 6.51)	(SD = 2.17)	(SD = 2.91)
Age of respondent			
18-30 years	14.89	3.13	2.52
	(SD = 5.75)	(SD = 2.04)	(SD = 3.14)
31 and above	15.66	3.42	2.66
	(SD = 6.54)	(SD = 2.31)	(SD = 3.10)
Education status			
No education	16.47***	3.54**	2.73
	(SD = 6.35)	(SD = 2.37)	(SD = 3.14)
At least primary education	14.21	3.06	2.47
	(SD = 5.93)	(SD = 2)	(SD = 3.09)
Near versus far from the ECF			
Near ECF	11.55	2.28	1.79
	(SD = 3.33)	(SD = 1.46)	(SD = 2.22)
Far from ECF	19.42***	4.39***	3.43***
	(SD = 6.05)	(SD = 2.36)	(SD = 3.66)
Accessed environmental information (EI)			
Did not access EI	14.26	3.00	2.11
	(SD = 5.48)	(SD = 2.1)	(SD = 2.76)
Accessed EI	16.62***	3.65**	3.12***
	(SD = 6.80)	(SD = 2.29)	(SD = 3.39)

Note: *** p<0.01, ** p<0.05

7.5.2. Effects of individual explanatory variables on engagement in environmentally friendly behaviors

Effects of environmental knowledge on environmentally friendly behaviors. Ordinary Least Square (OLS) results revealed a positive relationship between environmental knowledge[86] and engagement in environmentally friendly behaviors. As shown in Table 7.8, the results remain significant even after controlling for gender, age, education, location of the individual in relation to the local forest, and previous access to environmental information. As presented in Table 7.8, the OLS results show that for every additional knowledge attribute, an individual engaged in 0.16 more EFBs on average, with other factors held constant. While this implies that a person with more knowledge about causes of forest degradation and solutions to environmental problems was more likely to engage in more EFBs, the impact of knowledge was not substantial. The results also show that engagement in environmentally friendly behaviors was dictated by many other factors. Women were less likely to report engaging in environmentally friendly behaviors compared to men. Also, people with at least some primary level education were more likely to report engaging in environmentally friendly behaviors compared to those with no education. Furthermore, results showed that people who live near the forest and those who previously participated in an environmental education project were more likely to engage in environmentally friendly behaviors compared to those who live far from the forest and those who did not participate in the EE project respectively.

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86 Environmental knowledge index include knowledge in causes of ECF destruction and knowledge in actions and behaviors that can help sustain the ECF.

Engagement in fewer environmentally friendly behaviors by women was mainly due to women's lower participation in providing conservation education to other people, volunteering to guard the forest, restricting livestock grazing in the forest, and sensitizing other people to guard the forest. These activities are typically highly gendered in the traditions and social contexts of the Maasai and other tribes found in Tanzania. For example, men are expected to go guard the forest while women are expected to take care of children, do household chores, collect firewood, fetch water, and build "*Bomas*" (Maasai women's huts are built by women). Also, men have more voice when it comes to forest-related issues, thus they are expected to participate more in solutions related to forests compared to women. Women, however, were more likely to report engaging in collecting only dry wood for firewood compared to men, probably because women are expected to perform most household chores. Furthermore, participants who live near the ECF were more likely to engage in more environmentally friendly behaviors possibly because they feel that it is their responsibility compared to those who live far from the forest. Villagers near the forest consider themselves as legitimate owners of the forest. Finally, participants who previously participated in the environmental education projects were more likely to report engaging in environmentally friendly behaviors, possibly due to their increased awareness of environmental issues.

Table 7.8. Effects of environmental knowledge on engagement in environmentally friendly behaviors

Predictors	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Environmental	0.236***	0.234***	0.231***	0.225***	0.185***	0.155**
Knowledge	(0.042)	(0.042)	(0.043)	(0.046)	(0.050)	(0.055)
Female		-0.993***	-1.027***	-1.108***	-1.05***	-0.982***
		(0.312)	0.308	(0.306)	(0.304)	(0.299)
Age			-0.014	-0.016	-0.011	-0.012
			(0.010)	(0.011)	(0.012)	(0.012)
Some primary				-0.309	-0.113	-0.223
school (vs none)				(0.348)	(0.401)	(0.399)
Near ECF					0.676	0.85**
					(0.345)	(0.362)
EE program						0.709**
participant						(0.336)
Observations	361	358	358	358	358	358
R-Squared	0.101	0.128	0.132	0.134	0.141	0.153
Number of villages	8	8	8	8	8	8

Cluster-robust standard errors in parentheses; clustered at household level.
*** p<0.01, ** p<0.05

Effects of attitudes on engagement in environmentally friendly behaviors. To assess the

relationship between attitudes and EFBs, I regressed their corresponding indices which

contain combined attributes from each construct. While in the theory of planned

behavior, Ajzen (1992) advises that when predicting behaviors, attitudes toward specific

behaviors should be measured instead of overall attitude, it was not feasible to do this

with small counts of individual behaviors. The linear relationship between overall

(cumulative) attitude toward environmentally friendly behaviors and engagement in these

behaviors revealed a positive association, as was expected. The association remains

highly significant and robust even after adding all control variables into the linear

regression model (see Table 7.9). A one unit increase in positive attitude toward environmental behaviors led to increased engagement in environmentally friendly behaviors by 0.70 points on average, with other factors held constant. If the coefficient of 0.7 is rounded up, the results show that positive attitude toward one additional EFB can lead to engagement in about one additional EFB on average in a six months period. Since people in Loliondo were likely to engage in only a few desirable behaviors (as shown in Table 7.9), this represents a large increase in engagement in EFBs. There were no significant differences between males and females, age, individuals with some primary school education versus those with none, individuals who lived close to the forest versus those who lived farther from the forest, and between individuals who participated in the environmental education project versus those who did not. These findings show that individuals with overall positive attitudes toward environmentally friendly behaviors are also likely to engage in more environmentally friendly behaviors compared to those whose attitudes were less positive.

Table 7.9. Effects of cumulative attitudes on cumulative engagement in environmentally friendly behaviors

Predictors	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Attitudes	0.754***	0.735***	0.732***	0.728***	0.727***	0.702***
	(0.116)	(0.120)	(0.120)	(0.123)	(0.137)	(0.135)
Female		-0.500	-0.539	-0.565	-0.565	-0.535
		(0.301)	(0.303)	(0.312)	(0.310)	(0.310)
Age			-0.015	-0.015	-0.015	-0.016
			(0.009)	(0.009)	(0.010)	(0.010)
Some primary				-0.094	-0.091	-0.171
school (vs none)				(0.304)	(0.361)	(0.356)
Near the ECF					0.010	0.086
					(0.296)	(0.302)
EE program						0.485
participant						(0.279)
Observations	361	358	358	358	358	358
R-Squared	0.287	0.294	0.298	0.298	0.298	0.304
Number of villages	8	8	8	8	8	8

Cluster-robust standard errors in parentheses; clustered at household level.
*** p<0.01, ** p<0.05

Table 7.10. Effects of cumulative environmental knowledge on cumulative attitudes

Predictors	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Environmental	0.330***	0.327***	0.327***	0.322***	0.274***	0.264***
Knowledge	(0.029)	(0.027)	(0.028)	(0.027)	(0.033)	(0.035)
Female		-0.669***	-0.664***	-0.737***	-0.667***	-0.645***
		(0.154)	(0.160)	(0.141)	(0.138)	(0.134)
Age			0.002	0.000	0.005	0.005
			(0.006)	(0.006)	(0.006)	(0.006)
Some primary				-0.276	-0.037	-0.072
school (vs none)				(0.228)	(0.220)	(0.220)
Near the ECF					0.827***	0.882***
					(0.188)	(0.188)
EE program						0.224
participant						(0.155)
Observations	361	358	358	358	358	358
R-Squared	0.395	0.416	0.416	0.419	0.441	0.443
Number of villages	8	8	8	8	8	8

Cluster-robust standard errors in parentheses; clustered at household level.
*** $p<0.01$, ** $p<0.05$

Effects of sense of personal responsibility on engagement in environmentally friendly

behaviors. As shown in Table 7.11, the OLS assessment of the relationship between sense

of personal responsibility and engagement in environmentally friendly behaviors shows

that individuals with a sense of personal responsibility were more likely to engage in

environmentally friendly behaviors compared to those with none. As with other results

above, the observed findings remain highly significant even after controlling for various

demographic and geographic factors. As shown in Table 7.11, having a sense of personal

responsibility toward protecting the ECF increased the chances of engaging in

environmentally friendly behaviors by 0.87 points on average, all else held constant. The

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observed effect is very large and it suggests that individuals might engage in almost one additional EFB over a period of six months whenever they feel that it is their responsibility to help protect a local forest.

As with other explanatory factors, results showed that female participants were less likely to engage in environmentally friendly behaviors compared to male respondents even when they seemed to have a sense of personal responsibility. Furthermore, results showed that with a sense of personal responsibility, participants who lived near the forest and those who participated in the environmental education project were more likely to engage in environmentally friendly behaviors compared to individuals who lived far from the forest and those who did not participate in the project. A sense of personal responsibility seemed to have no effect on engagement in environmentally friendly behaviors for respondents of different ages and education levels. As other studies have shown, these findings suggest that for individuals to engage in environmentally friendly behaviors, they need to feel that protecting a forest in their proximity is everyone's responsibility and not just the responsibility of leaders.

Table 7.11. Effects of sense of personal responsibility on engagement in environmentally friendly behaviors

Predictors	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Sense of personal	1.15***	0.975***	0.914**	1.078**	0.99**	0.869**
Responsibility	(0.331)	(0.344)	(0.351)	(0.356)	(0.336)	(0.331)
Female		-0.869***	-0.913***	-1.103***	-0.935**	-0.857**
		(0.312)	(0.312)	(0.319)	(0.309)	(0.31)
Age			-0.014	-0.019	-0.006	-0.007
			(0.009)	(0.01)	(0.012)	(0.012)
Some primary				-0.846	-0.271	-0.404
school (vs none)				(0.347)	(0.409)	(0.396)
Near the ECF					1.493***	1.542***
					(0.349)	(0.341)
EE program						0.953**
participant						(0.329)
Observations	361	358	358	358	358	358
R-Squared	0.033	0.051	0.054	0.070	0.119	0.141
Number of villages	8	8	8	8	8	8

Cluster-robust standard errors in parentheses; clustered at household level.
*** p<0.01, ** p<0.05

7.5.3. Identifying determinants of engagement in EFBs

In the OLS model specified in equation 7.5, I included environmental knowledge, attitudes, and sense of personal responsibilities as major predictors. While single predictor models presented in previous sections produced the effects of each explanatory variable, this model ensured that other predictors are held constant while estimating the effects of other factors of interest. Due to the high correlation between attitude and both environmental knowledge and sense of personal responsibility, however, this model produced unexpected relationships; only attitude seemed to produce expected effects on self-reported EFBs (see Table 7.12). When attitude was excluded from the model, both knowledge and sense of personal responsibility had the expected relationships with self-

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reported EFBs (see Table 7.13). Increase in one knowledge attribute, particularly on the causes of deforestation or actions and action and behaviors suitable for forest sustainability, led to engagement in 0.08 additional EFBs. This positive increase in engagement in environmentally friendly behaviors remained significant even after adding in all the control variables, with the exception of participation in the EE project. While the observed effect of knowledge on EFBs was statistically significant, the magnitude was very small, suggesting that knowledge is necessary but not enough to translate into taking action; it is thus not a good predictor of engagement in environmentally friendly behaviors.

The OLS model also revealed that individuals who reported that it is their responsibility to protect the forest also reported engagement in more environmentally friendly behaviors compared to those who said it is other people's responsibility to protect the forest. If an individual had a sense of personal responsibility to protect the forest, it was likely that he/she would engage in almost one additional environmentally friendly behavior compared to otherwise. Unlike environmental knowledge, sense of personal responsibility had a much bigger effect on engagement in environmentally friendly behaviors.

Furthermore, the results showed that both gender and distance to the forest had a much larger effect on engagement in EFBs; men were more likely to report engaging in more environmentally friendly behaviors than women (i.e., a participant was likely to report engagement in almost one EFB fewer if that person was female compared to if the person was male). While the differences between men and women were likely due to the

rural women's lack of confidence to express their opinions, this difference might have been caused by the inherent gender differences between responsibilities undertaken by men versus those undertaken by women, as well as inequalities in decision-making at both the intra-household and the community level regarding household and community resources. As noted above, Maasai men (and other tribes in Loliondo) are more responsible for making decisions that concern forest resources. It was thus not surprising that male participants reported more engagement in forest-related behaviors compared to female participants. Similarly, individuals who live close to the forest were likely to report engaging in more environmentally friendly behaviors compared to those who live far from the forest, possibly because the forest of concern is also claimed by communities that are more adjacent to the forest. Individuals from more adjacent communities were thus likely to report engaging in more EFBs to help protect the forest compared to those from distant villages. No differences were observed between age groups, education levels, or participation in EE program (see Table 7.13).

Table 7.12. Effects of environmental knowledge, sense of personal responsibility, and attitudes on engagement in EFBs

Predictors	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Environmental	-0.021	-0.013	-0.015	-0.018	-0.025	-0.042
Knowledge	(0.023)	(0.023)	(0.023)	(0.023)	(0.034)	(0.040)
Sense of personal	0.315	0.240	0.180	0.227	0.250	0.244
Responsibility	(0.246)	(0.252)	(0.258)	(0.266)	(0.270)	(0.275)
Cumulative	0.772***	0.746***	0.750***	0.747***	0.741***	0.731***
Attitude	(0.115)	(0.120)	(0.118)	(0.120)	(0.125)	(0.121)
Female		-0.457	-0.499	-0.541	-0.531	-0.486
		(0.303)	(0.306)	(0.315)	(0.310)	(0.314)
Age			-0.014	-0.015	-0.014	-0.014
			(0.008)	(0.009)	(0.010)	(0.010)
Some primary school				-0.177	-0.142	-0.234
(vs none)				(0.322)	(0.363)	(0.353)
Near the ECF					0.168	0.349
					(0.424)	(0.466)
EE program						0.572
participant						(0.342)
Observations	361	358	358	358	358	358
R-Squared	0.290	0.295	0.299	0.300	0.300	0.307
Number of villages	8	8	8	8	8	8

Cluster-robust standard errors in parentheses; clustered at household level.
*** p<0.01, ** p<0.05

Table 7.13. Effects of environmental knowledge and sense of personal responsibility on engagement in EFBs

Predictors	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Environmental Knowledge	0.14***	0.143***	0.142***	0.134***	0.098**	0.075
	(0.026)	(0.025)	(0.026)	(0.028)	(0.034)	(0.039)
Sense of personal Responsibility	0.712**	0.531**	0.486**	0.582	0.670**	0.655**
	(0.284)	(0.293)	(0.302)	(0.307)	(0.309)	(0.309)
Female		-0.895**	-0.929***	-1.012***	-0.954***	-0.889***
		(0.303)	(0.301)	(0.305)	(0.302)	(0.301)
Age			-0.011	-0.013	-0.009	-0.009
			(0.010)	(0.011)	(0.012)	(0.012)
Some primary school (vs none)				-0.372	-0.217	-0.332
				(0.367)	(0.407)	(0.395)
Near the ECF					0.728	0.951**
					(0.406)	(0.444)
EE program participant						0.732
						(0.362)
Observations	361	358	358	358	358	358
R-Squared	0.1072	0.1284	0.1305	0.1334	0.1407	0.1525
Number of villages	8	8	8	8	8	8

Cluster-robust standard errors in parentheses; clustered at household level.
*** $p<0.01$, ** $p<0.05$

7.6. Discussion and conclusion

As hypothesized, multivariate linear regression models revealed positive associations between all three explanatory factors and the outcome variable. These findings follow previous studies that show that each of the three explanatory variables, knowledge, attitudes, and sense of personal responsibility, is positively related to engagement in environmentally friendly behaviors (Bamberg & Möser, 2007; Clayton & Myers, 2009, 2015; Hines et al., 1987; Kollmuss & Agyeman, 2002). As in previous studies, the results also showed that both attitude and sense of personal responsibility

seem to have larger effects on engagement in environmentally friendly behaviors (compared to knowledge), suggesting that the two factors have more influence on environmental behaviors (see results provided in Hine's et al., 1987). The results confirm the hypothesis that for individuals to engage in desired environmental behaviors, they must be aware of environmental issues and their solutions as well as have a positive attitude toward EFBs and a sense of personal responsibility, all else constant. Despite the differences in the environmental constructs employed in previous environmental behavior models (most of which are based on studies from Western world contexts) versus those used in this study, I argue that the observed relationships between various components of the model, and the estimated effects of each explanatory factor ascertain the applicability of these environmental behavior models in forest use and management in rural contexts.

While positive associations were observed between the dependent and the explanatory factors in various groups of people, the results also revealed differential effects among different groups. For example, women and individuals who live far from the ECF had a much lower effect on engagement in EFBs. Female participants reported they engaged in many fewer EFBs over the period of six months prior to the study compared to male participants. Similarly, individuals who live far from the forest were less likely to report engaging in EFBs compared to individuals who live near ECF. The differences between males and females in the effects of explanatory factors on reported behaviors may be explained by gender differences in access to resources, decision making and labor divisions within individual households and at the community level in the Maasai communities. As with most ethnic groups of Tanzania (and Africa in general),

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men have more access to resources than women and make most decisions that concern resources in households and in society (Eckman,1996; Eckman, et al., 1995; Leach, 1992; Fieldstein & Jiggins, 1994; Rocheleau & Edmunds, 1997). Due to the patriarchal nature of the Maasai societies, Maasai men not only participate more in leadership positions but also engage more in forest-related activities compared to women. It is thus not surprising that men were more likely to report engagement in more EFBs compared to women. Most EFBs engaged in by men include providing conservation education to other people, volunteering to guard the forest, sensitizing other people about forest guarding, and in restricting livestock grazing in the forest. It is not only forest use and management that fall within the men's decision making and resource access; men also have other responsibilities that give them the privilege to perform other forest-related activities. For example, since it is the Morans' (male Maasai) responsibility to guard the forest, it is likely that they also take part in sensitizing one another to go guard the forest or are sensitized by their male elders. One cannot expect women to equally engage in behaviors perceived as men's responsibility or in EFBs that involve decision-making. The same reasoning may also explain why men appeared to report higher engagement in most other EFBs related to forests.

This implies that women can take part only in certain activities related to the forests, such as collect wood for firewood and constructing their *bomas* because these are perceived as women's responsibilities as part of their household chores. The gender division of labor and differential decision-making power between men and women might also have influenced the extent to which women perceive their responsibilities with

regard to forest protection and their attitude toward various EFBs. Consequently, women also demonstrated a much less positive attitude toward most EFBs and had a lower sense of personal responsibility toward protecting the ECF compared to men. Women felt less responsible to protect the ECF but this does not necessarily mean they care less about the forest, as most of them depend on it for food, water, shelter, and income.

In addition to required knowledge, attitudes, and personal responsibility for individuals to engage in EFBs, I also acknowledge that other factors not accounted for in this analysis help determine whether an individual will engage in desired behaviors or not. For example, people must possess skills to implement any desired behavior that require specific skills (Bamberg & Möser, 2007; Hines et al., 1987). While most environmental behaviors assessed in this study did not require new skills for individuals to perform them (as most of them learn through life experiences) lower participation in some EFBs may have been a result of limited skills. One example is tree-planting; although participants demonstrated higher knowledge in tree planting as a solution to forest degradation, very few of them reported having engaged in this behavior. Lack of participation in tree planting may be partly due to lack of skills and resources (a situational factor discussed in the section below) to perform this behavior.

Situational or environmental factors may have to align with an individual's need to protect the forest. For example, people may need to have access to alternative sources of forest products (Kollmuss & Agyeman, 2002) to avoid engaging in some destructive behaviors such as over extraction of trees for construction. People may understand that collecting only dry wood for firewood leads to preservation of the natural forest, but if

dry wood is scarce and there are no alternative sources of cooking energy, they may still

cut living trees or branches. Availability of planted forest blocks may act as alternative

sources of wood for both construction and firewood; consequently, overexploitation of

the natural forest may decline, a factor that may contribute to the forest's sustainability.

Since Loliondo does not have alternative sources of forest products, natural forests act as

the main suppliers of forest products. While situational factors were not included in the

model, other studies have shown that they contribute greatly to engagement in

environmentally friendly behaviors by either counteracting or facilitating the effects of

individuals' cognitive and personality factors (Kempton, Boster, & Hartley, 1996).

Other proposed environmental factors that influence behavior include *affordances*

and social norms (Clayton & Myers, 2009). According to Clayton and Myers (2009),

affordances are simply available options that people would engage in that would promote

sustainability. They also argue that when one is aware of desired behaviors yet has no

access to information that will allow him/her to acquire enough skills to perform the

behavior, this lack of information may bar the person from acting. *Social norms* are

unwritten rules about how people in a particular society ought to behave. This implies

that if social norms in a community align with conservation goals, they are likely to lead

to protection of the forests, and vice versa. One relevant social norm with regard to forest

use in Loliondo is the cutting of live green trees for construction of *bomas* and livestock

enclosures. Since this is a norm among the Loliondo people, knowledge that using dry

wood for construction is more sustainable may not necessarily lead to engagement in

respective behaviors since people are likely to continue doing what others do. Regarding

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this study, however, situational factors were expected to be more uniform across villages, and thus were not expected to influence the results in any significant way.

While several studies have in the past been used to model environmental behavior, most studies have focused on contexts of developed countries.[87] Consequently, most attributes in the explanatory and outcome constructs cannot be applied in studies of developing countries in the same way, especially in rural contexts. Concepts such as recycling, energy use, or water use behaviors cannot be operationalized in rural areas of Tanzania. By using contextualized constructs for both predictors and outcome variables, my study contributes to the understanding of factors that can help predict engagement in sustainable forest-related behaviors in the Loliondo area of Northern Tanzania and in similar contexts.

One of the limitations of this study is relatively small sample size and coverage. While it was plausible to assess the effects of the three explanatory factors on engagement in EFBs based on the limited sample size, it was difficult to disaggregate the data by various demographic factors or other contextual data and determine their relationships with the outcome variable. This was especially true for individual attributes of the outcome variable used since many fewer participants reported engaging in specific EFBs. Future research may thus aim at improving the sample size and cover a much larger area and different contexts to obtain more generalizable findings. Also, the accuracy of the predictions may be improved by focusing on individual EFBs as outcome

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87 Most studies implemented in rural contexts of developing nations are qualitative in nature and have not been used in modeling environmental behaviors.

variables; that is, instead of using an index variable based on multiple behaviors as in this study, one may assess factors related to using dry wood for firewood. Focusing on one behavior may also allow the researcher to collect additional contextual factors and include them in the model, thus improving the reliability of the model's predictive power. Additionally, one may consider using the Likert Scale format of questions in studies of more literate populations. Since the Likert Scale uses closed-ended questions (as opposed to open-ended questions used in this study), the problem of underreporting answers may be minimized; the Likert Scale may, however, introduce the problem of over-reporting answers in contexts that are culturally not accustomed to five-point scale questions. Finally, to improve the accuracy of the model estimates, one might consider assessing behaviors that can be observed directly rather than relying on self-reported behaviors.

8. Conclusions and Policy Implications

In Chapter Five, I demonstrated that environmental education is critical for managing forest resources. As shown in the results, the face-to-face group discussion strategy contributed highly to increased knowledge about behaviors contributing to forest degradation, environmental problems facing the ECF and their solutions, as well as improved attitudes toward various EFBs. Participants in the treatment group were more willing to take actions and engage in behaviors that would help sustain the local forest compared to those in the control group. Additionally, the group discussion strategy contributed to increased engagement in EFBs, although the differences between the treatment and the control were statistically significant only at the 90% confidence interval. These findings suggest that while the focus group EE strategy contributed highly to improved knowledge and attitudes toward forest-related behaviors, neither increased knowledge nor positive attitudes translated into a significant increase in engagement in sustainable behaviors. These findings were not surprising, because the EE was informational and thus did not provide any hands-on training for complex behaviors. Moreover, none of the contextual factors were altered to facilitate change in behaviors. The results observed not only concur with the available literature on the impact of environmental education on people's knowledge, attitudes, and behavior but also expand on the understanding of environmental knowledge constructs relevant to rural contexts of developing countries, specifically on forest-related topics.

On the other hand, the mobile phone text messaging strategy did not contribute to improved knowledge, attitude or behavior. The effectiveness of the mobile phone texting strategy was hampered by various contextual factors, including limited mobile phone ownership, high illiteracy and limited skills in technology use, unreliable mobile network, and political climate. While this study concludes that a mobile phone texting strategy did not lead to improved environmental knowledge, attitudes, and behavior, it provides some insights into how observed hindering factors can be addressed in future to better implement other programs. Future studies may focus on identifying circumstances under which mobile phone text messaging might yield more positive results in rural and urban contexts of developing countries. Effective implementation of this strategy might increase access to environmental information among rural population and might minimize implementation costs of EE program, a factor critical in countries like Tanzania which have limited resources for natural resource management activities such as environmental education, especially if resources are found on unprotected lands.

The study also revealed differences between male and female participants. Men demonstrated much higher knowledge and more positive attitude toward EFBs, and they reported having engaged in more EFBs compared to females. The differences observed were not surprising, since gender roles are still very differentiated between men and women among most African societies, even more so in rural areas (Arora, 2015; Eckman,1996; Eckman, et al., 1995). Men and women also have unequal access to resources, and decision making varies between them at both the household and community levels (World Bank, n.d). The gendered nature of access to resources,

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decision-making, and labor division might have influenced what forest-related activities are perceived as relevant to women in Loliondo and consequently affected the level of knowledge demonstrated, their attitudes toward various EFB demonstrated, and their participation in EFBs. Despite the differences observed, both groups equally care about the forest.

One of the policy implications is that efforts to disseminate environmental information should continue. Also, as proposed by Lippmann (1946), dissemination of a particular message should not be a one-time event; instead similar information should continue to flow to the intended audience. As shown, implementation of EE programs can help improve environmental literacy and consequently improve people's attitudes toward various EFBs. This could in turn help them convert their knowledge into actions and behaviors that have great potential to improve the health of local forests. While informational-based strategies may continue to be employed to remind people that a known (e.g. local forest guarding) behavior is called for, more effective strategies are needed for complicated behaviors or actions that require skills, cultural shifts, or resources. Providing hands-on training—rather than informational only—for behaviors such as tree-planting may help ensure that knowledge acquired is translated into actions. The district authority and NGOs like FZS, in collaboration with villages, can provide hands-on training on sustainable behaviors such as tree-planting, rotational grazing, and sustainable or conservation agriculture. Provision of adequate training on these behaviors will help locals master the process for their implementation and subsequently improve

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individuals' skills and attitudes toward these behaviors. Improved skills and attitudes are both likely to lead to engagement in these behaviors by locals.

Most participants in the group discussion treatment demonstrated high knowledge of environmental issues and their solutions, yet very few of them engaged in known EBFs. Most people, for example, reported engaging in community guarding and reporting of illegal activities to the authorities either at the village or district level as strategies for ensuring that the local forest is preserved. While these efforts can help reduce pressure from destructive activities, such as illegal logging and charcoal burning, they overlook the unavoidable pressure from the high demand for forest products. As population continues to grow demands for trees for timber and other uses will continue to grow and the consequences on the forest are bound to worsen. This implies that under high demand of forest products, local guarding may fail to yield expected outcomes. As interviews with village leaders and elders reveal, some forest guards do receive bribes from illegal loggers and thus do not report destructive behaviors encountered or arrest the culprits. These petty corruptions are likely to increase as demand for forest products increases and no alternative sources are available. With more resources from the government or NGOs, there is a need to address contextual factors such as high demand for forest products and lack of alternative sources of these resources. One way to do this is initiating sustainable energy production such as biogas production plants. Since the Maasai tend to own large herds of cattle, it would be easy to obtain enough cow dung to feed the biogas plants. The main challenge with such an endeavor, apart from the difficult cultural shift and many other challenges, is that water would have to be nearby since biogas plants require a lot of

water (Rupf, Bahri, Boer, & McHenry, 2015). Biogas or similar projects would help minimize demand for trees for firewood, and thus reduce pressure on the natural forests.

Because the people in Loliondo will continue to rely on trees for various uses, tree planting projects that aim to increase forests in the area would help remove pressure on the natural forest. New planted trees might serve as sources of wood for construction and firewood. I thus recommend finding alternative sources of forest products instead of relying on community guarding which is bound to fail with increased pressure. Additionally, the district and NGOs, in collaboration with villages, may also help lead campaigns that promote engagement in known friendly behaviors, such as collecting only dry wood for firewood or construction of cowsheds or the use of live fences, so that there is less pressure on the natural forest. The district authority and local NGOs may also promote other EFBs that are not popular in Loliondo. For example, they may encourage villagers to conserve forests found on their land as these may serve as alternative sources of forest products as well as help conserve the soil. Such actions can help reduce pressure on the community forest which is critical for various ecological processes.

Due to observed gender differences in knowledge, attitudes, and practices, I recommend implementing EE programs such that these differences are accounted for. While it may be plausible to promote gender parity in forest-related activities it may be counter-productive to do so in short-term projects. Gender differences may be due to culturally rooted differences in access and ownership of forest resources, decision-making, and labor division. It may thus be more effective to promote behaviors and actions in a way that imitates culturally-embedded differences between men and women

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in the Maasai communities. For example, it may be counter-productive to promote

rotational grazing among Maasai women since it is men who tend to own livestock and

decide where to graze them. It may be beneficial, however, to promote dry wood

collection and use of improved cooking stoves among women since these fall under

women's responsibilities. For behaviors that require decision making by both men and

women, both groups should have equal access to the training.

Selection of a strategy for implementing EE is another factor that should never be

overlooked. As reported here, the face-to-face group discussion strategy—the traditional

approach—outperformed the text-messaging strategy – the modern approach. While

traditional approaches may be critical for the success of any EE program, they can also be

very costly if implemented on a larger scale. There is thus a need to test the effectiveness

and cost of other EE strategies that have been reported to have had positive impacts in

other places, including use of radio, cinema, and drama. Identifying cost-effective but

also feasible and impactful strategies is especially crucial for Tanzania since the

government rarely allocates any resources for management of forests that are not under

protection. Another policy implication is that funding must be made available to support

programs that explore various alternative strategies in an effort to identify cost-effective

and impactful educational strategies and to develop appropriate curricula in local

languages.

In Chapter Six, I demonstrated that participation in marking earth features on

photo-maps led to improved understanding of the local forest's health conditions. The

question about forest health status was politicized and yielded unexpected results.

Consequently, the data could not be analyzed further to learn how understanding of the local forest health conditions contributed to engagement in EFBs. Nevertheless, most participants in the treatment group acknowledged increased understanding about the forest. Increased knowledge about boundaries of the ECF, types of destructive activities taking place inside the forest, and about features that previously existed inside the forest but disappeared within the past 15 years all provided evidence for increased understanding due to participation in the photo-mapping activity. I thus recommend that more participatory-photo-mapping activities should be implemented in Loliondo to help villagers get a better understanding of the health status of their forest as well learn more about types of destructive activities taking place in their forest. Understanding where destruction is largely taking place, for example, may help village authorities channel their management efforts to parts of the forest where needed. Furthermore, participatory photo-mapping can also be implemented to help villagers implement land use planning (Mundia, 2016a, 2016b). Since most villages are not mapped (i.e., do not have formal geographic boundaries marked) and do not have land-use plans (due to the high implementation costs) (Development Partners Group, n.d.), participatory photo-mapping might help speed up the process of zoning village lands, and consequently contribute positively to forest management. The district authority can acquire freely available satellite images and facilitate the process of land-use planning using photo-maps and physical marks.

Finally, in Chapter Seven, I show that engagement in EFBs was positively related to all three explanatory factors: knowledge about environmental problems and their

solutions, attitudes toward EFBs, and a sense of personal responsibility. Both attitude and sense of personal responsibility seemed to have more effect compared to knowledge, however. I thus concluded that all three factors are critical for predicting whether an individual will engage in EFBs. I also found that being a woman or living closer to the forest affected the number and types of EFBs an individual engaged in. EFBs reported by female participants seemed to follow gender-differentiated roles; women were likely to report EFBs they engaged in that also fall under the women's household responsibilities; the same was true for male respondents and male responsibilities. Also, individuals who lived near the forest were more likely to report engaging in EFBs compared to those who lived far from the forest, possibly because individuals from nearby villages claimed ownership of the forest. While situational factors (socio-economics, social norms, availability of alternative sources of forest products, etc.) were not accounted for, I do acknowledge that they can influence engagement in some EFBs. Situational factors were not a concern for this study because they were not expected to vary with respect to the outcome variable. The influence of situational factors may depend on the type of EFB being promoted. If a behavior requires resources, for example, then socioeconomic status must be accounted for. I thus recommend that the district authority and NGOs should continue to implement EE projects in the Loliondo area so that people's knowledge, attitude and personal responsibility continue to improve. These are critical factors for engaging in EFBs. Since the forest benefits and is impacted by both adjacent and non-adjacent villages, education efforts should be implemented in nearby and distant communities.

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More importantly, and if funds are available, environmental problems must be approached in a more holistic manner. Program managers need to ensure that all procedures for project implementation are followed and that all the contextual (situational) factors are addressed. Situational factors that may need to be addressed include slowing down the population growth rate because high population implies increased consumption of resources. Through implementation of effective family planning programs in rural areas, population growth can be slowed down as women start having fewer children. Second, the education system must be improved. Since the Maasai are among the least educated people, it is challenging to implement educational programs because most of them require some level of literacy. The more educated people are, the easier it will be for them to follow the instructions provided, whether it is through mobile phone or face-to-face. More educated individuals will also be able to critique forest-related policies more effectively without being misled by politicians. Furthermore, the more educated men and women are, the fewer children they are likely to have, and the less pressure put on the forest. Third, another contextual factor that needs to be addressed is the availability of water resources. Currently, Maasai people and other tribes in Loliondo rely on water from springs in the forest. This implies that most of them travel long distances to fetch water. Lack of tapped water in each *boma* makes it a challenge to implement various projects. For example, biogas plants would be ideal for producing energy for cooking and lighting, and would consequently reduce pressure on the forest. However, biogas plants cannot be installed on dry lands like in the Maasai area as they are likely to fail for lack of adequate water. Despite the fact that most households in

Loliondo are likely to get enough cow dung for the gas plant, women cannot manage to fetch enough water for the plants. Similarly, without water, it is impossible to have kitchen gardens that would save families from hunger (and thus avoid tree-cutting for money to buy food) as well as allow families to plant new tree nurseries. Financial assistance, in the form of affordable loans and other vehicles, is also critical for the success of EE projects. This is true especially for poor households.

Finally, another critical factor is the capacity building of men and women. Men and women need training in various aspects, including on how to be an advocate for their resources, understanding proposed policies that affect their lives, financial management, and leadership skills. Most leaders in Loliondo villages have attained only a primary level of education but receive no comprehensive training about training about forest resources management. Leadership skills will help communities collaborate among themselves to fulfill common goals such as managing a forest depended on by multiple villages.

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Appendices

Appendix A: Certificate of forest ownership by surrounding villages

Jamhuri ya Muungano wa Tanzania

WIZARA YA MALIASILI NA UTALII

Anwani ya Simu: "MALIASILI NA UTALII",
Simu: 2861872-4
Fax: 255-022-2864255
E-mail-ps@mnrt.go.tz

S.L.P. 9372,
DAR ES SALAAM

Unapojibu Tafadhali taja:

Kumb. Na. JA 168/374/08/18

1 Februari 2013

Mkurugenzi Mtendaji
Halmashauri ya Wilaya ya Ngorongoro
S.L.P. 1
LOLIONDO

YAH: KUOMBA MSITU WA LOLIONDO II KUHIFADHIWA NA KUSIMAMIWA NA JAMII

Tafadhali rejea kiswa cha habari hapo.

Barua ya Wizara ya maliasili na Utalii yenye kumb. Na. JA 168/374/08/15 ya tarehe 19/11/2012 kwa Katibu tawala wa Mkoa wa Arusha iliagiza vijiji vinne vinavopakana na Msitu wa LoliondoII vilete mihtasari ya mikutano yao mikuu inayoridhia eneo hili la msitu lisimamiwe na jamii na vilevile kupata maoni ya Kata kuhusu nia hii ya vijiji kusimamia msitu tajwa na mihutasari ya vikao halali ngazi ya wilaya vinavyounga mkono wazo hili.

Wizara imepokea vielelezo vyote kama ilivyoagizwa. Na kama barua tajwa hapo juu ilivyoeleza, wizara haina kipingamizi chochote kuzuia jamii kusimamia msitu tajwa.

Ili jamii iweze kuusimamia msitu huo maelekezo ya sheria ya Misitu Na. 14 ya 2002 vifungu 32 – (33) (1), 40 na 41 na mwongozo wa Usimamizi Shirikishi wa Misitu kwa Jamii ni lazima yatekelezwe ikiwa ni pamoja na:
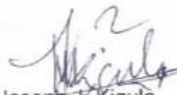
- Katika kila kijiji iundwe kamati ya usimamizi wa msitu itakayochaguliwa kwenye mkutano mkuu wa kijiji,

- Uamuzi ufanywe wa jinsi ya kuusimamia msitu baina ya vijiji vyote vitano vinavyouzunguka msitu, kwamba vitausimamia kwa pamoja au vitagawana maeneo ya usimamizi,

- Tathmini shirikishi ya rasilimali za msitu ifanyike ili kubaini rasilimali iliyomo msituni na kupanga jinsi itakavyolindwa na kutumika kwa uendelevu,

- Uandaliwe mpango wa usimamizi wa msitu wote, ndani yake ukionesha kanda za matumizi mbalimbali kwa kuzingatia umhimu wa msitu huo kwa jamii na

wana Loliondo wote kwa ujumla,

- Zitungwe sheria ndogo za kusimamia msitu

- Mpango wa usimamizi wa msitu pamoja na sheria ndogo za msitu viwasilishwe kwenye mikutano mikuu ya vijiji husika kwa idhini,

- Mpango wa usimamizi wa msitu pamoja na sheria ndogo viwasilishwe kwenye Baraza kuu la Halmashauri ya wilaya kwa idhini kama inavyoelezwa kwenye mwongozo wa Usimamizi Shirikishi wa Misitu kwa Jamii.

Kwa barua hii, kibali kimetolewa kwa jamii za vijiji vya Loliondo, Sakala, Orkyu, Ng'arwa na Naan kusimamia msitu wa Loliondo II. Wizara itaendelea kufuatilia kuona jinsi jamii husika inavyosimamia msitu huo.

Nawatakia utekelezaji mwema wa sera ya Misitu na usimamizi wa msitu huu muhimu.

Joseph J. Kigula
Kny: KATIBU MKUU
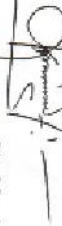
Nakala
Katibu Tawala Mkoa wa Arusha S.L.P 3050 Arusha- Taarifa
Mkuu wa Wilaya Ngorongoro S.L.P 10 Loliondo – Taarifa
Diwani Kata ya Enguserosambu S.L.P 1 Loliondo – Taarifa

Source: Copy of the certificate acquired by Sirima, 2015.

Appendix B: Letter from the ward councilor: Evidence of politics at play

DIWANI KATA YA ENGUSEROSAMBU
S. L. P. 1, LOLIONDO, ARUSHA
9/6/2015

MKURUGENZI MTENDAJI HALMASHAURI YA (W) NGORONGORO
S. L. P. 1, LOLIONDO-ARUSHA, TANZANIA

YAH: MALALAMIKO YA JAMII YA ENGUSEROSAMBU KUHUSIANA NA MTAFITI MAJORY K. SILISYNE ALIYEPEWA KIBALI NA OFISI YAKO KUJA KUFANYA UTAFITI JUU YA RASILIMALI ZA MISITU KATA YA ENGUSEROSAMBU

Tafadhali husika na kichwa cha habari hapo juu.

Nimepokea malalamiko mengi kutoka vijiji vya Ng'arwa, Naan, Orkiu juu na Enguserosambu ikiwemo pa Bodi ya Wadhamini inayosimamia msitu wa Jamii/wa Enguserosambu juu ya mtafiti tajwa hapo juu. Mtafiti Majory Silisyene alianza kufanya utafiti mwaka 2009 hadi sasa kwa kuwezeshwa na shirika la Frunkfurt Zoological Society lenye makao makuu yake nchini Ujerumani. Jamii nzima imepata hofu juu ya mtafiti huyu na hasa mbinu anazotumia na muda mrefu wa takriban miaka mitano sasa. Hofu ya jamii juu ya mtafiti huyu imejikita katika maeneo yafuatayo:

1. Mtafiti kutotambua msitu wa Enguserosambu kuwa ni msitu wa Hifadhi ya Jamii katika muhtasari wa ripoti aliyotoa kwa uongoz wa vijiji, mtafiti hajaweza kutambua tukio hilo la kisheria la msitu kusimamiwa na Jamii.

2. Mtafiti pia amekataa kutambua Bodi ya Wadhamiri (Board of Trustee) iliyosajiliwa kisheria na kupewa idhini ya kisheria ya kusimamia msitu kwa niaba ya jamii. Aidha, katika mahojiano yote na hata baada ya kuelekezwa na Serikali za vijiji, mtafiti ameshindwa kutambua chombo hicho muhimu kwa uelewa na uendelewu wa msitu huu muhimu.

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report ya kuingereza

3. Mbinu ya uhaulji wa elimu kwa njia ya simu za mkononi kwa jamii ambayo asilimia kubwa hawajui kusoma wala kuandika, imezua hofu na huku jamii ikiamini mbinu hii imefanywa makusudi ili wadanganyike.

4. Mtafiti kuambatana na wafadhili wake katika kupita kwenye maeneo ya kata yangu, na hivyo wananchi kujiuliza kama ni utafiti wa kimasomo, kwaniri aambatane na mfadhili? Hofu ya wananchi imejijenga kwenye dhana kwamba huenda utafiti huu unaendea miradi wa uhifadhi bila kushirikishwa ipasavyo. Hata hivyo, ushahidi wa kimazingira unaoryesha kuwa kuna agenda iliyojificha.

(3)

5. Kukabidhi muhtasari wa ripoti ya kazi yake ya utafiti kwa miaka minne iliyopita baada ya kushinikizwa na uongozi wa vijiji. Matokeo ya awali imeonyesha kuwa jitihada za jamii ya kuhifadhi msitu wa Enguserosambu zimebezwa na ripoti hiyo na kuonyesha mapungufu tu kwa upande wa jamii. Hii imefanya sehemu kubwa ya ripoti yake kuegemea upande moja (Biased) na hivyo kuzua hofu juu ya mantiki ya utafiti huu na matokeo yake.

6. Kwa mujibu wa muhtasari wa ripoti ya mtafiti, vijiji vingine vinne vimeongezwa ambavyo havipo kwenye msitu wa Jamii ya Enguserosambu. Matokeo ya mahojiano ya vijiji ambavyo havijapitia mchakato wa uanzishwaji wa msitu wa jamii na wala havikutajwa katika Kibali ya Wizara. Aidha, mkanganyiko huu umeunganishwa kwenye matokeo ya jumla ya mahojiano na kusababisha kutokuwepo kwa uhalisia wa kitakwimu.

7. Mtafiti amejitambulisha kama mwanafunzi lakini mwenendo mzima wa kazi yake imeendelea kuonyesha kuwa haijengi juu ya jitihada za kijamii wala za wadau wengine wa uhifadhi na badala yake, kujua mapungufu yasiyoweza kuthibitishwa. Mahusiano ya mtafiti na mwezeshaji (FZS) na matokeo ya utafiti huu unaacha mengi ya kujiuliza na hivyo kusababisha hofu kubwa.

Kwa mantiki hiyo basi na kwa malalamiko hayo, Kamati ya Maendeleo ya Kata yangu itakutana mapema wiki hii ili kujadili kwa undani ripoti hii na hatimaye kuja na mapendekezo ya namna bora ya kuleta mawazo yetu pamoja. Aidha, kwa barua hii tunaomba usinamishe zoezi hili kwa usa ama wa mtafiti katika kata yangu wakati tunajadiliana na kutoa mapendekezo ya namna ya kumshauri mtafiti.

Wako katika ujenzi wa taifa,

Mhe Kaigili Ngukwo Ole Mashati

Diwani Kata ya Enguserosambu

Nakala:

1. Dr. Kunei, Mshauri mwandamizi wa Mradi wa FZS- Tunaomba zoezi hili lisitishwe kwa usalama wa mtafiti.

2. Mwenyekiti wa Halmashauri ya Wilaya Ngorongoro- kwa taarifa

3. Wenyeviti wa vijiji vya Ng'arwa Enguserosambu, Orkiu Juu na Naan- kwa taarifa

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Appendix C: Questionnaire

<u>**THIS SURVEY SHOULD ONLY BE ANSWERED BY INDIVIDUALS IN THE HOUSEHOLD THAT ARE 18 YEARS AND ABOVE.**</u>

When the interviewer visits a household he/she should indicate if the survey was completed on the first visit or second or third visits. Indicate the reasons for not completing the interviews in the note book provided.

Interviewer visits:
1) First visit
2) Second visit
3) Third visit

EACH ENUMERATOR WILL HAVE A COPY OF NAMES OF INDIVIDUALS WHO WERE INTERVIEWED IN 2013 AND THE NAMES OF HOUSEHOLD HEADS THE INDIVIDUAL COMES FROM. THESE INDIVIDUALS WERE ASSIGNED IDENTIFICATION NUMBERS - 1, 2, 3, 4; YOU SHOULD WRITE DOWN THESE IDS FOR EVERY PERSON. PLEASE CHECK NAMES OF EVERY INDIVIDUAL YOU INTERVIEW TO SHOW THAT THE INTEVIEW IS COMPLETE. BECAUSE NAMES CAN BE CONFUSED, CONFIRM WITH THE VILLAGE GUIDE THAT THE PERSON COMES FROM THE HOUSEHOLD HEAD LISTED ON THE FORM PROVIDED.

REFER TO THE INFORMED CONSENT FORM AND VERBALLY ASK THE PARTICIPANT'S CONSENT BEFORE YOU BEGIN THE INTERVIEW – MAKE IT A CONVERSATION.

Date _____ Village_____ Sub Village_____

Ward _____

Household number _____

Name of Household head _____

Name of interviewer _____

Name of interviewee _____

RESPONDENT ID _____

Section A: Knowledge, attitudes, and practices questions

1. Are you aware of Loliondo II (Enguserosambu) forest?
   00 No ➔ GO TO SECTION C
   01 Yes

2. What are the benefits of Loliondo II (Enguserosambu) forest? **(Allow multiple responses. Do not read answers. Prompt: Anything else?)**
   a) Brings rainfall

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b) Provides fuel wood
c) Provides poles/timber for construction
d) Provides medicine
e) Provides water (springs and rivers)
f) Provides pasture for livestock
g) Provides food to people
h) Provides income for people
i) Cools down the air
j) Provides trees for cultural practices (e.g. matambiko, olpul)
k) Prevents soil erosion
l) Provides clean air (oxygen)
m) Prevents pasture from drying
n) Conserves wildlife (wild animals)
o) Provides tourist attractions
p) None
q) Other (specify) _____

3.   Do you use Loliondo II (Enguserosambu) forest?
00 No GO TO QN5
01 Yes

4.   If yes: Ask; how do you use Loliondo II (Enguserosambu) forest? **(Allow multiple responses. Do not read answers. Prompt: Anything else?)**
a) Fuel wood
b) Poles for construction
c) Medicinal plants
d) Water
e) Grazing livestock
f) Food
g) Trees for cultural practices
h) Source of income
i) Honey
j) Other (specify) _____

FOR QUESTION 4A TO 4G, WRITE NAMES IN KISWAHILI, KIMAASAI, OR KISONJO

4a. Which trees from Loliondo II (Enguserosambu) forest do you use for food
_____

4b. Which trees from Loliondo II (Enguserosambu) forest do you use for income
_____

4c. Which trees from Loliondo II (Enguserosambu) forest do you use for medicine
_____

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4d. Which trees from Loliondo II (Enguerosambu) forest do you use for fuel wood
_____

4e. Which trees from Loliondo II (Enguerosambu) forest do you use for constructing buildings _____

4f. Which trees from Loliondo II (Enguerosambu) forest do you use for cultural practices
_____

4g. Which trees from Loliondo II (Enguerosambu) forest do you use for feeding livestock during dry season _____

5. Is Loliondo II (Enguerosambu) forest getting better, staying the same, or getting worse?
    01 Getting better
    02 Staying the same
    03 getting worse
    88 Don't know

6. When you compare the current conditions of Loliondo II (Enguerosambu) forest to 10-15 years ago, do you think it have improved, stayed the same, or gotten worse?

    01 Better ➔ GO TO QN7
    02 Same ➔ GO TO QN9
    03 Worse ➔ GO TO QN8
    88 Don't know ➔ GO TO QN9

7. What signs/evidence show that conditions of Loliondo II (Enguerosambu) forest have gotten better compared to 10-15 years ago? **(Allow multiple responses. Do not read answers. Prompt: Anything else?)**
    a) Increase in fuel wood
    b) Increase in trees for construction
    c) Increase in medicinal plants/trees
    d) Increase in rainfall or moisture
    e) Increase in water in rivers and springs
    f) Increase in pasture
    g) Increase in some tree species
    h) Better air quality
    i) Decline in temperature around the forest
    j) Increase in dense forests
    k) Other (specify) _____

8. What signs/evidence show that conditions of Loliondo II (Enguserosambu) forest have gotten worse compared to 10-15 years ago? (**Allow multiple responses. Do not read answers. Prompt: Anything else?**)
    a) Decline in firewood
    b) Decline in trees for construction
    c) Decline in medicinal plants/trees
    d) Decline in rainfall/moisture around the forest
    e) Decline in water in rivers and springs
    f) Decline in pasture
    g) Disappearance of some tree species
    h) Less green pasture during dry season
    i) Increased number of houses and agricultural fields within the forest
    j) Increased temperature around the forest
    k) More shrub areas inside forest
    l) Decline in air quality
    m) Other (specify) _____

9. What behaviors/factors contribute to decline of Loliondo II (Enguserosambu) forest (**Allow multiple responses. Do not read answers. Prompt: Anything else?**)
    a) Cutting living trees for firewood
    b) Charcoal burning
    c) New and expansion of farms inside the forest
    d) Cutting of living trees for construction
    e) Illegal logging for timber
    f) Overgrazing (Grazing of livestock)
    g) Settlements inside the forest
    h) Cutting of trees for animal/livestock feeds
    i) Debarking tees for medicinal purposes
    j) Other (specify) _____

10. Are there any negative impacts of destroying Loliondo II (Enguserosambu) forest?
    00 No ➔ GO TO QN12
    01 Yes

11. If yes: Ask; what are they?
    (**Allow multiple responses. Do not read answers. Prompt: Anything else?**)
    a) We won't be getting fuel wood
    b) We won't be getting wood for construction
    c) We won't be getting medicinal plants/trees
    d) We won't be getting rainfall
    e) Rivers and springs will dry
    f) We won't be getting pasture for livestock
    g) Some tree species will disappear
    h) We won't have sources of livelihoods
    i) Wildlife will disappear
    j) Increased temperature in areas surrounding the forest
    k) Increased soil erosion

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l) Reduced air quality
m) Other (specify) _____

12. What actions would help sustain Loliondo II (Enguserosambu) forest? **(Allow multiple responses. Do not read answers. Prompt: Anything else?)**
   a) Plant trees
   b) Restrict cutting of trees
   c) Ban charcoal burning
   d) Exclusion of livestock from the forest
   e) Ban logging for timber
   f) Community action (such as guarding)
   g) Provide conservation education to people
   h) Report illegal activities to village leaders
   i) Collect only dry wood for firewood
   j) Collect only dry wood for construction poles
   k) Practice rotational grazing
   l) Establish and abide to forest bylaws
   m) Conserve forested areas that are outside protected forest
   n) Practice sustainable agriculture – e.g., create contours in hilly areas
   o) Stop extending farms/settlements inside forest
   p) Other (Specify) _____

13. What specific actions could you take that would help conserve Loliondo II (Enguserosambu) forest? **(Allow multiple responses. Do not read answers. Prompt: Anything else?)**
   a) Report illegal activities to village leaders
   b) Volunteer to guard the forest
   c) Construct houses using other materials such as cement bricks
   d) Provide conservation education to people
   e) Stop (never) expanding farms/settlements towards forests
   f) Plant trees
   g) Sensitize others about guarding the forest
   h) Ban charcoal burning
   i) Prevent livestock from entering the forest
   j) Ban logging for timber
   k) Collect only dry wood for firewood
   l) Collect only dry wood for construction
   m) Rotational grazing
   n) Participate in establishing and abiding to forest bylaws
   o) Conserve forested areas that are outside protected forest
   p) Practice sustainable agricultural – e.g., create contours in hilly areas
   q) Restrict cutting trees
   r) Other (Specify) _____

14. In the past six months, did you take any action (engage in any practices) to help protect/conserve Loliondo II forest (Enguserosambu)?
   00 No ➔ GO TO QN18

01 Yes

15. If yes: Ask; which actions/practices? **(Allow multiple responses. Do not read answers. Prompt: Anything else?)**
   a) Planted trees ➔ GO TO QN 16
   b) Practiced rotational grazing
   c) Provided conservation education to other people
   d) Reported illegal activities to village leaders/district officials/NGO leaders
   e) Volunteered to guard the forest
   f) Collected only dry wood for firewood
   g) Collected only dry wood for construction poles
   h) Proposed or participated in establishing and abiding to forest bylaws
   i) Conserved forested areas that are outside protected forest
   j) Practiced sustainable agriculture – e.g., create contours in hilly areas
   k) Restricted grazing livestock in the forest
   l) Stopped expanding farms/settlements towards forests
   m) Sensitized other people about guarding the forest
   n) Other (Specify) _____

16. If planted trees within the last six months: Ask; how many trees did you plant? _____

17. If planted trees within the last six months: Ask; where did you plant? **(Allow multiple responses. Do not read answers. Prompt: Anything else?)**
   a) Along field boundaries
   b) Inside the field (mixed with crops)
   c) Near/around the house
   d) On a block, separately
   e) Other (Specify)_____

   GO TO QN19

18. If he/she did not participate/engage in any practices/behaviors: Ask; what prevented you from participating/engaging in practices/behaviors to help protect/conserve Loliondo II forest (Enguserosambu)? **(Allow multiple responses. Do not read answers. Prompt: Anything else?)**
   a) Didn't have time
   b) Not my role
   c) Not my culture
   d) I don't know how
   e) Nothing
   f) Other (Specify) _____

19. What would motivate you to take more action to help conserve/protect Loliondo II (Enguserosambu) forest? **(Allow multiple responses. Do not read answers. Prompt: Anything else?)**
   a) Seeing other people conserve/protect the forest
   b) Drought experience

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c) Getting information about the forest from someone in the community
d) Observing with my own eyes something that works
e) Advice from trusted person
f) Forest information from community monitors
g) Forest information from District forest official
h) Forest information from conservation organizations (e.g. NGO)
i) When I see the forest is being destroyed
j) When I see the negative impacts of deforestation
k) Getting more environmental education
l) Other (Specify) _____

20. Who do you feel is responsible for taking action to conserve/protect Loliondo II forest?
(Allow multiple responses. Do not read answers. Prompt: Anything else?)
a) Village leaders
b) Village elders
c) The moran
d) Everyone in the village
e) Everyone in all neighboring villages
f) The government (the district)
g) NGO
h) Other (Specify) _____

21. How would you feel if Loliondo II (Enguserosambu) forest disappeared?
      01 Happy
      02 Sad
      03 Indifferent
      66 Not answered

21a. IF HAPPY: Why? _____
21b. IF SAD: Why? _____
21c. IF INDIFFERENT: Why _____
Section B: Environmental education information [ONLY ASKED DURING POST-TEST STUDY]

1. Since 2013, have you ever received any environmental education information from someone or an organization?
00 No ➔ GO TO QN17
01 Yes

2. If yes: Ask; from whom or which organization? **(Probe to make sure the person is not confusing Majory/FZS with other organizations - Allow multiple responses. Do not read answers. Prompt: Anything else?)**
a) Majory/FZS
b) Leaders/elders from this village
c) Leaders/elders from neighboring village
d) Friend/relative from this village
e) Friend/relative from neighboring village

      f) Other NGO (Specify) _____

      g) District officials

      h) Other (Specify) _____

3. If he/she received environmental education information: Ask; how?
      a) Relative/friend/neighbor
      b) Cell phone ➔ GO TO QN6, ELSE GO TO QN11
      c) Village group meeting/seminar
      d) Radio
      e) Television
      f) Leaflets or posters
      g) Village assembly meetings
      h) Meetings with village elders
      i) Meeting with NGO (specify)_____
      j) Other (Specify) _____

4. If via cell phone: Did you receive environmental messages via your own phone?
      01 Yes
      02 No, my husband's/wife's
      03 No, my brother's/sister's
      04 No, my mother's/father's
      05 No, my son's/daughter's
      06 No, other (friends)
      07 No, village leader's
      08 No, other (specify) _____

5. If via cellphone: did you read the environmental education messages sent to you?
      01 Yes, I read them myself
      02 Yes, someone read for me
      03 No, I did not read ➔ GO TO QN10

6. If did read (or someone read for him/her) the environmental education information sent via phone: how many times a month did you read? _____

7. If someone read for him/her: Ask; who read the messages to you most of the times?
(Allow multiple responses. Do not read answers. Prompt: Anything else?)
      a) Husband/wife
      b) Son/daughter (biological offspring)
      c) Parent
      d) Brother/sister
      e) Relative by marriage
      f) Other relative
      g) Grandchild
      h) Grandparent
      i) Friend
      j) Cell phone shop personnel
      k) Village leader/elder

l) Other (Specify) _____

8. If did not read: Ask; why?
   01 Don't have phone
   02 Don't know how to read
   03 Could not access phone network
   04 Didn't have time to read
   05 Thought the messages are phone company promotions
   06 Other (Specify) _____

9. If he/she received environmental education: Ask; was any information totally new to you?
   00 No ➔ GO TO QN14

   01 Yes

10. If he/she received environmental education that was totally new to him/her: Ask; which information was totally new to you? **Ask for each type of environmental education below;**

    10a. Benefits of Loliondo II forest. **(Allow multiple responses. Do not read answers. Prompt: Anything else?)**
    a) Brings rainfall
    b) Provides fuel wood
    c) Provides poles/timber for construction
    d) Provides medicine
    e) Provides water (springs and rivers)
    f) Provides pasture for livestock
    g) Provides food to people
    h) Provides income for people
    i) Provides clean air (oxygen)
    j) Provides trees for cultural practices (e.g. matambiko, olpul)
    k) Prevents soil erosion
    l) Cools down the air
    m) Prevents pasture from drying during dry season/drought
    n) Preserves wildlife
    o) Provides tourist attractions
    p) Other (specify) _____

    10b. Behaviors/factors that contribute to decline of Loliondo II forest. **(Allow multiple responses. Do not read answers. Prompt: Anything else?)**
    a) Cutting living trees for firewood
    b) Charcoal burning
    c) Expanding farms/settlements inside forests
    d) Cutting of living trees for construction
    e) Illegal logging for timber

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f) Overgrazing (Grazing of livestock)
g) Settlements inside the forest
h) Cutting of trees for animal/livestock feeds
i) Debarking tees for medicinal purposes
j) Other (specify) _____

10c. Negative impacts of destroying Loliondo II forest. **(Allow multiple responses. Do not read answers. Prompt: Anything else?)**
a) We won't be getting fuel wood
b) We won't be getting wood for construction
c) We won't be getting medicinal plants/trees
d) We won't be getting rainfall
e) Rivers and springs will dry
f) We won't be getting pasture for livestock
g) Some tree species will disappear
h) We won't have sources of livelihood
i) Disappearance of wildlife
j) Increased temperature in areas surrounding the forest
k) Increased soil erosion
l) Decline in air quality
m) Other (specify) _____

10d. Behaviors/actions that can help conserve/protect Loliondo II forest. **(Allow multiple responses. Do not read answers. Prompt: Anything else?)**
a) Plant trees
b) Restrict cutting of trees
c) Ban charcoal burning
d) Exclusion of livestock from the forest
e) Ban logging for timber
f) Forest guarding by community
g) Provide conservation education to people
h) Report illegal activities to village leaders
i) Collect only dry wood for firewood
j) Collect only dry wood for construction poles
k) Practice rotational grazing
l) Establish and abide to forest bylaws
m) Conserve forested areas that are outside protected forest
n) Practice sustainable agriculture – e.g., create contours in hilly areas
o) Stop expanding farms/settlements towards forests
p) Other (Specify) _____

[QN14-16 - FOR THOSE WHO RECEIVED ENVIRONMENTAL EDUCATION VIA MEETING/SEMINAR]

11. **If he/she received environmental education via meeting/seminar (group discussion): Ask**; did you participate in marking boundaries of Loliondo II forest and earth features found inside the forest on the map?
00 No ➔ GO TO QN 19
01 Yes

12. **If he/she participated in marking boundaries of Loliondo II forest and earth features found inside the forest: Ask**; did participating in marking earth features on Loliondo II forest map improve your understanding of Loliondo II forest?
00 No
01 Yes
88 Don't know

13.   If understanding improved: Ask; which knowledge increased? **(Allow multiple responses. Do not read answers. Prompt: Anything else?)**

Knowledge on;
   a)   Boundaries of Loliondo II forest
   b)   Location of fields and houses inside the forest
   c)   Location of water springs and rivers inside the forest
   d)   The extent to which the forest has been cleared
   e)   Location of roads inside the forest
   f)   Other (Specify) _____

14. **If he/she received environmental education: Ask;** did you share with other people any environmental education information you received?
00 No GO TO QN24
01 Yes

15.   With who did you share environmental education information you received **(Allow multiple responses. Do not read answers. Prompt: Anything else?)**
   a)   Village elders
   b)   Village leaders
   c)   Religious leaders
   d)   Family members, relatives, or friends
   e)   Environmental committee members
   f)   Community monitors
   g)   Teachers
   h)   Organizations such as NGO (specify) _____
   i)   None
   j)   Other (specify) _____

16.   What could the researcher (Majory/FZS) or other people/organization have done to improve your learning?
   _____

17. If did not receive any environmental education via cellphone: Ask; what prevented you from receiving environmental education via cellphone? (**Allow multiple responses. Do not read answers. Prompt: Anything else?**)
    a) Not interested
    b) Do not have phone and did not have someone to receive message from
    c) I cannot read, and did not have someone to help me read
    d) I deleted – I could not differentiate environmental messages from spam
    e) Was not in the village during dissemination
    f) No one sent me any environmental information via phone
    g) Other (specify) _____

18. If did not receive any environmental education information: Ask; what prevented you from getting environmental education? (**Allow multiple responses. Do not read answers. Prompt: Anything else?**)
    a) I cannot read
    b) I speak a different language from that used at village assemblies
    c) I have a physical disability (cannot go to meetings)
    d) Long distance walking to village meeting areas
    e) Too much work to do
    f) Time inconveniences (Bad time of day)
    g) I'm not interested
    h) No one gave me any information
    i) Other (Specify) _____

Section C: Demographic Information

1. What is your relationship to the household head?
    01 self
    02 wife/husband
    03 son/daughter (biological offspring)
    04 parent
    05 brother/sister
    06 relative by marriage
    07 other relative
    08 other, non-relative
    09 grandchild
    10 grandparent
2. Sex 01 male / 02 female

3. What is your age? _____ (Years) (**Estimate if the respondent does not know**)

4. What is the highest level of education reached by you?
    00 nursery
    01 standard 1
    02 standard 2
    (etc.)

07   standard 7
08   form 1
09   form 2
10   form 3
11   form 4
12   form 5
13   form 6
14   certificate
15   diploma
16   vocational
17   university
18   adult education
19   other type of education
20   none
88   Don't know

5. Over the past 4 weeks, what kind of work have you spend the <u>most</u> time doing?
    (**Choose one**)
    01 Housework
    02 Farming
    03 Tending livestock
    04 Casual labour
    05 Working at a small business (< TSh 100,000/-)
    06 Working at a large business (>= TSh 100,000/-)
    07 Professional (teacher, nurse, doctor, extension officer, etc.)
    08 Looking for work
    09 Not working (I was sick)
    10 Nothing (disabled/very old)

6. What is your religion?
    01 Moslem _____   02 Catholic_____   03 Protestant _____   04 Traditional _____
    05 None_____   99 Other

7. What is your tribe:_____

8. What languages do you speak? (**List the languages spoken in order of fluency**)
    First language _____ (**Use coded list**)
    Second language _____ (**Use coded list**)
    Third language _____ (**Use coded list**)

Section D: Interviewer's opinion at end of interview

1. Level of cooperation (CHOOSE ONE):
    01 Did not cooperate
    02 A little cooperative
    03 Somewhat cooperative

04 Mostly cooperative
05 Very cooperative

2. Level of understanding of the content (CHOOSE ONE):
    01 very little
    02 little
    03 good
    04 very good
    05 excellent

3. How much Swahili does the respondent speak and understand? (CHOOSE ONE)
    01 Most or all
    02 Some
    03 Very little or none
    88 Don't know because respondent would not speak to interviewer in Swahili

4. Interpreter used for interview? 00 no   01 yes

5. IF YES: Sex of interpreter?   01 male 02 female

6. Comments:_____ (FOR EXAMPLE: careful or sloppy
    responses, women won't talk near strange men; etc.)
    a. Respondent answered carefully
    b. Respondent did not seem free to talk / was scared of giving answers
    c. Having a male interviewer/interpreter was a problem for this woman
    d. Interpreter was not good
    e. Interview went well overall
    f. Interview was ok but there were a few difficulties
    g. Difference in age between respondent and interpreter affected responses
    h. Interview frequently interrupted
    i. Respondent seemed affected by the presence of on-lookers
    j. On-lookers sometimes participated in the interview, suggesting answers to respondent
    k. Other (SPECIFY in English): _____

Appendix D: Interview Guide

Name of Interviewee: _____

Name of Interviewer: _____

Interview Date: _____

Thank you for agreeing to speak with me today.

Note: Before beginning the interview, read aloud the consent form

At this time I would like to ask for your permission to record this conversation to help me maintain an accurate record of our conversation.

Interview Questions (points to cover)

- How do men or women in the community receive information on Loliondo II forest? Any traditional or non-traditional mechanisms?
- Do men or women in the community have preferred means of receiving information on Loliondo II forest? What are the preferences for men? What are the preferences for women?
- What strategies are used to ensure that more men or women in the community receive information on Loliondo II forest?
- What strategies are used to ensure that more men or women in the community understand the message on Loliondo II forest?
- Do men or women learn from each other on Loliondo II forest? What is the process for learning from each other on Loliondo II forest?
- What barriers do men or women face when asked to do something differently? For example, learning and adopting new skills such as use firewood efficient cooking stoves.
- What do men or women do when they want to learn about new things?
- Is there anything else you would like to add?

Thank you once again for participating in this study, and I welcome any additional comments or feedback.

Appendix E: Survey consent form

You are being asked to consent for your participation in a study that aims at evaluating the role of disseminating environmental information on forest resources management in natural resources areas.

You have been asked to participate because you have been selected randomly, and you are a member in a village near a forest. We will ask questions on your knowledge on ways of conserving forests, indicators of destroyed forests, causes of deforestation, negative impacts of clearing forests, and benefits of protecting the forests; how you perceive forest resources; and how you use forest resources. For all of the questions, you are free either to answer or remain silent, or end the interview at any time. The interview will take about half an hour of your time.

The information you will provide will be kept confidential. Your names will not be linked to the information we collect from you. Your name will not appear anywhere in the report. Your choice to participate in the interview will have no impact on your status and your ability to access services in your community; therefore, there is no risk expected to arise because of your choice to participate in the study.

Your participation is important because results obtained from the study will help your village and other similar communities in future management of your forest resources. The results from the study will also be shared with your community.

Your participation in the study is voluntary and there is no compensation for your participation. You have the right to refuse to participate or withdraw from the study even after consenting to participate without being asked for reasons of your decision. You are free to ask for clarifications or ask questions about the study, either before the interview begins, during the interview, or after the interview ends.

If you have any questions or concerns regarding the study and would like to talk to someone other than the researcher, you are encouraged to call Dr. Deborah Levison, Majory K. Silisyene's academic advisor +1612-624-3540

You will be given a copy of this form to keep for your records.

Appendix F: Focus group participants' consent form

You are being asked to consent for your participation in a study that aims at evaluating the role of disseminating environmental information on forest resources management in natural resources areas.

You have been asked to participate in this study on the basis of your knowledge and expertise. I will ask questions on strategies and mechanisms of information dissemination that are used in the community when informing local people about Loliondo forest. The purpose is to highlight ways to improve environmental education strategies in forest resources areas. For all of the questions, you are free either to answer or remain silent, or end the interview at any time. The interview will take about an hour and a half of your time. During the interview, we will have sodas and snacks.

The information you will provide will be kept confidential. Your names will not be linked to the information we collect from you. Your name will not appear anywhere in the report. Your choice to participate in the interview will have no impact on your status and your ability to access services in your community; therefore, there is no risk expected to arise because of your choice to participate in the study.

Your participation is important because results obtained from the study will help your village and other similar communities in future management of your forest resources. The results from the study will also be shared with your community.

Your participation in the study is voluntary and there is no compensation for your participation. You have the right to refuse to participate or withdraw from the study even after consenting to participate without being asked for reasons of your decision. You are free to ask for clarifications or ask questions about the study, either before the interview begins, during the interview, or after the interview ends.

If you have any questions or concerns regarding the study and would like to talk to someone other than the researcher, you are encouraged to call Dr. Deborah Levison, Majory K. Silisyene's academic advisor +1612-624-3540

You will be given a copy of this form to keep for your records.

Appendix G: Research Permits

IRB form from the University of Minnesota: received in June, 2013.

The IRB: Human Subjects Committee determined that the referenced study is exempt from review under federal guidelines 45 CFR Part 46.101(b) category #2 SURVEYS/INTERVIEWS; STANDARDIZED EDUCATIONAL TESTS; OBSERVATION OF PUBLIC BEHAVIOR.

Study Number: 1305E35002

Principal Investigator: Majory Silisyene

Title(s):
The role of community level environmental information on individual decision making in forest resources management in Tanzania. CREATE grant title: The role of community level feedback in natural resource management decision-making in the Loliondo Forest.

This e-mail confirmation is your official University of Minnesota HRPP notification of exemption from full committee review. You will not receive a hard copy or letter.

This secure electronic notification between password protected authentications has been deemed by the University of Minnesota to constitute a legal signature.

The study number above is assigned to your research. That number and the title of your study must be used in all communication with the IRB office.

Research that involves observation can be approved under this category without obtaining consent.

SURVEY OR INTERVIEW RESEARCH APPROVED AS EXEMPT UNDER THIS CATEGORY IS LIMITED TO ADULT SUBJECTS.

This exemption is valid for five years from the date of this correspondence and will be filed inactive at that time. You will receive a notification prior to inactivation. If this research will extend beyond five years, you must submit a new application to the IRB before the study's expiration date.

Upon receipt of this email, you may begin your research. If you have questions, please call the IRB office at (612) 626-5654.

You may go to the View Completed section of eResearch Central at http://eresearch.umn.edu/to view further details on your study.

The IRB wishes you success with this research.

TAWIRI 🦌 **Tanzania Wildlife Research Institute**

TWRI/RS 327/2012/8

Our Ref:

Your Ref:

Date: June 8, 2012

District Executive Director
Loliondo District
LOLIONDO

RE: INTRODUCTORY LETTER FOR MAJORY KAZIYA

Please refer to the heading above.

The above mentioned is a Tanzanian research scientis and registered by TAWIRI to conduct reserch titled: "*Conservation Research in Eastern Africa's Threatened Ecosystem - CREATE*" This research will be done in your distict.

Please provide her with all necessary assistance. If you require any further assistance, please do not hesitate to contact us.

Yours sincerely,
TANZANIA WILDLIFE RESEARCH INSTITUTE

Angela Mwakatobe
FOR: DIRECTOR GENERAL

TAWIRI is responsible for the co-ordination of all wildlife research in Tanzania

Njiro W.R.C.	Gombe W.R.C.	Kingupira W.R.C.	Mahale W.R.C.	Tabora R.S.	Serengeti W.R.C.
P.O. Box 661	P.O. Box 385	P.O. Box 16			

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HALMASHAURI YA WILAYA YA NGORONGORO
(Barua zote ziandikwe kwa Mkurugenzi Mtendaji)

MKOA WA ARUSHA
SIMU Na. 027-2535051/13
Fax. Na. 2535018/2535251

Kumb.Na.NGOR/DC/R.1/04/130

Ofisi ya Mkurugenzi Mtendaji (W)
S.L.P 1,
LOLIONDO

Tarehe: 07/01/2015

WATENDAJI WA VIJIJI VYA:
LOLIONDO, SAKALA, OLOIRIEN/MAGAIDURU
ENGUSEROSAMBU, TINAGA, ORKIU A, ORKIU B,
NAAN NA NG'ARWA.

YAH: UTAMBILISHO WA MAJORY KAZIYA SILISYENE.

Tafadhali rejea somo tajwa hapo juu.

Mtajwa hapo juu ni mwanafunzi wa Chuo Kikuu cha Minnesota. Atakuwa katika vijiji vyenu kwa ajili ya kufanya utafiti kwenye misitu ya Loliondo 1 & 2 ili kukamilisha kozi/mafunzo yake. Pia kwa kipindi hiki ataongezana na wafanyakazi wa Frankfurt Zoological Society.

Tafadhali mpeni ushirikiano utakaohitajika.

Fransisca John
Kny: MKURUGENZI MTENDAJI (W)
NGORONGORO