DISSERTATION

ILCHAMUS PASTORALISTS' INDIGENOUS KNOWLEDGE AND ITS USE IN COPING WITH AND ADAPTING TO CLIMATE CHANGE IN MARIGAT, KENYA

Submitted by

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ABSTRACT

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In view of present and future changes in weather and climate, documenting how pastoralists use their indigenous knowledge (IK) in coping with and adapting to climate change in their localities is increasingly important, as this knowledge may inform climate adaptation policies and practices. The objectives of this dissertation are: 1) to document the Ilchamus pastoralist IK about weather and climate, including indicators of environmental change; 2) to establish how the Ilchamus acquire, share and transmit their IK over generations and within their community; and 3) to investigate how their IK informs Ilchamus decision-making in their livelihood production systems.

To address these objectives, I conducted focus groups discussions with men and women in four communities, and administered a household questionnaire to 331 households in Marigat Sub-County, Kenya in 2010 and 2011. I found that the Ilchamus possess rich local knowledge on weather and climate, and use a variety of physical and biological indicators to detect environmental change. They observe changes in many of these indicators, and attribute many of these changes to climate change. Ilchamus obtain their indigenous knowledge through interactions with the biophysical environment, and from a variety of other traditional and non-traditional sources within the community. Ilchamus community members also use a number of formal information sources about weather and climate, including radio and television. Indigenous knowledge is not evenly distributed in the community, and Ilchamus often consult

local experts in addition to using their experiential knowledge. Use of traditional and formal sources of knowledge varies with age and education level. Community elders and those with less formal education rely more on traditional knowledge sources while younger and members that are more educated more often use formal sources of information.

Ilchamus IK is passed from parents to children though daily interactions and folklore, and is shared within the community through social networks and organizational structures. Although there are many social structures through which knowledge is shared, most of them are exclusive to men. Women are therefore disadvantaged in that only one informal social network is available to them, and this network is task-specific and short term. Traditional means of IK transfer remain intact, but face a challenge from young and educated members of the community, who disregard or dismiss IK and value foreign cultures and practices over local traditions and lifestyles. Ilchamus elders complain of formal education eroding their culture. However, the elders also support formal education for the community's children, which they see as providing more livelihood options for the future, beyond pastoralism. Ilchamus use a number of customary coping and adaptation strategies to deal with a variable and changing climate. They are aware of the possible consequences of climate change on their production systems and make livelihood decisions based on this knowledge coupled with their experience. However, the majority fail to take timely action in response to changing conditions.

This study demonstrates that Ilchamus community members hold extensive indigenous knowledge of weather and climate and that this knowledge has been used over time to inform livelihood decision-making in the community. I therefore recommend the Ilchamus indigenous knowledge system to be recognized by scientists and policy makers for its potential value in adaptation to climate change.

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Thanks you Ford Foundation- International Fellowship Program (IFP) for awarding me a scholarship to study in the USA, without which, I would not have come this far to get my PhD. I also wish to thank Egerton University, Kenya for granting me study leave.

This acknowledgement would not be complete without mentioning my American host family, Mr. and Mrs. Daniel Campbell and your three sons. You have made my life in Fort Collins and US for that matter meaningful. From my first month, first year in CSU 2009, you have welcomed me into your family to an extent, I am part of it, and I mean really part of the family with all privileges and rights anyone can get in their parental home.

Deep heart-felt thanks to my immediate family for accepting my many years away from home. I write this paragraph with fond memories as I recall those early days fall 2009 in CSU

when I wished something would happen so I can go back to Kenya and pursue my degree in any other local university. I could not have made it without your support, encouragement, perseverance, love and patience. Finally, I thank God for protecting, caring and providing us as a family all the period I was away.

DEDICATION

I dedicate this dissertation to my children who accepted to live and move on with their early schooling days while dad was away for such a long period. My special dedication goes to Ted for the obvious reasons. You are my inspiration to complete this degree. Finally, I wish to dedicate the entire study to the Ilchamus community in Kenya for giving birth, nurturing and caring for me throughout. I am forever proud to be one of your sons. Count on me to deliver in whatever you request.

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POSITIONALITY

(Reflection on my field research in Kenya)

I am a Kenyan by nationality, born and brought up in a district previously called Baringo, now a County by the same name. I was born into a community/tribe called the Ilchamus of Maa dialect. They live around Lake Baringo and practice pastoral and agro-pastoral livelihood systems. Born into this community, my long-term experience with them has made me most of the time wish to do something positive to change their livelihoods and destiny for the better. My two research works now (Master's thesis and this PhD dissertation) are all aimed at seeking an understanding of my community because through such knowledge, my guidance and advice to them will be more relevant and useful. I associate myself fully with the challenges they face in their day-to-day lives as they struggle to eke a living in a very hostile environment. These challenges are motivating me to do more research among my people. The close links may bring introduce some degree of bias into my work to the extent to which I collect information which in my own view and thinking will help them come out of the dire conditions in which they live. The Ilchamus have a lot of faith in their sons and daughters who pursue formal education, as I have, to the extent that they easily cooperate with them when the need arises. It is such cooperation and ease of communication in the local language that makes my fieldwork in Marigat attractive because I believe they will give me the best information they hold, which otherwise may not be shared with strangers.

Prior to conducting this research among the Ilchamus, I lived in a neighboring county called Nakuru for over twenty years since I finished by high school. In those years, though physically away from my tribe, I maintained close relations with them. Through my employment and other engagements, I interacted with its members both professionally and privately. This is not the first time I am doing a survey with them. My Masters thesis was written using data, I collected in this community and in the same areas where I collected data for my dissertation. My close working relations with the community makes access to them easy for me. Many elders and local readers are people I interact with regularly, so when I called to inform of my intension to carry out this research, I was warmly welcomed and they did their best to assist me identify my focus group members and provided to me the list of households in their respective locations.

In the previous and current works, I have endeavored to maintained professionalism in my academic, work-related and business engagements. At no time did I ever let my blood relations affect my objectivity and the need to get credible data that will help my study accomplish what it intended to. I believe, as much as I am part and parcel of the community, any bias from my part in research might as well ruin the good intentions I have for them.

During the actual data collection period, my role as a researcher was to get the best from them. In some instances when I see a conflict between the members in focus group discussions on some matters, I give guidance and step back since I can easily understand where their point of diversion arises from and my limited knowledge and experience in the community gives me that advantage of helping them arrive at a consensus. Nevertheless, to avoid possible bias, I make sure that I only pen down what is absolute their agreed consensus.

During the analysis of the results, I avoided any personal views and interpretations in the results but only reported what I captured during the discussions sessions. In any case I had no more to add as personal view since during the field discussions, I exhaustively collected all their views, which to me were sufficient to meet my research needs, so I had no room for additional bias or additional explanation other than what I wrote in the field.

To this end, I wish to declare that this dissertation was compiled and written with no pressure, bias or influence either from my side or from the members of the Ilchamus community**.**

CHAPTER 1

INTRODUCTION AND LITERATURE REVIEW

1.0 INTRODUCTION

1.1 Study background

Despite the scientific evidence of climate change and its impacts, a considerable amount of uncertainty still exists concerning the rate and extent of the environmental effects of climate change in specific regions (IPCC 2007; Schlenker and Lobell 2010, Thornton *et al.*, 2009). Such knowledge gaps may be bridged if we expand our scope of inquiry to include indigenous/traditional knowledge (IK/TK) systems to augment western scientific understanding of climate change (Klein *et al.*, 2014; Riedlinger & Berkes 2001). Western science provides global and regional perspectives on what to expect, while local knowledge systems provide area specific changes observed over time. Synergizing the two will give us a better understanding of changes associated with weather and climate. In this dissertation, I argue that the local indigenous knowledge held and used by Ilchamus pastoralists of Kenya provides a unique source of local climatic knowledge that can help bridge the gap in knowledge about local climate change impacts on environment and livelihoods. Ilchamus indigenous knowledge may provide local-scale climate history, knowledge of environmental indicators, and traditional coping mechanisms that may be useful to formulating climate change adaptation strategies.

Global climate data have shown a rise in greenhouse gases (GHG) emissions from anthropogenic activities that have resulted in warming of the earth's surface. This has led to a rise in sea level, and shift in global rainfall patterns, among other effects (IPCC 2001, 2007;

UNFCCC 2009, 2011). Warming has caused impacts including loss of biodiversity, desertification, and melting of Arctic ice among others (Botkin *et al.*, 2007; Knowles & Cayan 2002; Roessig *et al.*, 2004; Tavoni *et al.*, 2011, Hansen *et al*., 2006). Efforts to reduce and possibly stabilize the GHG concentrations in the atmosphere have not yet been successful (Ostrom 2010, Hansen *et al*., 2008). Environmental changes caused by global warming require the development of innovative mitigation and adaptation strategies (Smit & Pilifosova 2003, Klein *et al*., 2005 and McCarthy 2001). These strategies should reduce the community vulnerability associated with negative impacts of climate change (Nyong, *et al.*, 2007). To this end, I studied how the Ilchamus pastoral community in Kenya lives under a changing climate, using its traditional knowledge and experience to overcome possible environmental challenges (Adger *et al*., 2003, Galvin 2009, Nelson *et al*., 2007 and Tyler *et al.*, 2007). I documented the Ilchamus local indigenous knowledge system in the belief that this knowledge might hold solutions to some of the problems pastoralists and agro-pastoralists are facing or will likely experience in the near future. The emphasis of this research is on weather/climate-related indigenous knowledge. I also investigated how Ilchamus people acquire and transmit this knowledge from generation to generation and how they apply it in coping with and adapting to changing climate. Motivated by the need to document and promote the use of indigenous knowledge, this dissertation is guided by the following objectives, research questions and hypotheses:

The objectives of this research were:

1. To document the Ilchamus pastoralist community's indigenous knowledge on weather and climate, the indicators observed, and the sources of this information (Chapter 3).
2. To document how indigenous knowledge is acquired, accumulated and passed to others over time in the Ilchamus community (Chapter 4).
3. To document the historic and current coping and adaptation mechanisms that Ilchamus use in response to changes associated with weather and climate (Chapter 5).

1.2 Research questions

1. What is the Ilchamus community's indigenous/traditional knowledge about weather and climate and what are the sources of this information?
2. How is this weather/climate knowledge acquired, shared and passed from generation to generation over time among the Ilchamus?
3. What are the likely impacts/effects of weather and climate change on Ilchamus pastoral production systems and livelihoods?
4. How do Ilchamus use their indigenous local knowledge to cope with and adapt to climate change?

1.3 Research hypotheses

Hypothesis 1: The Ilchamus community possesses different and diverse sources of indigenous knowledge on weather and climate based on their long-term experience with environment.

Hypothesis 2: The Ilchamus observe a number of physical and biological variables/factors as indicators of changing weather and climate.

Hypothesis 3: The Ilchamus knowledge on weather and climate is acquired and transmitted orally through social networks and organizational structures.

Hypothesis 4: The Ilchamus knowledge on weather and climate does not differ with gender, age and education level.

Hypothesis 5: The Ilchamus community is aware of the likely consequences of changes in weather and climate on their livelihood production systems.

Hypothesis 6: The Ilchamus community members can respond in time to likely changes in weather and climate to avoid losses from these changes.

Hypothesis 7: The Ilchamus community has several coping and adaptation strategies to mitigate the impacts of climate change against their livelihood production systems.

1.4 Justification for the study

According to available literature (Agrawal 2010; Nyong, *et al*. 2007; Orlove *et al.,* 2010 and Porter *et al.,* 2014) people of the African Sahel have used Indigenous Knowledge (IK) in natural resources conservation measures serving the multiple purposes of meeting their immediate needs, reducing the emission of greenhouse gases (GHG) from anthropogenic sources, carbon sequestration and carbon substitution. Studies (Agrawal 2010 and Nyong *et al.,* 2007) further report that IK systems have been used in weather forecasting, vulnerability assessment, and implementation of adaptation strategies such as preserving biodiversity, use of emergency fodder in drought times, and multi-species composition of herds and mobility. Related studies have pointed out that incorporating IK can improve the development of sustainable climate change mitigation and adaptation strategies. Although these claims paint a positive picture about indigenous knowledge and its benefits, few studies have documented such knowledge systems in detail, including their use and possible future incorporation with other knowledge systems. This study is based on this premise that IK is potentially valuable for climate change adaptation and its primary aim is to contribute locally-specific information on how climate change is affecting local livelihood systems, and how local pastoralist knowledge can be used for coping and adaptation in the face of a changing climate.

1.5 Organization of dissertation

This dissertation is organized as follows. Chapter 1 introduces the research problem, objectives, questions, hypotheses and justification, and reviews the relevant literature. Chapter 2 describes the research setting, selection of study sites, methods used to collect data and how the data were analyzed. Chapters 3, 4 and 5 present the results of the field research. Chapter 3 describes the sources and nature of Ilchamus weather and climate knowledge, the indicators of environmental change Ilchamus observe, and the various information sources used. Chapter 4 explores how Ilchamus learn, share and transmit their IK within the community members, across, and over generations. Chapters 5 explore and describe how Ilchamus apply their knowledge to decision-making processes related to coping with and adapting to climatic changes. Chapter 6 summarizes the main findings across chapters 3, 4 and 5 and draws from them recommendations for future research, practice and policy. Because each of the three data results chapters (3, 4, and 5) are written as a stand-alone manuscript, there is some repetition in the introduction and methods of each of these chapters.

2.0 LITERATURE REVIEW

2.1 Introduction

The research on indigenous knowledge has in recent years elicited a lot of interest by various disciplines both in support and criticism of it (Agrawal 2002; Barnhardt 2005; Berkes 2012; Briggs 2005, Drew 2005, Davis & Wagner 2003; Mauro & Hardison 2000; Orlove *et al*., 2010). Reviewing articles on indigenous knowledge, one gets the impression that there are those optimists who believe this knowledge has its place and role in science due to its applications and use over time by different local communities, while others dismiss it arguing that it cannot be broadly applied in different geographical areas, cultures and economic settings (Beckford *et al*., 2010; Briggs 2005; Wilson 2007). In this section, I explore the literature on various aspects of indigenous knowledge, its presence and use in climate change-related studies. I also define pastoral livelihoods; examine how climate change affects them, and the coping and adaptation mechanisms pastoralists use. Specifically, I look into the use and relevance of IK in coping with and adapting to climate change in pastoral systems. The section highlights both support and dismissive arguments about IK and how it can enrich western science knowledge. I conclude by clarifying why indigenous knowledge is useful to local holders of the knowledge and scientists in promotion of sustainable adaption strategies to changes associated with climate change.

2.2 Defining and understanding indigenous/traditional knowledge

Indigenous/traditional/local knowledge (IK/TK/LK) is a body of knowledge held by a group of local or indigenous people, unique to a given society, and acquired through generations by living in close contact with nature and is transmitted orally (Agrawal 1995, Berkes & Berkes 2009, and MacGregor 2006). Berkes & Berkes (2009) defined TK/IK/LK collectively as "*a* *cumulative body of knowledge, practice, norms, values and belief, evolving by adaptive processes and handed down through generations by cultural transmission*", while Fernandez-Giménez *et al*., (2006), quoting from Huntington (1998), defined TK as a system of experiential knowledge gained by continued observation, transmitted among members of a community and intergenerational in character. Other definitions of the terms indigenous knowledge (IK), (Nakashima, *et al*. 2002), traditional ecological knowledge (TEK), (Berkes, 1999; Huntington, 2000), local knowledge (LK), (Olsson *et al.* 2001; Gilchrist *et al.* 2005) are used to refer to location specific knowledge, acquired through long-term observation and interaction with the environment. In other reviews, IK has been defined as local knowledge unique to a given culture or society (Warren 2011), a systematic body of knowledge by local people through accumulation of experience with their environment in a given culture (Becker & Ghimire 2003; Mercer *et al.*, 2010*;* Rajasekaran 1993). It consists of biophysical observations, skills and technologies, as well as the social and cultural values, norms and institutions that guide human-environment interaction (Berkes 1999; Fernandez-Giménez 2000). Although a common characteristic of IK is that it is locally bound and unique to a particular location where it is traditionally developed, it is not uncommon to observe similarities of IK systems of various local communities across the world (Harmsworth & Awatere 2013; Kahui & Richard 2014; Ulluwishewe *et al.* 2008).

IK/TK was previously viewed as inefficient, inferior, and an obstacle to development (Agrawal 1995, 2010; Berkes 2012) but conversely the wave embracing use of IK/TK could have been informed by the past failures of western science, technology and institutional models to acknowledge or incorporate it. In light of the failures, IK in combination with other scientific knowledge sources came to be viewed as best strategy in the fight against hunger, poverty, and underdevelopment (Atte 1992; Rahman 2000, Scoones *et al.*, 1992; Tjahjadi 1993 and Zapata

2011). This view is based on the observation that indigenous people have lived with this knowledge in relative harmony with nature, allowing them to use it sustainably (Anderson & Grove 1987; Berkes 2009, 2012; Compton 1989; Ghai & Vivian 1992; Inglis 1993; Moock 1992; Naiman *et al.*, 2010; Sen 1992).

Further, IK holds promise for agricultural production systems, sustainable development and management of natural resources (Alteri 1987; Anderson 2005; Brokensha *et al*., 1980; Chambers *et al.,* 1989; Gupta, 1990; Hobbs *et al.,* 2011; Niamir 1990; Rhoades & Booth 1982; Warner 1991; Warren *et al*., 1991). IK is now recognized as important in multiple fields (Pullin & Knight 2001; Raymond *et al*. 2010; Reed 2008 and Reed *et al*., 2007). Scholars and development professionals accept and discuss the merits of IK and deploy new optimistic approaches to assert its relevance (Warren *et al.*, 1993). The literature also notes that widespread failures of externally introduced development have impelled a shift towards a participatory and decentralized approach to development where a central point is the incorporation of IK in decision making (Berkes *et al.*, 2000; Berkes 1999; Mercer *et al.*, 2010; Schmink *et al*., 1992; Warren 2011). Environmental and natural resources specialists have promoted IK as holistic, adaptive by nature, accumulated incrementally, tested by trial-and-error and transmitted to subsequent generations orally or by shared practical experiences (Berkes 2012; Ford *et al.*, 2006; Ohmagari & Berkes 1997; Mesoudi 2011; Mesoudi & Whiten 2006). However, not all IK systems are ecologically sustainable and adaptive (Chapin 2013; Redford & Stearman 1993), so a critical perspective is needed. Some indigenous knowledge systems might become irrelevant/obsolete over time due to changing operational conditions.

Studies on contributions of IK to climate change research shows that IK and science can complement each other (Luseno *et al*. 2003; Mercer *et al.*, 2010; Riedlinger & Berkes 2001;

Speranza *et al.*, 2010; Warren 2011). Among the Tibetan herders' local knowledge has been shown to be valuable when combined with western science to resolve many challenges posed by their landscape (Klein *et al.*, 2014). In some parts of Africa, IK has been found to contribute to filling gaps in formal seasonal forecasts, which are largely at broader spatial and temporal scales (Luseno *et al*., 2003). It has also been said that indigenous climate forecasting methods can offer insights to improving the value of modern seasonal forecasts for pastoralists in east Africa as indigenous forecasting methods are need driven. It focuses on locality, the timing of rains, and indigenous forecasts are communicated in local languages and typically by "*experts*" known and trusted by pastoralists (Ayal *et al.*, 2015; Luseno *et al*., 2003; McLean *et al*., 2012; Riedlinger *et al*., 2001, and Speranza *et al*., 2010).

In support of the above views about IK, documenting and learning how it is applied becomes imperative. Documentation and use of IK systems have become a part of international environmental policy, especially since after the Rio Earth Summit in 1992. This summit was a significant step towards legitimizing indigenous concerns (Cicin-Sain *et al*., 1995; Massoud *et al.*, 2004). After that, advocates of indigenous knowledge have promoted it as a component of improved scientific research and management through more and sometimes better information (Huntington & Suydan 2004; Johnson 1992; Brook & McLachlan 2008; Mercer 2010; Inglis 1993; Mailhot 1993; Hansen 1994); and as a means by which new scientific knowledge paradigms can be identified to understand the natural world and our relations to it (Barnhardt 2005; Berkes 2012; Colorado 1988; Deloria 1996; Kawagley 1995; Kovach 2010 and Ng'asike 2010). The importance of indigenous knowledge systems cannot be underestimated, even though we know that studies on the contribution of TK to climate change research are still few (Berkes 1999; Huntington 2000; Olsson *et al.* 2001). The contributions of TK to understand and interpret ecological process and for use in environmental, social impacts assessments and balanced development have widely been acknowledged (Berkes 2009, 2012; Compton 1989; Naima et al., 2010; Niamir 1990; Warren 1990; Ulluwishewa 1999; Briggs & Sharp 2004). A study by Speranza, *et al.* (2009), reported that TK has been used in weather forecasting, vulnerability assessment, and implementation of adaptive strategies such as preserving biodiversity, use of emergency fodder in drought times, and multiple species composition of herds and mobility. They proposed that incorporation of TK into western science could improve the development of sustainable climate change adaptation strategies.

However, to date IK systems has not been embraced fully in academic and development circles. There are many possible reasons for this. First, there is general resistance to change because it is un-familiar and people are more comfortable doing things the way they are used to. Working with an established paradigm is simpler than adapting to a new one. Acceptance of IK therefore has remained elusive despite general acceptance of its importance. This elusiveness is explained by the favor of established scientific practices and the need to describe IK in western scientific terms. Other factors that might explain the lack of acceptance of IK include social science research methods unfamiliar to ecologists and cross-cultural issues such as the reluctance of some indigenous populations to share information about their livelihoods (Berkes 2012; Drew 2005; Huntington 2000). It is therefore proposed that since IK is rarely written down, it is important to document it as a first step towards its acceptance into another scientific undertaking (Drew 2005; Huntington 2000).

2.3 The role of culture in IK development and its use in climate change

Adger, *et al.*, 2012, claimed that climate change threatens cultural dimensions of lives and livelihoods and concluded that society's response to global climate change is mediated by culture. Culture is important for understanding both mitigation and adaptation to weather and climate change. In most settings, culture dictates the modes of production, consumption and social organization of a community (Hulme 2008; Adger *et al*., 2012), hence culture is important in the understanding and implementation of adaptation, decisions about response, and ways of reducing risks associated with changes. This is an important aspect because recent studies have shown that climate change and weather related risks are becoming threats to current culture. For example, impacts of climate change include increased extent of areas affected by drought, which has direct impacts on pastoralism. As a cultural phenomenon, pastoralism therefore faces the threat of erosion of pastoral social structures as populations exit the livelihood due to drought (Adger *et al*., 2012; Rudiak 2011).

Many indigenous peoples have traditional ecological knowledge based on oral transmission of their cultural heritage in ways that inform current interactions with the environment (i.e. cultural identity). This cultural heritage provides information about how people coped with past environmental and social-ecological challenges and about important values that influence future responses to change in both the environment and resource management (Berkes, 1999). Integration of IK with the formal knowledge (i.e. "*scientific knowledge*") that often informs resource management decisions is not easy because the "*facts*" (e.g. the nature of human-environment relationship) sometimes differ between the two knowledge systems (Berkes 2008).

Another area to note is that IK systems are being eroded by social and technological changes (Ayal *et al.,* 2015; Brodt 2001; Hoopers 2002; Ross 2011). Many indigenous knowledge systems are maintained orally and are therefore tightly linked to language. However, many of these languages are threatened by national efforts to assimilate people into one or a few national and official languages. Therefore language loss and cultural assimilation generally erodes traditional knowledge, so efforts to sustain local languages and cultures can be critical to sustaining the knowledge and practices by which people traditionally interact with the ecosystem (Brekes 2009, 2012; Folke *et al.,* 2005; Olsson, *et al*. 2001; Walker & Salt 2012).

2.4 Defining and understanding pastoral livelihood systems

Understanding pastoralism and its features and future has been a subject of serious debate. The term "pastoralism" has been used to describe societies that derive some, but not necessarily the majority of their food, and income from livestock. For example Nori *et al.,* (2008), in an IIED issue paper no. 148, "*Browsing on fences*"….defined pastoralism as "*a complex livelihood system seeking to maintain an optimal balance between pastures, livestock and people in uncertain and variable environments*". In this study, we adopt broadly the definition provided by Nassef, *et al*. 2009 to define pastoralism both in the economic and cultural sense. In an economic sense, people in the pastoral realm who earn part of their living from livestock and livestock products and in cultural sense, we define them as those people whom livestock do not form the main source of income, but they remain culturally connected to a pastoral lifestyle in which the significance of livestock is more cultural than economic. In most instances, they practice these kinds of livelihoods in areas considered resources scarce with extreme climatic conditions that limit for alternative land use and livelihood systems.

Due to the variable and unpredictable nature of the environment, many people have to practice livelihood strategies that are adaptive to the environment. Despite the role pastoralism plays in supporting local livelihoods, contributing to national and regional economies in some of the world's poorest countries (Behnke 2008, Davis & Hatfield 2007 and MacGregor 2006), and providing diverse ecological services, pastoralists' capacity to adapt to changes is facing many challenges, including those posed by climate change (Vuori *et al.*, 2014; Hesse *et al.*, 2006).

Pastoral systems occupy two-thirds of global dryland areas and an estimated 1billion people depend on livestock which serve as sources of income and food security; among them the world's 880 million rural poor (200 million pastoral households in Africa), (Clay 2004; Nori 2005; FAO 2009). In Africa, 40% of the population relies on dry and sub-humid lands for their daily livelihoods (CBD/UNEP/IUCN, 2007). These drylands used for livestock production are particularly sensitive to land degradation with 10-20 percent of drylands already degraded (Millennium Ecosystem Assessment, 2005). Some 23 percent of the world's poor (nearly 300 million people) are located in sub-Sahara Africa, and about 60 percent of these depend on livestock for some part of their primary source of income and livelihoods (IFPRI & ILRI, 2000; Thornton, *et al.* 2008).

Success in improved management of grazing lands and enhancing livelihoods of pastoral and agro-pastoral peoples and their adaptive capacity will be realized with targeted capacity building, and effective incentives for improved management of these ecosystems. These can be backed-up by pro-poor livestock policies with integrated processes that address natural and social dimensions that enable multi-stakeholders engagement (FAO 2009). Pastoralism is considered the most economically, culturally, and socially appropriate strategy for maintaining the well-being of communities in dryland landscapes because it provides secure livelihood, conserves ecosystem services, promotes wildlife conservation, and respects cultural values and traditions (ILRI 2006, UNDP 2006).

2.5 How climate change affects pastoral production systems

Some of the most important impacts of global climate change will be felt most among the groups predominantly practicing livestock keeping (pastoral systems) (Harvey *et al.*, 2014; Morton 2007). Their vulnerability to climate change is due their location in the tropics, socio-economic systems and limited policy provisions to support their adaptive capacity. This is despite the fact that climate fluctuation has always been a defining feature of drylands, home to thousands of these pastoral communities that evolved and developed resilient livelihoods systems to cope with variable climates (Adger *et al*., 2003, Galvin 2009, Nelson *et al*., 2007 and Tyler *et al.*, 2007). Currently, global climate change is raising new challenges for pastoral systems particularly in Africa (Hesse *et al*., 2006, IPCC 2007). Although the use of local experiential knowledge systems has enabled pastoral groups to effectively use rangeland resources over time (Adger, *et al*., 2012; Nyong, *et al.*, 2007 and Shongwe *et al.*, 2010), the challenge currently is to gain recognition of this knowledge system as an asset that can be utilized to assist pastoralists as they cope with climate change. Successful reports of pastoral systems and management of their resources abound, for example in Ethiopia (Gemedo-Dalle 2004; Kassahun *et al*., 2008); Kenya (Kuria *et al.*, 2011; Tura *et al*., 2011 and Wajala *et al*., 2010); and Somalia (Abdullahi 1990). Pastoralists all over the world use different strategies to cope with changing environment such as meeting feed shortages (Behnke *et al*., 1993), feed purchases and migration (Scoones, 1995), diversity of species (Homewood 2008) and sales as a last option (Hoffman *et al*., 2007; Katjiua & Ward, 2007). Their livelihoods are greatly and negatively affected by changes in weather and climate in eastern Africa (Mortimore & Turner, 2005). However, failure to incorporate pastoral communities indigenous knowledge on coping practices and strategies in national development plans, lack of their participation in planning and implementation processes are some of the reasons for their poor response to climatic changes and adaptability to variations (Kassahun *et al*., 2008; Maystadt & Ecker 2014; Red *et al*., 2008; Oba & Kotile, 2001; Sietz *et al.*, 2011).

Global climate change is raising new challenges for pastoral systems in Africa generally (Hesse *et al.,* 2006, IPCC 2007). There are new claims predicting that climatic models are showing a rise in temperature in east Africa, especially in dryland areas, but along with these are enhanced rainfall (Hulme *et al*., 2001; Christensen *et al.* 2007; IPCC 2007; Funk *et al*., (Eds) - 2010; Williams & Funk (2010). As a result, these areas will experience both hot and dry spells and short period of flash floods during the rainy months. Such climatic changes are likely to bring about even more erratic and unpredictable rainfall and more extreme weather conditions, such as larger and more frequent droughts (Hulme *at al*., 2001; Hesse *et al*., 2006; IPCC 2007; Funk *et al*., (Eds) (2010). In Kenya and East Africa for example, long time historical records show a series of smoothed rainfall and inverted Indian Ocean and global temperatures, expected to increase December-February rains by 5-30%, reduce March-May as temperatures cool and decrease June-August rains by 5-10% (Funk *et al*., 2010; Hulme *et al*., 2001). The impacts of climate change are likely to be highly spatially variable, but developing countries, many in Africa are considered more vulnerable than developed countries due to their lower capacity to adapt (Thomas & Twyman, 2005). In East Africa, data from Guha-Sapir, *et al*. (2004) have shown that the mean annual number of people estimated to have died or been severely affected by drought increased tenfold in the 30 year period from 1974 to 2003, from 584 per 100,000 to

6,067 per 100,000. Burke *et al.*, (2006) reported that the increased extent and duration of drought periods will impact sustainability, viability, and resilience of livestock and cropping systems and livelihoods in drylands and that post-drought recovery of pastoral systems through herd reconstitution and replenishment of water sources will be less dependable. In similar studies, Christensen *et al.* (2007), Shongwe *et al*. (2010), also predicted from global climatic change models that there is likely to be an increase in annual mean rainfall in East Africa in total agreement with Hulmes' *et al.* (2001) earlier models. An increase in rainfall will certainly be good for pastoralists in the region; however, with rising temperatures, the net effect will be more evaporation leading to overall drier land. This will affect livestock production, which is the basic and most important commodity that every pastoral household possesses. Climate change has caused global average surface temperatures increase of about 0.6 degree Celsius during the twentieth century (IPCC, 2007) and current temperatures are predicted to increase further between 1.4 and 5.8 degree Celsius by 2100, depending largely on the level of fossil fuel combustion. Most of the observed increase in temperatures will likely be due to the increase in anthropogenic greenhouse gas concentrations (IPCC, 2007). It is predicted that during this period many people, particularly those in developing countries, will face changes in rainfall patterns and extreme events, such as severe water shortages, droughts, or flooding. Such changes will also affect the length of growing seasons and crop and livestock yields, and increase risks of food shortages, insecurity, pest, and disease incidences, putting populations at great health and livelihood risks (FAO, 2009). Impacts of climate change on pastoral and other vulnerable communities are becoming too apparent (FAO, 2009). Despite climate change and constraints imposed by policies and institutions, pastoral communities have historically demonstrated their capacities to change their practices in the drylands in order to maintain production and livelihoods. For example, in East Africa; pastoralists are reported to use a diversity of strategies to sustain production. These strategies include moving livestock according to vegetation needs and water availability, keeping species-specific herds to take advantage of the heterogeneous nature of the environment, diversification of livelihood, and both temporary and permanent migration (Adger *et al.,* 2012, 2014; Crate 2011; Coppock *et al*., 2011; Galvin *et al.* 1994; Galvin, 2009).

Pastoral institutions and production strategies are potentially better adapted to respond to increased climate variability than other land-use systems and provide higher net returns and flexibility under conditions of variability (Jones & Thornton, 2009). This calls for policies that support climate response measures and promote benefits of adaptive and mitigative approaches to enhance livelihoods, ecosystem services and food security. These strategies among other options available need to integrate both conventional and local knowledge systems for sustainability.

In support of pastoral livelihoods, FAO (2009)- acknowledged that there is a need to support adaptations to climate change and climate variability among livestock producers. These measures should including bringing existing traditional as well as modern technical management and institutional options into play. However, a number of challenges lie in the way of mitigating and adapting to climate change. The challenges are simply unprecedented but not insurmountable as described by Kristin, *et al*. (2006).

Timely and adequate adaptation strategies specific to pastoral systems are required. Adaptation involves adjustments to decrease the vulnerability of communities and regions to climate change and variability (IPCC, 2007). Adger *et al.* (2001a, 2013, and 2014) views adaptation as a dynamic social process and believes that the ability of a society to act collectively determines its ability to adapt. The adaptive capacity of a system (region or community) is its potential or ability to adapt to the effects or impacts of climate change. Increasing the adaptive capacity of a system represents a way of coping with changes and uncertainties in climate. Smit *et al*. (1999; 2000) and the subsequent IPCC reports refer to adaptations as the adjustment in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects or impacts. IPCC (2007) also refer it to changes in processes, practices, or structures to moderate or offset potential damages or to take advantage of opportunities associated with changes in climate.

2.6 Social aspects and strategies of adaptation to climate change

Common distinctions between adaptations are their purpose and timing. Autonomous or spontaneous adaptations occur as a reactive response to climatic stimuli, without the intervention of a public agency. Planned adaptations can be either reactive or anticipatory and are generally undertaken by governments on behalf of society. Some adaptations undertaken by individuals are planned while others will be spontaneous or reactive to the changes related to resource use or to changing economic constraints or opportunities. Institutional and economic parameters determine the vulnerability and adaptive capacity of societies. There is therefore a clear role for public policy to create the right environment for appropriate adaptation to climate change (Adger *et al*., 2001b, 2014). Societies acting collectively can adapt to climate change more easily through their inherent capacities. Resource-dependent communities have historically managed their resources collectively albeit uncertainties and fluctuations in the systems they depend on. Synergies can be built with other players, like the government, and non-governmental institutions to reduce the risks and promote adaptive capacities of communities to cope with change. Adger, 2003, notes the risk of undermining social capital at times by social and political changes and further argues that levels of decision-making in society are not independent, but rather are embedded in social processes that reflect the relationship among individuals, their networks, capacities, social capital, and the state. For climate change adaptive capacity to have a meaning, we must be able to consider those factors that undermine it, or else we may be attempting to provide a solution to the wrong problem. This calls for attention to many areas of society that normally are considered outside the realms of climate. We need to pay some attention to issues like natural hazards and policy environment to support adaptation capacities (Adger, 2003). We need to know and document approaches to reduction in impacts of climate change advocated by major non-governmental organizations and government agencies on one hand and community preference. This could be used to build a unified approach that yields sustained results (Adger et al., 2005; Agrawal 201; Smit & Wandel 2006; Pelling & High 2010; Smith *et al.* 2000).

Comparative studies have shown that the poor and marginalized have been most at risk from climate-related hazards (Hawitt, 1997; Hufschmidt 2011; Lein 2009; Smith 2013). This calls for concerted collective action at all levels if adaptive strategies are to succeed in mitigating the impacts of climate change. Collective action is at the heart of all adaptation decisions. According to Adger, (2003), collective actions are those actions taken by groups or on their behalf through an organization in pursuit of members' interest. It requires networks and flow of information between individuals and groups to oil the wheels of decision-making. This is made up of norms and networks that enable people to act collectively (Woodcock & Narayan, 2000). It is necessary "*glue for social resilience, but also for economic development,*" (Adger, 2001b). Community is the most important ingredient for collective management (Brown *et al*. 2002).

Finally, with all the above claims, findings and conclusions, the big question that we endeavor to answer here is how do people use indigenous knowledge to cope with and adapt to weather and climate change? Pastoralists found not to use forecasts to support livestock management decisions due to a number of reasons. They make their decisions based on outcomes of rains rather than forecasts of rains (Rancoli *et al.,* 2001a; Speranza *et al.*, 2010). Other reasons include high rainfall variability characteristics over time, lack of awareness as barriers to adaptation, cultural impediments, spiritual beliefs and traditional governance structures (Crona *et al.,* 2013; Egeru 2012; Lata & Nunn 2012 and Mayrand *et al*., 2010). Against this background, this study seeks to document and analyze the indigenous knowledge, which pastoralists in the semi-arid Marigat Sub-County, Baringo County, Kenya, hold and how they use it to monitor, cope, and adapt to impacts of climate change. I explored whether or not pastoralists actively use their indigenous knowledge on indicators of weather and climate to cope and adapt their practices. Then the other big challenge is how this largely theoretical knowledge can be translated into practice for integration, given the perceived inferiority of the knowledge of local indigenous peoples by scientists compared to that of western science (Ayal *et al*., 2015; Riedlinger & Berkes 2001; Ross 2011). This study approached the issues of coping and adaptation strategies from a traditional/indigenous knowledge system as opposed to conventional western science to suggest solutions to problems of adjusting to possible impacts of climate change. The study was premised to determine the existence of such knowledge, modes of its transmission and application in day-to-day decisions making in coping and adapting to changes related to weather and climate.

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CHAPTER 2

METHODOLOGY

1.0 INTRODUCTION

This chapter describes the methods used to select the study sites, study population, and respondents, and how data and information for the study were collected and analyzed. Two separate but related approaches were used in this study: quantitative and qualitative (Brinkman 2009; Maxwell 2012; Creswell 2007, 2012; Marshall & Rossman 2014). An initial reconnaissance study consisting of two focus groups was conducted in Kenya in July-August 2010 (Appendix 3). The main study was carried out in June through July to mid-August 2011 for both household survey and focus group discussions (Kvale & Brinkmann 2009; Maxwell 2012). The first two focus group discussions in 2010 helped me to gain a general feeling and ideas about the Ilchamus community (a sub-tribe of the Maa speaking groups in Kenya), I learned about their general traditional knowledge systems on climate, what kind of knowledge systems they hold, and how these knowledge systems were acquired and used. This preliminary study informed the design, framing and drafting of the household survey questionnaire and helped further refine focus group discussion themes for the 2011 field research work.

This study was carried out in four (4) administrative locations of Marigat Sub-County with the objective of documenting indigenous knowledge (IK) of the Ilchamus community on climate and weather, collecting information on how this knowledge system is acquired, stored, and transmitted among the community members, and investigating its use in decision-making on livelihood strategies. These administrative locations were selected because they represent the areas occupied by the Ilchamus agro-pastoralists. These were also more accessible areas with the time I had to undertake my filed work, but equally, the sample in thought to represent the community well. Other Ilchamus locations in the sub-county not visited have a mix of different production systems and tribes with very limited pastoralism.

The study endeavored to find out how the community prepares itself in the face of changes due to climate and weather, and what coping and adaptive strategies are used. The data were collected using focus group discussions and a household survey. Focus group discussions were conducted using general guiding questions or themes (Miles & Huberman 1984; Rubin & Rubin 1995; Creswell 2012; Marshall & Rossman 2014), while household survey data were collected using a questionnaire (Kvale 2009; Rubin & Rubin 1995) with a mix of closed- and open-ended questions.

All the plants nomenclature referred in this dissertation follows PLANTS DATABASE classification (www.plants.usda.gov/).

1.1 Materials and methods

This section describes the background of the study population, sites and how sample units were identified and selected, where and how the data were collected and analyzed.

1.1.1 Study population (Background of the Ilchamus)

Written and oral histories point to the presence of a Maa-speaking group, the Ilkeroi, inhabiting Lake Baringo area prior to the Ilchamus (Adam & Anderson 1988; Dundas 1910). They were there by at least the mid eighteenth century, since around that time Uasin Gishu Maasai refugees of the war between the Maasai and Loikop are said to have joined the community at Lake Baringo (Adam & Anderson 1988; Vossen 1978 and Weatherby 1967). Further evidence of the early Uasin Gishu connection is corroborated by the migration pattern of the Ilkeroi after they were dispersed. Elders note that many of them resettled on the Uasin Gishu plateau. While the ethnic origin of this earlier group is not known, they are likely to have had strong ties to the Kalenjin (i.e. Okiek), besides the Uasin Gishu Maasai. Their reliance on hunting and fishing and their lack of cattle suggest comparisons between them and such Maa-speaking hunters and gatherers as the Iltorobo (Ndorobo).

Other supportive literature on the history of the Ilchamus is traced in the report on early irrigation along Rift Valley tribes. The practice of irrigation predates to the late eighteenth century, but was documented in the mid-nineteenth century based upon report from Swahili caravan traders in the 1840's (Adan & Anderson 1988). Like other Maa-speaking cultivating communities along the edge of the Rift Valeey, the Ilchamus had a closer relationship with their pastoralists' neighbors. The villages at Lake Baringo acted as a safety net for destitute pastoralists during period of drought or social dislocation. Mid-nineteenth century the Ilchamus absorbed a number of Samburu who had been defeated by the Pokot, and a variety of refugees from the internal struggle then raging among the Maasai. The Samburu pastoralists could become Ilchamus cultivators and vice-versa. The irrigation of the Ilchamus begun to decline sometime in the 1870's due to three related factors- villages began to lose more labor than they attracted, Ilchamus were able to accumulate cattle through barter with coastal traders for ivory, and thereby move into pastoralism. Third irrigation declined with reduced labor and ivory trade went down after large herds of elephants were diminished and ivory trade moved further north. To the Ilchamus, it is clear that irrigation cultivation and livestock husbandry are not mutually exclusive activities, but are complementary (Adam & Anderson 1988).

1.1.2 Study sites

The field study was done in Kenya in 2010 and 2011 in four (4) administrative locations of Marigat Sub-County, Kenya. These locations were selected because they represent areas occupied by the Ilchamus agro-pastoralists. The study's focus group discussion participants and household survey samples were drawn from these four locations.

The Sub-County covers approximately 1,244 km^2 with a total population of approximately 48,534 people, and the four locations used in this study have a population of approximately 25,000 people (GOK 2010). Marigat ranges from 1000m to about 1200m above sea level in elevation. The study region is characterized by low overall rainfall and high temperatures. It experiences low and erratic annual rainfall which varies between 500mm to 750mm with a mean annual rainfall of 650mm yr^{-1} and a potential evapotranspiration rate varying between 2000mm and 2800mm per month (mean annual pan evapotranspiration of 2576mm) (Ngaira 2006; Snelder & Bryan 1994; Sutherland *et al.*, 1991). The coefficient of variation for annual rainfall is about 28% (Rowntree 1991). The rates of evapotranspiration often twice exceed the annual rainfall (Omiti & Irungu 2002). But the temperatures do vary and they follow the annual rainfall pattern with relatively warm to hot June and October-November months. December to March are the hottest, and July to August are the coldest. The daily mean temperatures vary from around 15^0C to 35^0C and can rise to 37^0C in some months (Sunya 2001); a typical climate of arid and semi-arid areas (Jaetzold & Schmidt 1983).

The area is generally flat with relatively fertile soils of coarse loam and clay. Originally, semi-deciduous woodland dominated, especially along rivers and northern parts of the Ilchamus flats classified as umbrella thorn [(*Acacia tortilis* (Forssk) Hayne)] savanna woodland (Kiyiapi 1994), but currently the land is widely covered by mesquite [(*Prosopis juliflora* (Sw.) (DC)] an exotic invasive species. Shrub and tree cover is generally widespread, but intensive grazing pressure has led to a disappearance of most of perennial grasses and large parts of the grazing areas are now covered by mesquite.

1.1.3 Sampling design and data collection

Data were collected from four local administrative locations: Ng'ambo, Salabani, Ilng'arua and Kiserian. We held four focus group discussions (one per location) and surveyed 331 household heads distributed proportionally according to locational populations. Focus group members were selected with the help of local leaders, while household heads were randomly selected using households lists held by local chiefs for every location. Focus group discussions were held in every location when the surveys were completed.

Data analysis was based on the frequencies and percentages of the responses to research questions and the hypotheses. Qualitative data were analyzed descriptively, while quantitative data was analyzed both descriptively and statistically by use of SPSS version 14.0 for windows statistical software.

During the data collection period, focus group discussions were held in August 2011, and household surveys questionnaire between June and August 2011. Stratified sampling using expertise in local knowledge, gender and age was used in selecting focus group participants with the help of traditional institutions like peer groups (*Ilamal*), local elders, opinion leaders, village headmen and government administration chiefs. Selection of focus group members were based on their known knowledge and experience on matters of weather and climate. Simple random sampling was used to select household participants so that all genders, ages, occupation and education levels had equal chances of being included in the survey. Secondary data were also collected from literature reviews.

1.2 Data collection process

Researchers explore individuals' stories through various methods including interviews, focus groups, observation, and creative expressions (Rubin & Rubin 1995; Chase, 2005; Creswell 2012; Marshall & Rossman 2014). For the purpose of this study, I collected household data using a questionnaire (Appendix 2) with the help of four enumerators. Later facilitated four focus group discussions (Appendix 1) after household questionnaires by asking the group participants questions that lead to discussion of their knowledge and experience with weather patterns and climate change, causes of climate change, consequences of such changes to their livelihood systems, and how this knowledge system can be shared among the members of their community. As local/indigenous people who have lived in that area for many years, what best could be done to cope and adapt to changes associated with weather and climate.

1.2.1 Focus group

Focus group discussions provide an opportunity for group participants to reflect on their own experiences as they listen to the experiences of others (Kvale 2009; Rubin & Rubin 1995). Focus groups provide opportunities for synergy among participants, resulting in more description and exploration of concepts or themes generated in the individual questionnaire (Merriam, 2009; Merriam & Tisdell 2015; Maxwell 2012; Rabiee 2004 and Ward *et al.,* 2013). I conducted four focus group discussions- (one in each location) with the participants to discuss and explore their knowledge, concepts, and ideas related to the themes of this study.

Participants with experience specifically related to the topic being explored ensure a thick, rich description in qualitative research (Creswell, 2007; 2012; 2013; Marshall & Rossman 2014). In each of the four locations, 8-10 focus group members were identified with the assistance of the chiefs, headmen and area counsellors (then, now called Members of County Assembly). Those chosen were men and women trusted by the community and known for their wide and deep knowledge and experience on various issues in ecological, social and cultural undertakings of the community. These are individuals regularly consulted by others on several matters related to environmental changes and fortune telling (or dreamers). They are known for their wisdom and honesty, and understand community customary norms, rules, rituals and regulations. The second criterion was that elderly persons of ages 35 and above were preferred. These are people assumed to have lived in these areas long enough to know some elements of rainfall variation, drought cycles, and other environmental issues as well as good in socio-cultural memories.

The focus groups served as both a form of member-validation (Lather & Smithies, 1997; Olesen 2011) and an opportunity for participants to explore ideas generated in the individual interviews in more depth. Further, the focus groups provided the opportunity for participants to work together and agree on certain principles as they reach a consensus about certain contentious facts and ideas (Creswell 2012; Miles & Huberman 1994; Marshall & Rossman 2014). General guiding questions related to traditional climate knowledge, transmission of the knowledge, effects of climate change on their production systems and adaptation strategies were discussed. The researcher's role was that of a general facilitator as I keenly wrote down all responses. The discussions were also audio recorded, while all of the enumerators would help in taking notes so that I could later corroborate the notes and fill out areas that I might have missed. The procedure was to allow participants to contribute in turns and occasionally get interrupted to get a clarification of what they said, or to allow time to capture what was said verbatim. In other instances, I would seek clarification on some meanings of certain statements and phrases that are made in such discussions. Before the discussions started, a consent form was read to participants, and they were asked individually to sign indicating their free-will to participate in the exercise. Those who could not read and write, or sign were asked to thumb-stamp the form.

1.2.2 Household survey

One way to collect information and stories from participants is through individual surveys (Kvale 1996, 2009). Questions designed to elicit memories of experience relevant to the topic provide opportunities for the researcher to gain insight into the issue in question and for the participant to understand their own experiences through recall and reflection (Chase, 2003; Kvale 2009). In-depth and extensive discussions were conducted with individual respondents from a wide range of backgrounds and locations throughout the four locations in the sub-county. In-depth interviews were used because this allowed the researcher to understand respondent's complex perceptions and understandings without imposing any prior categorization that may limit the field of inquiry (Kvale & Brinkmann 2009; Fontana & Frey, 1994; Marshall & Rossman 2014). This methodological approach also allows the respondents to answer in their own words and clarify their responses, and it provided for novel responses that were not anticipated by the researcher.

The household questionnaire included a variety of questions asking about traditional climate change knowledge. It included questions about sources of this knowledge, its importance, storage, and its transmission among generations; effects of climate change on production systems and consequences on lives and likely production systems that will be vulnerable/affected by changes in climate. Finally, it contained questions about how respondents cope and adapt to changes associated with weather and climate. Individual respondents were given time to think through the questions, and ask for clarification before I started to fill the questionnaire. At the end of the survey, respondents were asked to field any questions they may have to the researcher.

1.2.3. Sampling frame and sample selection for household survey

I collected and compiled a full list of households in the four study locations (Ng'ambo, Salabani, Ilg'arua, and Kiserian) from their respective chiefs. In each location, I randomly selected about 10% of the local population as my sample to represent the total population. With the help of the four enumerators, we randomly picked the names from a pool of names from a bowl/container. The target persons for the household questionnaires were the household heads (either male or female). There was a mix of all ages and backgrounds. One major assumption was that those sampled possessed some important social-political-economic, ecological and climatic knowledge systems, knowledge on coping and adaptation strategies to mitigate impacts of climate change. A total of 331 household heads were surveyed: 92 from Kiserian location, 55 from Ng'ambo location, 88 from Ilng'arua location and 96 in Salabani.

1.2.4 Questionnaire instrument and survey implementation

A questionnaire was administered to each household head individually to get all possible and relevant data. The questionnaire was divided into four sections. Each section has specific questions to address different parts of the research questions and for testing the hypotheses.

Section I: We asked specific and general questions about climate knowledge and other information related to weather and climate change. This section was to address the research question: "What is the indigenous knowledge of the Ilchamus community about climate change?"

Section II: We asked specific and general questions about the consequences or effects of climate change on production systems/livelihood strategies as evidence of impacts of climate change. This section was to address the research question: "What are the consequences of weather and climate change for pastoralists' production systems?"

Section III: We asked specific and general questions about how traditional knowledge systems are used in adaptation to climate change. This section was to address the research question: "What are the coping strategies and adaptations to climate change?"

Section IV: This section contained questions on household demographic data. The data here were used to compare different households in terms of how they understand and interpret weather/climate knowledge. Independent variables including gender, age, and education levels were useful in data analysis especially in comparing and contrasting traditional knowledge levels, diversification strategies and decision making in relation to climate and weather.

Prior to the actual data collection, four enumerators were hired, one from each location. These were individuals identified by the local councilors and who met certain set criteria. They must come from those locations, and they can speak and understand English, Swahili and Ilchamus language fluently. In addition, they must either hold a university degree or currently be registered in a local university or qualified to join a local university.

The enumerators were trained for two days. On day 1, they were briefed about the research, its objectives and what was expected of them in the survey exercise. We went through the questions, one question after the other to make sure that we all had the same understanding of what each question was asking for and that we had the same meaning for each. Later, that day, we had an open discussion where anyone could ask questions related to the survey, survey questions, or any other matter related to this research. On day 2, we conducted pre-testing of the instrument to be sure it captured the information required, was not ambiguous and tested for length of time it took to complete one survey. We visited nearby homesteads to do the pre-testing exercise. First, we approached the homeowners and introduced ourselves and why we were interested in interviewing them. When the household head agreed to participate in our interview, we asked them to read and sign a consent form (those who could not read were assisted by reading to them what the form said and if they agreed, they thumb-stamped the form). This was used as evidence that each respondent had fully understood our purpose and that they ready to participate freely without coercion and could withdraw their participation at will at any stage of the interview. Each enumerator pre-tested two households, and we jointly pre-tested two households as a team. This exercise gave the enumerators an opportunity to practice what they would be doing on their own, build confidence and get to know an approximate time to complete each interview. When I was satisfied that all was understood, I distributed the questionnaires to each of them to go prepare and start the survey the following day. I visited each one of them on the starting day of the actual data collection to be sure that they were doing things correctly. The first enumerator started his work the following day after the training while the second, third and fourth started after every consecutively day to enable me to be present with each of them on the starting day.

1.2.5 Data analysis

Data analyses were guided by the research questions and associated hypotheses set out in Chapter 1. Qualitative data analysis methods (Miles & Huberman 1984; Rubin & Rubin 1995; Marshall & Rossman 2014) were used for the focus groups and a combined analysis method (qualitative and quantitative) was used for the household surveys (Kvale 1996; Kvale & Brinkmann 2009; Maxwell 2012; Creswell 2012).

1.2.6 Qualitative analysis of focus group data

For the focus group data, the field notes were typed into a Word document for ease of reading interpretation and transfer to coding template. These notes were read through thoroughly to sieve out key messages and determine themes manually. I used categorical coding to classify the data (Appendix 3). This form of analysis involves reading each line of the typed field notes to identify the main themes and patterns from the text by a word or short phrase (Creswell, 1998; 2012; 2013; Lincoln & Guba, 1985; Miles & Huberman 1984; Marshall & Rossman 2014; Taylor & Bogdan 1984). This procedure consists of moving from the initial reading and analysis of the notes through later steps of describing, classifying, and interpreting the data. This led to the first stage of coding. Subsequent readings on the first codes allowed me to narrow the themes. Some of the key sub-themes/codes common throughout the analysis include: climate change indicators, signs of a change; human activity, natural phenomena, human factor, environmental factor, cultural dynamics, biological change, social change, security concern, livelihood change, traditional livelihood and attitude change among others (see Appendix 3 for details). About six main themes were identified and they include: natural physical changes, natural biological changes, human/social changes/ physical/biological indicators and traditional vs formal knowledge sources.

Definite responses from various groups were lumped according to similarity in their meaning and implications. The analysis was driven by general and specific research questions seeking to understand the local indigenous knowledge on climate change: the history of this knowledge, and its passage, storage and relevance to addressing the effects of climate change. In this analysis, I sought to describe how the respondents answered the research questions and their meanings and relevance to their livelihoods. These analyses involved comparing responses from different groups and linking them to the household questionnaire findings in the results section of every chapter (3-5). Three stages of coding finally reached a pattern for the various responses (see Appendix 3). This helped in testing some research hypotheses, as rich text descriptive explanations from both focus groups and household data, while some were statistically tested as the case requires (Household questionnaire).

1.2.7 Analysis of household questionnaire

For the quantitative analysis, response data from the household questionnaire were cleaned and coded (Kvale 1996; Kvale & Brinkmann 2009; Basit 2003; Miles & Huberman 1994). I prepared and kept a code book manually which was frequently referred to when reading and entering the data in the SPSS version 14.0 for windows software. The code book assisted in keeping track of how different questions' responses were coded and the meaning of the codes. I used Statistical Package for Social Science (SPSS-14) software for this analysis. I created variables and did various data coding and manipulations to facilitate undertaking of specific hypothesis testing. The variables were entered into the SPSS data editor window. They were labelled appropriately to allow for further statistical analysis where necessary. Various data manipulations and transformations, as described for each hypothesis test below, were used to allow for testing different attributes of the population and to answer the research questions.

1.2.8 Hypotheses testing

Research hypothesis 1: (**The Ilchamus as a community has different and diverse sources of knowledge on weather and climate**). This hypothesis was tested first by computing the list and total number of sources of knowledge used currently by the community on climate (Q2) across the sample. I ran a descriptive analysis (frequencies and percentages) to determine the total and average number of climate knowledge sources used commonly. If the average number of commonly used methods were more than 30% of the total list generated, we considered this as many sources of knowledge. The above list was analyzed along with Q8, which asked for observations made to indicate a change in weather/climate. A list of the total number of observations was made and percentages were computed of those respondents who mentioned it. A frequency distribution of more than 30% of the parameters commonly observed are sufficient to confirm and conclude that the Ilchamus have many sources and indicator parameters to determine climate and change knowledge. A descriptive analysis guided the decision to reject or fail to reject this hypothesis. Q11 asked about indigenous (traditional knowledge) sources of knowledge on climate. I computed the total list of sources and calculated the average number of commonly used ones. A list of more than 30% of the total sources used is an indication of diverse sources. This list was also ranked to describe the mostly used/trusted sources.

Research hypothesis 2: (**Ilchamus as a community observes a number of physical and biological variables/factors as indicators of changing weather and climate**). This hypothesis was tested by computing two indices; biological indicator and physical indicator indices (Q14). I also computed indices for traditional and non-traditional sources of climate/weather knowledge (Q13). These indices were used to compute the different sources and their frequencies of use as an indication of their usefulness and trust in the indicator. Responses to Q5 were used to determine different variables/factors Ilchamus consider to influence climate. A summed index was computed for this by means of Principal Component Analysis (PCA) and three factors (kinship, traditional and formal sources) were generated. A reliability tests was run across all the variables entered for every index, the indices were tested across the variables gender, education, and age of respondents. Analysis of Variance (ANOVA) ($p<0.05$) was used to determine the effects of age, gender and education level on the number of indicators used. Where there is a significant statistical difference in the use, a *t*-test was done to determine the means that are different.

Research hypothesis 3: (**The Ilchamus use of sources of knowledge on weather/climate change differs with gender, age, and education levels of the respondents**). This hypothesis was tested by ANOVA and t-test statistics. Dependent (kinship, traditional and formal) variables indices were used to test the hypothesis by gender, age and level of education.

Research hypothesis 4: (**The Ilchamus knowledge on weather and climate change is transmitted through community social structures and organization**). Q9 addressed this hypothesis by exploring the existence of social structures and organization while Q10 obtained details about how useful each structure is in transmitting information, and Q12 addressed the social structures used for learning and trusted to pass information about weather. This hypothesis was tested by determining the extent to which the findings agree with the stated hypotheses about the usefulness of the social structures/organization used to transmit information about climate. A list of social networks /organization structures compiled and frequencies use for each computed. Chi-square statistics tests run to determine the association between social structures and population demographic characteristics (education, age and gender) done.

Research hypothesis 5: (**Ilchamus community members are aware of the likely consequences of weather and climate change on their production systems and livelihoods**). This was tested by use of responses to questions Q16 & Q20. Separate descriptive statistics of consequences were computed for questions 16 & 20 and a summary of the responses from focus group discussions. The higher the percentages of those who identified the consequences was taken as an indication of the high level of awareness of the consequences and that they are familiar with the climate change indicators.

Research hypothesis 6: (**Ilchamus community members can respond in time to avoid losses as a result of weather and climatic changes**). Responses to Q18 were computed to determine the number of respondents who will undertake a response action(s) in anticipation of bad or good weather. It was assumed that more than 50% of the samples (population) will always respond in time to avoid heavy losses in the event that weather was likely to change badly. Responses to Q19 were computed to determine exactly whether the response actions were in anticipation or after the climatic changes. These would inform the researcher about the likelihood of households avoiding or incurring heavy loses. Responses to Q20 would inform the commonly taken actions to avoid losses. A frequency of response action taken was computed to determine actions common among the community members.

Research hypothesis 7: (**Ilchamus community members have several coping and adaptation strategies to mitigate the impacts of climate change against their production systems**). The response frequencies computed in Q20 were used here since the actions undertaken are meant to be adaptation strategies. The commonly used adaptation strategies were computed using Q20 and were ranked according to those that score highly. Responses to Q24 were computed to determine commonly used coping strategies. Using the list of coping options, their frequencies were used to determine the level of use of each coping by the households, with those scoring higher considered more effective.

For the above hypotheses, focus group responses/notes were transcribed, coded into themes of response (Appendix 3) and facts as narrated by the respondents. The themes were compared with the household findings. Focus group responses were used to explain organization, social functions and various actions, community thinking and justifications for certain findings in the household data. The focus group data were expanded into narratives about the community stand on social, cultural and environmental issues. These were used to test the hypothesis. Depending on the agreed views of the focus group members to various discussion questions, I critically examined their responses as they were compared with individuals' responses as summarized in the household survey.

1.3 Criteria for rigor

Scholars continue to discuss emerging criteria for rigor for qualitative research (Sandelowsi, 1986; Krefting, 1991; Guba & Lincoln, 2008; Morse *et al.*, 2008 and Lincoln, 2009). Rigor, or trustworthiness, relates to the research paradigm used in the study, specifically aligning with the axiology, or ethical guidelines, associated with a paradigm. Researchers have a responsibility to ensure their research is both rigorous and ethical. A central question related to validity and rigor is asking ourselves the much we know when we have specific social inquiries that are good and that members of the community in which the research is conducted may respond on them? (Guba & Lincoln, 2008 and Rolfe, 2006). In other words, how do researchers know that what they are doing is both ethical and meaningful? Social studies require the researchers to consider the community as central to the research, including the process of ensuring rigor.

Historically, scholars of qualitative research worked to establish criteria for a rigor that mirrored the rigor established in positivist research (Lincoln, 2001). More recently, those same qualitative research scholars challenge the notion that qualitative research should mirror positivist research and recognize the importance of establishing rigor independently in ways that connect to the paradigms most often used in qualitative research (Tobin *et al.*, 2004; Guba & Lincoln, 2008; Lincoln, 2009). For the purposes of this research, I engaged various methods that align with qualitative research paradigms to ensure trustworthiness, clarity of the study and authenticity. Through regular member-checks and verification with the research participants about the data from my findings and conclusions, I am clear and confident that the data I collected are a true representation of respondents' views. My findings are authentic and truly reflect the community knowledge on weather and climate as it relates to their livelihood coping and adaptation strategies.

Finally I investigated the more traditional criteria for rigor, including transferability, dependability, credibility, and confirmability. While these criteria are regularly emerging and changing (Lincoln, 2001; Morse *et al.*, 2008; Tobin *et al.*, 2004), I employ each of them in this research to ensure more traditional scholars accept this work as valid. I ensured and checked for transferability through drawing of broad generalizable conclusions that can be applied in other related or similar settings. I established dependability by using multiple data gathering methods through individual interviews and focus group discussions. Next, I established credibility by conducting member-checks throughout the process. During the process of data analysis, I designed a system where I confirmed the reliability and facts about the data I have collected before drawing my conclusions. I will satisfy the confirmability criteria through peer reviews by colleagues of the findings. Finally, the transferability criteria have been addressed by providing a thick, rich description from which people can draw their own inferences and understandings (Lincoln, 2001 and Tobin *et al.*, 2004).

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CHAPTER 3

DOCUMENTING INDIGENOUS SOURCES OF KNOWLEDGE ON WEATHER AND CLIMATE USED BY THE ILCHAMUS PASTORALISTS

1.0 INTRODUCTION

Indigenous/traditional/traditional ecological/local knowledge (IK/TK/TEK/LK) is a body of knowledge held by a group of local or indigenous people, unique to a given society, and acquired through generations by living in close contact with nature (Berkes & Berkes 2009). Berkes & Berkes (2009) defined TK/IK/TEK/LK collectively as "*A cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission.*" Fernandez-Giménez *et al*., (2006), quoting from Huntington (1998), defined TEK as a system of experiential knowledge gained by continued observation, transmitted among members of a community and intergenerational in character. It consists of biophysical observations, skills and technologies, as well as the social and cultural norms and values, and institutions that guide human-environment interaction (Berkes 1999, 2012; Fernandez-Giménez 2000).

Of what use is documenting these knowledge systems on weather and climate to the pastoralists groups? How often do they make use of their knowledge systems in decision-making day to day? Climate change is no doubt becoming a concern to all, and more so, to groups like pastoralists whose livelihoods depend on resources that are climate-sensitive. Studies on climate change have shown that Africa is highly vulnerable to climate variability and change (Sivakumar *et al*. 2005; Boko *et al*. 2007) due to multiple stresses and general low adaptive capacity

(Speranza *et al*. 2010). Currently, global climate change is raising new challenges for pastoral systems in Africa (IPCC, 2007). The use of local experiential knowledge systems has enabled these groups to effectively utilize rangeland resources over time. The challenge, therefore, is recognition of this knowledge system by scientists and policy planners, and incorporating these knowledge systems into national development plans. However, pastoralists, whose livelihoods evolved with climate and who have developed resilience over time by use of locally acquired experiential knowledge, lack the capacity to adapt to abrupt changes due to internal and external constraining factors. These factors include lack of accurate climate information updates (Adger *et al*., 2003, Nelson *et al*., 2007), stereotypic attitudes towards pastoral systems, poverty, globalization and marginalizing government policies (Adger *et al.*, 2013, 2014; Crate 2011; Coppock *et al.*, 2011; Galvin, 2009; Tyler *et al*., 2007 and). Experiential knowledge has helped pastoralists survive over centuries; and it is hoped here that such knowledge if documented and used will be very useful when planning and implementing coping and adaptation strategies.

Today, indigenous knowledge systems are seen as pivotal in many spheres of development and poverty alleviation in developing countries (Berkes 2009, 2012; Brokensha *et al*., 1980; Compton 1989, Leakey *et al*., 1997, Niamir 1990, Rahman 2000 and Zapata *et al*., 2011). This knowledge is increasingly regarded as a precious resource. Much has been documented about IK use in agricultural development and environmental management and a host of other human activities which utilize this knowledge but inherently use scientific principles based on their past experiences and outcomes (Atte, 1992; McCorkle 1994; Lansing & Kremer 1995; Zapata 2011). In line with this, the use of IK in pastoral production systems also needs to be documented and put in perspective so that it can be used along with other knowledge systems such as western science.

The wave embracing use of traditional/indigenous knowledge is informed by past mix of successes and failures of western science and technology, and development models that ignored the views of indigenous peoples. They failed to involve those supposed to benefit from such projects (Obudho, 1983; Sabatier, 1986; Wallner *et al*., 1996). In light of these failures and successes, IK in combination with western science is viewed as the best strategy in the fight against hunger, poverty, and underdevelopment (Atte, 1992; Kelbessa 2005; Raymend *et al.*, 2010; Richards, 1985; Scoones *et al.,* 1992; Sillotoe 1998; Tjahjadi, 1993). This assumption comes from the observation that indigenous people have lived with this knowledge in relative harmony with nature, allowing them to use it sustainably (Berkes 2012; Anderson & Grove, 1987; Berkes 2009; Flora & Flora, 1989; Ghai & Vivian, 1992; Inglis, 1993; Sen, 1992) while previously IK was seen as inefficient, inferior, and an obstacle to development (Agrawal, 1995; Berkes 2012).

IK holds promise for agricultural production systems, sustainable development and management of natural resources, (Brokensha *et al*., 1980; Chambers *et al.,* 1989; Gliesseman, 1981; Gupta, 1990; Mercer *et al.,* 2010; Mekoya *et al.,* 2008; Moock, 1992; Niamir, 1990; Rhoades & Booth, 1982; Sears *et al.,* 2007; Warner, 1991; Warren, 1999). Evidence of recognition of the importance of IK is found in several fields (Agrawal, 1995, 2010; Cowling *et al*., 2008; Pullin & Knight, 2001; Raymond *et al*., 2010; Reed, 2008 and Reed *et al*., 2007). The widespread failures of externally introduced development has impelled a shift towards a participatory and decentralized approach to development in which a central point is incorporation of IK in decision making (Berkes *et al.,* 2000; Berkes, 1999, 2012; Mercer *et al.,* 2010; Schmink *et al*., 1992; Warren 2011). This approach has informed the well-publicized, "Bottom-Up" approach to development in developing countries (Obudho, 1983; Otiso & Owusu 2008; Oyugi

& K'Akumu 2007; Wallner *et al.,* 1996). IK has been promoted as holistic, adaptive by nature, accumulated incrementally, tested by trial-and-error and transmitted to subsequent generations orally or by shared practical experiences (Ohmagari & Berkes 1997; Berkes 2012; Mesoudi 2011). However, not all IK system practices are ecologically adaptive (Berkes 2012; Chapin, 1988; Redford & Stearman, 1993; Vandermeer & Perfecto 2013). Some indigenous knowledge system practices and views might become irrelevant/obsolete overtime due to changing operational conditions (Adger 2010; Berkes 2004, 2012; Diamond, 1993).

Studies on contributions of IK to climate change research show that IK and science can complement each other (Luseno *et al*., 2003; Riedlinger & Berkes, 2001; Speranza *et al.*, 2010). For example, Tibetan herders' local knowledge has been valuable when combined with western science to resolve many challenges posed by their landscape (Klein *et al.*, 2014). It has been claimed that indigenous climate forecasting methods can offer insights to improving the value of modern seasonal forecasts for pastoralists in east Africa because indigenous forecasting methods are need driven. These forecasts focus on locality in the timing of rains, and indigenous forecasts is communicated in local languages and typically by "*experts*" known and trusted by pastoralists (Luseno *et al*., 2003; Speranza *et al*., 2010).

In light of the above views about IK, documenting it becomes imperative. Documentation and use of IK systems have become a part of international environmental policy, especially since the Rio Earth Summit in 1992. This summit took a strong step toward helping legitimize indigenous concerns (Cicin-Sain & Knecht, 1995; Massoud *et al.,* 2004). Advocates of indigenous knowledge have promoted it as a component to improve scientific research and management through more and sometimes better information (Huntington & Suydan 2004; Brook & McLachlan 2008; Mercer 2010; Freeman & Carbyn, 1988, Johnson, 1992, Brooke, 1993, Inglis, 1993, Mailhot, 1993, Hansen, 1994). It is a means by which new scientific and management knowledge paradigms can be identified to understand the natural world and our relations to it (Berkes 2012; Colorado, 1988; Deloria, 1996; and Kawagley, 1995; Kovach 2010; Ng'asike 2010).

However, to date the IK system has not been embraced fully in both academic and development circles (Adger 2006; Marglin & Marglin, 1990; Smit & Wandel 2006). There are many possible reasons for this. First, there is general resistance to change because it upsets the familiar and people are more comfortable in doing things the ways they are used to. Other factors that might explain the lack of acceptance of IK include social science research methods unfamiliar to natural scientists, and cross-cultural issues, such as the reluctance of some indigenous populations to share information about their livelihoods (Huntington, 2000). Acceptance of IK, therefore, has remained elusive despite general acceptance about its importance.

Of what relevance is indigenous climate knowledge to pastoral communities in relation to their livelihood systems? Every society has its own knowledge systems and an understanding of how the natural world works, from which its members construct their production systems and livelihoods. Successful reports of pastoral systems and management of their resources abound; for example, in Ethiopia (Gemedo-Dalle, 2004; Kassahun *et al*., 2007); Kenya (Kuria *et al.*, 2011; Tura *et al*., 2011 and Wanjala *et al*., 2010); and Somalia (Abdullahi, 1990). Pastoralists all over the world use different strategies to cope with a changing environment and feed shortages (Behnke *et al*., 1993), feed purchases and migration (Scoones, 1995), diversity of species (Homewood, 2008) and sales as a last option (Hoffman *et al*., 2007; Katjiua & Ward, 2007). Their livelihoods are highly affected by changes in weather and climate (Mortimore & Turner, 2005). However, failure to incorporate indigenous coping knowledge, practices, goals and strategies of the pastoral communities, as well as lack of their participation in the planning and implementation processes, are some of the reasons for their poor adaptability to variations in climatic conditions (Ayana, 2002; Oba & Kotile, 2001).

In addition to documenting indigenous knowledge and its use by pastoral groups, there is a second reason to undertake this study. Climatic models are showing a rise in temperature in the east African region, especially in dryland areas, but along with these are enhanced rainfall (Christensen *et al.*, 2007; IPCC, 2007; Funk *et al*., (Eds) - 2010; Williams & Funk (2010). As a result, these areas will experience both hot and dry spells and short period flush floods during the rainy months. Such climatic changes are likely to bring about even more erratic and unpredictable rainfall and more extreme weather conditions, such as larger and more frequent droughts (Hesse *et al*., 2006; IPCC 2007; Funk *et al*., (Eds) (2010). In Kenya, for example, long time historical records of a series of smoothed rainfall and inverted Indian Ocean and global temperatures, show that low frequency declines in Kenya's March-May rains tend to follow temperature trends (Funk *et al*., 2010). Against this background, this study set out to document IK as known and used by the Ilchamus pastoralists in the semi-arid and arid district of Marigat in Kenya and to propose how this knowledge system can be linked with conventional scientific knowledge to plan and assist this community to better adapt to on-going environmental changes.

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1.1 Objective of the study

The growing interest in traditional knowledge since the 1980s to date is indicative of the need for further insights into how different groups of indigenous/local people acquire their knowledge, and how they use and practice it in their daily lives. Studies on climate change and its effects show that Africa is highly vulnerable due to factors such as poverty, poor response mechanisms and limited research on specific impacts (Boko *et al.*, 2007; Crona *et al.*, 2013; Egeru 2012; Sivakumar et al., 2005 and Speranza *et al.*, 2005). Thus, the problems of climate change needs to be addressed using different and varied approaches to achieve effective mitigation, coping and adaptation strategies (Speranza *et al.*, 2010 and Lata & Nunn 2012). Use of indigenous/traditional knowledge may provide one such approach to improving climate change monitoring, coping and adaptation.

Therefore, the objective of this study was to document the Ilchamus pastoralist community's indigenous knowledge on weather and climate, the indicators observed, and the sources of this information. Correspondingly, the main research question was: What is the Ilchamus community's indigenous/traditional knowledge about weather and climate and what are the sources of this information?

To answer this question, I posed three hypotheses.

1. The Ilchamus community has diverse experiential sources of traditional ecological knowledge systems constructed around observing natural processes.
2. Ilchamus community observes a number of environmental (physical and biological) indicators used in weather and climate forecasting through practical experience.
3. The local experiential knowledge on weather and climate change differs with education, age, and gender among the community members.

   H_0: The local experiential sources of knowledge on weather and climate change do not differ with education levels, age, or gender.

   H_A: The local experiential sources of knowledge on weather and climate change differ with education level, age, or gender.

Evidence used to evaluate the first two hypotheses was descriptively analyzed while the third hypothesis was evaluated statistically.

1.2 Materials and methods

This section describes in brief the background of the study sites and how research samples were identified and selected, and where and how the data was collected and analyzed.

1.2.1 Study area

The study was done in Kenya in 2010/2011 in four (4) administrative locations of Marigat Sub-County, Kenya. The study's focus group discussion participants and household survey samples were drawn from these four locations. The four locations in the sub-county are where the Ilchamus community practice pastoral production systems. Other locations in the sub-county have mixed tribes, hence mixed livelihood production systems.

The Sub-County covers approximately 1,244km^2 with a total population of approximately 48,534 people (GOK 2010). The study region is characterized by low overall rainfall and high temperatures. It experiences low and erratic annual rainfall which varies between 500mm to 750mm with a mean annual rainfall of 650mm yr^{-1} and a potential evapotranspiration rate varying between 2000mm and 2800mm per month (mean annual pan evapotranspiration of 2576mm) (Ngaira, 2006; Snelder & Bryan, 1994; Sutherland *et al.,* 1991). The coefficient of variation for annual rainfall is about 28% (Rowntree, 1991).

The area is generally flat with relatively fertile soils of coarse loam and clay. Originally, semi-deciduous woodland dominated, especially along rivers and northern parts of the Ilchamus flats, but currently, the land is widely covered by mesquite (an invasive exotic weed). Vegetation was originally classified as umbrella thorn savanna woodland (Kiyiapi 1994).

1.2.2 Sampling design and data collection

Data was collected data using two methods: focus group discussions and household survey questionnaires (Kvale & Brinkman 2009; Maxwell 2012 and Creswell 2007, 2013). Data were analyzed accordingly, to answer research questions and test the hypothesis. Qualitative data were analyzed descriptively after coding process (Miles & Huberman 1984; Rubin 1995; Marshall & Rossman 2014) , while quantitative data was analyzed both descriptively and statistically by use of SPSS version 14.0 for windows statistical software.

During the actual data collection period, focus group discussions were held between July-August 2010 and June-July 2011, and household survey questionnaires were done in June through July to August 2011. Stratified sampling, using expertise in local knowledge, gender, and age, was used in selecting focus group participants with the help of traditional institutions like peer groups (*Ilamal*), local elders, opinion leaders, village headmen, and government administration chiefs. Simple random sampling was used in selecting household participants. Secondary data were also collected by literature reviews.

1.2.3 Focus group discussions

Locally known experienced participants ("*experts*") on matters of local ecology and climate-related knowledge, age, and gender variables were used to stratify and select focus group participants. In summer of 2010, an initial reconnaissance focus group discussion was done in Ng'ambo location. The data collected then was used to design and refine a second round of focus group discussion questions and the survey questionnaire that was later administered in summer 2011. A pre-testing of the questionnaire administered before the actual survey was undertaken (Kvale 1996; Kvale & Brinkmann 2009 and Maxwell 2012).

During the actual data collection period, four focus group discussions held, one per administrative location. The groups were comprised of between 10-15 participants (Table 1). Focus group discussions used to document collective local traditional knowledge on weather and climate (See Appendix1).

1.2.4 Household survey

The survey questionnaire (See Appendix 2) was administered (Kvale 1996 Kvale & Brinkmann 2009) to 331 household heads (237 men and 94 women) representing about 10% of the total households' populations in the four administrative locations predominantly inhabited by the Ilchamus pastoral community. Households were selected randomly from the total list of all households held by the local administration offices. Those interviewed were the household heads. In cases where the heads were not available, their spouses were interviewed, or any other responsible adult found in the household.

A questionnaire was administered to each household head individually to get all possible data and all data relevant to this study. We asked specific and general questions about climate knowledge and other information related to weather and climate change. The questions asked and responses given were used to address the research question: "What is the indigenous knowledge of the Ilchamus community about climate change?"

Prior to the actual data collection, four enumerators were hired. The enumerators were trained for two days. Day 1, they were briefed about the research, its objectives, and what was expected of them in the survey exercise. Day 2, pre-testing of the instrument to make sure that it captured the information required, was not ambiguous and tested for length of time it would take to complete one survey. We visited nearby homesteads to do the pre-testing.

Table 1: Number of participants in the focus group and household survey

	Members of the Focus group			Household survey participants		
Location/site	Men	Women	Total	Men	Women	Total
Ng'ambo	7	3	10	43	9	52
Salabani	10	5	15	47	44	91
Kiserian	7	4	11	76	24	100
Ilg'arua	6	5	11	71	17	88
Total	30	17	47	237	94	331

Source: Focus group discussions and household survey, Marigat, 2011.

1.3 Data analysis

Both qualitative and quantitative data were collected and analyzed. The qualitative data underwent a two stage analysis. The first stage of analysis involved tracing particular responses (themes) that were common across the groups from specific questions. The second step of analysis began by synthesizing various related responses so as to form evidence of local community responses to that given question. The focus group discussion responses were summarized and key points were used to provide thick rich description of the overall study findings for each variable and question that was analyzed (Miles & Huberman 1984; Rubin 1995; Maxwell 2012; Marshall & Rossman 2014) (*see Appendix 3*).

The Statistical Package for Social Science (SPSS version 14.0 for windows) software was used for household survey data analysis. The data were coded and entered into the SPSS software as variables for analysis. A total of 354 variables were created and analyzed. Three hundred and thirty-one questionnaires were completed and entered for this analysis. Descriptive statistics such as mean, standard deviation, and percentages were used to summarize and describe sample data. The statistical research hypothesis was tested through a comparison done between different gender, age, and education level on the commonly used sources of knowledge on weather and climate.

In the analysis, the 18 variables for traditional and non-traditional knowledge sources were reduced into fewer unmeasured (latent) factors using Principal Component Analysis (PCA) by means of Exploratory Factor Analysis (EFA) to obtain the best linear combination of variables based on similarity (Jolliffe 2008; SPSS version 14.0 for windows) The variables were shrunken into three components. Each component had its constituent variables run for a coefficient of reliability tests, and overall Cronbach's alpha (α) reported along with latent factors.

The household head's education levels were recorded into 4 categories. Category 1: No education, recorded "1"; category 2: primary level education, recorded "2"; category 3: secondary level education, recorded "3"; and category 4: post-secondary education, recorded "4." The household heads' ages were categorized into three age-group categories. Category 1: 18-35 years; category 2: 36-55 years; and category 3: >55 years. Gender categorization was nominal: male=1 and female=2.

A One-Way-Analysis of Variance (ANOVA) test was done to determine if there were statistical significance differences ($p<0.05$) between the groups (age, education levels and gender) in the test variables (knowledge sources). Where there was a significant difference in the means between groups, a test for multiple comparisons using Bonferroni test and means difference tests done to identify the means that differ. This statistical test was used because it allows comparison within and between different groups under test for similarity or differences.

2.0 RESULTS

The results of the study are presented in this section and are analyzed from both focus group and household survey sources. In each sub-section, the findings from the focus groups are summarized by themes in narrative form to depict the broad community view on the subject. The survey data are summarized and presented in frequency tables for ease of reading with brief notes about each table to ensure the reader understands the content and statement about the main finding(s) for both the narrative and of the statistical analysis where such were performed. These quantitative findings provide information on how households understand and view certain issues/themes compared to the focus group discussions. The results are presented in 7 sub-sections; each sub-section represents a response to various questions discussed in focus group and survey responses by the household heads. The sub-sections summarize the findings both qualitatively (themes) and quantitatively (frequencies, percentages, and statistical significances).

Nature and sources of IK/TK used by Ilchamus in relation to weather and climatic change

In the sub-sections, the results for questions asked in focus group and household survey are presented. The following themes are covered: sources of knowledge on weather and climate, local indicators on weather, observed changes over time, meaning and implications of the observed changes, local season’s calendar, and the role of the local experts and formal sources of climate/weather knowledge. Each sub-section presents findings both from focus group discussions and the household surveys.

2.1 Sources of IK/TK of weather and climate

Based on focus groups discussions, responses on the nature of knowledge on weather and climate, groups indicated that they base their knowledge on information obtained from local "*experts*". The experts are *Loomanyit (intestines reader), Loolakir (stars reader), loiboni (fore/fortune-teller, also a dreamer)* and personal experiences over time through regular observation of the changes in the environment, such as temperature, clouds formation, strength and direction of winds, and changes in the vegetation. Participants indicated that they would anticipate and prepare themselves based on past experiences for future weather scenarios, and that many derive IK-based forecasts for an up-coming season from friends and local observation in the movement of bees and other wildlife species just before the beginning of the rainy season or a possible dry spell. However, the opinion and advice from the "*experts*" is what mostly is used and relied upon by many members in their daily decision-making related to weather and climate risks. This knowledge is experiential and cumulative over time. Once the experts have given their general overview and likelihood future scenarios of the season, this is regularly revised by close observation. As season progression, additional site-specific information are obtained through regular observations (personal experience) which can further be complemented by consulting local experts. Some people complement this local forecasting knowledge with government updates broadcasted by a local radio news bulletin. Experts confirmed to this researcher that they compare their forecasting knowledge with government daily weather information.

Household survey findings acknowledged both traditional and non-traditional sources of knowledge. Respondent household heads were asked to indicate used and reliable sources that aid in decision-making related to weather and climate. The top 10 most frequently used sources (out of 18) are listed in Table 2. Table 2 shows that the majority of household heads (74%) use their own experiences as a basis of knowledge on climate and weather, compared to consulting the traditional experts and local elders.

Table 2: Commonly used sources of local/indigenous knowledge on weather and climate reported by households (n=331)

Source of weather and climate knowledge	% respondents who reported using this source
Own experience	74
Immediate family member	69.5
Radio	64
Community ceremony	51.4
Peer group	46.2
Relative (clan)	44.7
Foreseer/dreamer (*Loiboni*)	41.7
Community elders	36.4
Intestines reader (*Loomayit*)	32.6
Stars reader (*Loolakir*)	31.7

Source: Household survey, Marigat, 2011.

In a related survey question, household heads were asked to indicate if they had ever heard of "*climate change"? ("Enkiwatwatata esiwo anaa enakop"?)* If the response was a "YES," they were asked: "*from which source?*" A list was read to them to confirm a source one has heard about climate change (Table 3). 86% of the respondents claim to have heard issues of climate change discussed or talked about.

Table 3: Percentage of household survey respondents (n=331) that reported hearing about climate change from specific sources

Source of information about climate change	% of household survey respondents
Herders	76
Peers	59
Leaders meeting and friends	58
Family	57
Radio	48
School meeting	26
Government	21
Newspaper	20
Television	19
NGO	14
Internet	4

Source: Household survey, Marigat 2011.

Many of the respondents have heard about the issue "*climate change*" being talked about as depicted from the above list in Table 3. From the percentages shown, the source that people use most is from other herders followed by peers, leaders meeting, friends and family, least heard sources are from conventional sources (TV, radio and internet).

2.2 Local indicators used as sources of knowledge in weather and climate forecasting

Focus group participants were asked to list indicators commonly used to predict and inform about weather and climate-related changes. The following is a list of environmental physical and biological indicators:

1. Stargazing (called "*reading of stars*").
2. "*Intestines reading.*"
3. Movement and direction of winds associated with rains.
4. Temperatures.
5. Clouds observations.
6. Movement of large mammals and direction of these movements.
7. Birds' behavior, songs, and movements.
8. Movement and direction of swarms of bees.
9. Changes in vegetation- flowering and foliage.

Each of the indicators has its meaning about the season. These signs are interpreted to inform what to expect in coming days or months.

In addition to the above commonly used indicators, survey respondents were asked for other additional environmental indicators used frequently to predict or forecast weather not mentioned above (Table 4).

Table 4: Local indicators used to monitor weather and climate reported by respondents (n=331) in a household survey

Weather/climate indicator	% of respondents who use this indicator
Previous season's rainfall	96.7
Water bodies (lakes and rivers)	78.2
Human health conditions	45.2
Other natural features- mountains	43.0
Livestock population	42.4

Source: Household survey, Marigat, 2011.

From the above Table 4, respondents gave a number of environmental natural indicators they also observe to forecast the season rains. The researcher never thought these indicators so were not given in the original list for them to pick from.

2.3 Observed changes over time and trends of change

Led by the local experts and key informants, participants in the focus group discussions acknowledged that many weather and climate indicators have changed over the past 30 years, especially in the last couple of years. They call these changes "*Enkiwatwat E Nkop"* or "*Enkiwatwat E siwo*" (meaning change of earth/land and change of winds, respectively). Some changes observed over time include change in the amounts and timing of the rains, hence changes in seasons. Previously, the onset of the long rainy season was around March/April, but in recent years, rains delay to around May/June and may prolong all the way to August. Other changes include reduction in livestock population, loss of wildlife in the land (migrated away), poor health of pastures (loss of pasture diversity), and loss of traditional medicinal trees and shrubs (many of these have been cut down while others died off due to long droughts).

Other than the physical and biological environmental changes, they complained of socio-cultural changes that have led to young people ignoring and disrespecting cultural knowledge related activities/rituals that were performed to bring in rainfall and heal the land among many others. They attribute loss and dilution of culture and other social changes to western formal education. All focus groups complained about non-adherence to their cultural values due to influence of formal education, which the young generation has embraced. One elder quipped to me: ("*Apaaiya, ena skul rei nitii aisomea naiyeua kuna baa nikidolita. Kaingasia dei ninye nanu amu kadol enaa igira iyie aiyieu niyiolu imbaa elkuak, naa intae aitoki leilo lemeiyieu nesuj yoo"* (My in-law, it is this school education that has brought these issues we are witnessing. But am wondering when you are asking us about our cultural knowledge and it is you with others who are refusing to follow it").

The household respondents were asked to indicate changes observed over the last 20 years (Table 5), the trend of change in relation to their production systems, and whether they attribute these changes to climate (Table 6). Table 5 shows that a very high number of respondents think that rainfall amounts and timing, vegetation cover and diversity, and temperatures have changed. Overall, the majority of household respondents (88.2%), when asked whether they believe that climate has changed in their area over time, affirmed that it had changed. Only 11.8% were either uncertain or could not tell.

Table 5: Environmental indicators reported to have changed by the household survey respondents (n=331) over the last 20 years

Indicator reported to have changed	% of respondents who reported this change
Rainfall timing and amount is poor	96.7
Vegetation on land- replaced by weeds	89.4
Temperature changes (risen)	87.3
Crop yields (low yields)	79.5
Water availability (scarcity)	79.2
Winds direction and timing	71.9
Livestock health (poor)	68.9
Human health (poor)	66.5
Stars position in the sky (unpredictable)	58.0
Wildlife population (loss)	51.7

Source: Household survey, Marigat, 2011.

Table 5 also shows that majority of the respondents reported and believe that there has been a change in the weather/climate indicators. Overall 88.2%, of the respondents reported that weather/climate indicators have changed over time.

Table 6: Observed and perceived trend of change in climatic and weather indicators attributed to climate change by household survey respondents (n=331)

Weather/climatic indicator	Trend of change			
	Good/improving (%)	Bad/ getting worse (%)	No change (%)	Change attributed to climate (%)
Temperature	3.3	84.3- more hot than before	12.4	88.8
Rainfall	5.4	91.2- less, unreliable	3.3	95.5
Stars	16.3	39.6- unreliable	44.1	-
Winds	28.4	43.5- unreliable	28.1	45.9
Vegetation	6.9	79.2- poor/weedy	13.9	71.9
Wildlife numbers	0.9	51.2- few animals	47.9	44.1
Livestock health	12.4	55.5- unhealthy	32.1	68.6
Crop yields	16.4	63.3- poor harvest	20.3	76.7
Water availability	16.7	63.9- less water	19.4	75.2
Human health	7.6	59.1- poor health/sickly	33.3	63.1

Source: Household survey, Marigat, 2011.

Respondents indicated that the observed changes are in a negative trend, i.e. from previously good to currently bad conditions for all indicators (Table 6). They attribute these changes to climate change and other unexplained natural changes over time.

2.4 Meaning and implications of the observed changes to livelihoods and production systems

This question was asked only to household heads in the survey and not in focus group discussions. For those household respondents who indicated observed changes, they were asked to indicate if the change would improve or worsen their livelihood production systems (Table 7).

Table 7: Implications of changes to production and livelihood systems reported by household survey respondents (n=331)

Weather/climatic indicator	% of respondents who observed this change	Reported meaning and implication of the changes to production and livelihoods systems
Temperature	85.5	• Depending on direction of change, temperatures indicate more about rains, crops success and animals conditions • Clear skies leads to high temps on land, drought • High/increasing temps reduce livestock production/yields • Drastic increase in temps at night and day time means some rain will come so high temps sometimes means rain is about • High temps at night for consecutive days indicate onset of rains/coming rains soon, cold nights no rains

		• When it is about to rain, temperatures become higher than normal
Winds	72.8	• This depends on time of the day, direction, intensity and speed • *Mpatpat* winds (from south to north) bring rain, *sukuta* winds (from north to south), no rain • Thick/heavy strong winds/sandstorms mean rains are about to come • Certain winds bring respiratory diseases to human, and other diseases to crops and livestock, hence low production expected in such seasons • Constant winds blow for a number of days just before it rains, start to slow down and stop blowing, rains start in few days after or immediately • West-east winds bring rains, north-south winds mostly cause dryness and drought, in few instances bring some rain • Rare "devils" *(Nkaputputi")* dark, strong and tall touching high sky winds is a sign of near rains
Atmospheric (clouds) changes	72.2	• Clouds are observed regularly to determine their color, direction of movement, speed, and time of the day they are forming • Clouds from east and north-east carry/bring rains,

		those from north or south, no rain, there are exceptions to these. • Thick clouds indicate rain, scattered ones bring diseases • White clouds no rain, black/dark/grey clouds carry water • More clouds in the afternoons indicate rains are about to come • Heavy clouds in the morning during drought is a sign that rains are near
Stars (Astronomic observations)	58.3	• Several types and constellation of stars are observed to determine their relative position in the sky, brightness/or lack of them • Stars/constellation movement has indications to rains. • 4 key kinds of stars (*lipong* ***(female star)***, *laingoni* ***(male star)***, *nkowa and nkorikineji* ***(constellations)***) are closely monitored by the "*experts*" because they use them to predict rains • Rain is expected when the "*female*" is up in the sky • An anomaly observed in the *female* star, means no rains/less rains • When the predictive stars are to the west, there will

		be rains • When the male star disappears (*goes underground*), rains begin • When female is in east, expected to rain • Rain is expected when *nkokwa (constellation)* is down in the west • When all indicator stars are on the same side with moon and sun, there will be rains
Moon position	48.3	• Moon is regularly observed year round to predict the likelihood of rains occurring or dry spell coming • Rainfall is possible only during new moon until when it is full moon • Location/position of the moon in the sky indicates whether it is possible to rain or not (South/North orientation) • When the moon in down (not seen at night), either in the east or west, chances of rain is high, but when it is up in sky, no rain • When it moves towards NE/NW no rain, *nkang e nkolong* • Moving to SE/SW there will be rain, *nkang e lari* • When the moons horns are tilted to the right, it show rain, but when tilted to left it shows calamity

		• When in the same side with sun in the sky, it is likely to rain
Wildlife movements and birds	41.1	• Wildlife movements are good indicators of the prevailing or coming season's conditions. • Movement of wildlife follow availability of water and pastures • Reduced wild animal numbers (migrate away) is sign of looming drought • Migratory birds like flamingoes into different directions (North-South night migration and vice-versa) is weather related • When white pelicans migrate away, rains are very near • Many animals, including birds move away when approaching dry months towards shores of the lake • When Ostriches come around homes, rain is close • When birds like *Iltarmagas* (vultures) are seen flying high in the sky in dry season, rains are near
Sun position	36.9	• People observe the rising position (North-South orientation) of the sun • Very hot sun indicates drought but drastic extreme hot can also mean coming rains

		• The sun moves from home of drought (*nkang e nkolong*) in the south (tropics of Capricorn) to home of the rain (*nkang e lari*) in the north (tropics of Cancer) • When in the north hemisphere, then there is rain • When the sun passes overhead, more rains in that period

Source: Focus group discussions, Marigat, 2011.

Table 7 provides biological and physical environmental variables that the Ilchamus community elders regularly observe and monitor to inform their decision and knowledge on weather and climate scenarios. Depending on the trend of change, each indicator has several implications, either negative or positive. Used alone or in combination, they give precise prediction of the seasonal changes.

2.5 Local season's calendar as source of indigenous knowledge

From discussions with the focus group participants, I learned that the Ilchamus community settled in this area since around mid-1800 (personal communication with the elders referring to initiation of certain *Ilkileku* age-sets, Maasai clans wars, the coming of White man and the Italian war (*larabal loo Iltalian*)- WWI and Anderson (1988); and Dundas (1910). They have accumulated a collective memory of weather patterns that extends into the past. This understanding of the historical pattern of seasons established the basic framework against which this seasonal calendar was drawn. They share a strong sense of the climatology or characteristics of the season. Local people give different names to different rainy and non-rainy seasons, and they are familiar with a number of associated attributes and duration of the seasons. This knowledge enabled them to plan in advance for the coming months/seasons.

In contrast to the conventional calendar, which uses some fixed number of days per month per year, the local calendar (Table 8) has its own social-economic implications that are defined according to rainfall seasons. This calendar is characterized and named according to rainfall patterns, timing, amounts, atmospheric temperatures, livestock health, grazing camps, and vegetation changes in the season, runt behavior, and even socio-economic activities. This calendar, like the conventional calendar, is cyclic.

In drafting this calendar with the focus group members, we tried to compare it with the formal calendar months. This was done deliberately to enable a comparison of their seasonal observations and occurrence of rains or drought, which follows the normal calendar months when rains are expected in their area. We later found out that the two agree generally.

Table 8: Ilchamus traditional calendar months *(Lapaitin le lari*)

Local name of the season (*Lapa*)	**Approximate month**	**Common natural observation made**
Lapa Le Arat	January	Light shower. *Sero* and *larat* are used for light grazing, dry immediately.
Purkula	February	*Sokoten* (*Salvadora sp*) are ripe, very dry month, *sokoten* fed to young children.
Purkula	March	Very dry month, similar to

		February.
Lapa Loo Nkokwa/ naingok	Late March/April	*Nkokwa* (constellation) in the sky, ranting season just before rains
Lorikine lekwe	Mid-AprilMay	Heavy rains expected, or light shower but stop after a week.
Lorikine le kiji	June	Light rains/shows, sometimes dry
Lorikine lesiadi (lapa le ladudakud)	July	Lots of rains, cattle pens are muddy.
Lapa le loirujruj lekwe	August	Light rains. These rains spoil food in farms.
Lapa le loirujruj lekiji	September	Dry to light showers.
Lapa le loirujruj lesiadi (lapa oorore nkatampo)	October	Season between rainy months and dry months.
Lapa lolkuluwa	November	No rains. People migrate.
Lapa le riar-mpala	December	Dry month, winds blow off leaves, dry air, animals in poor body condition; migrate.

Source: Focus group discussions, Marigat, 2011.

Table 8 is a schedule of a locally commonly used seasonal calendar to guide the community on the seasons. It is drawn from seasonal natural characteristics and observations. Observations are used to interpret the weather at that time.

2.6 Local "*experts*" as sources and custodians of knowledge on weather and climate

Focus group discussions revealed that most of the knowledge systems used in forecasting weather and other cultural engagements are the purview of a few "*experts.*" These experts come to be designated as such, due to interests, they developed to learn this knowledge early in life. This knowledge is mostly learned and acquired through kinship relations. No one is denied knowledge, but not all those showing interest have the capacity to master and share it out with others. There are three main natural knowledge systems L*akir (stars), Manyit (intestines)* and *Loiboni (Fortune-teller medicine-man)* and a fourth minor source, *Namuka (shoes*) – even though this one did not feature much in both focus groups and survey, but was mentioned.

From the household survey, individuals claim to obtain their IK on weather/climate either by experiential learning or consulting a number of local IK "*experts*" (Table 9). Respondents were asked about their level of trust on experts sources. A frequency of trust for these sources were computed.

Table 9: Used and trusted Traditional "*expert*" sources of IK on weather and climate used by household survey respondents (n=331)

Traditional *expert* source	**% of respondents who use and trust the source**
Loomanyit (Intestine reader)	74.0
*Loiboni (*Fortune-teller/witch doctor)	62.5
Loolakir (Stars reader)	55.6
Loonamuka (Shoes reader)	42.3
External experts	14

Source: Household survey, Marigat, 2011.

Table 9 above is about traditional knowledge "*experts*" showing use and level of trust respondents have on them. Results comparatively show that *"intestine readers*" and "*loiboni*" are more trusted and consulted. It was found out that local "*experts*" and community members in general consult other external "*experts*" from neighboring tribes (14%).

2.7 Other commonly used sources of formal knowledge on weather and climate change

Household heads were asked if they heard talks and discussions about climate change from formal sources other than traditional source. If they answered "yes", they were asked to indicate the source. Overall eighty-six percent (86%) of the respondents heard from some other formal sources. This tells us that information about possible global climatic changes are most likely being publicized through various media. In a multiple response frame, the respondents were asked to name their source (Table 10).

Table 10: Formal sources of information on weather and climate used by household survey respondents (n=331)

Source of information	% of respondents using this source
Radio	52.9
School meeting	26
Government (met station)	20.8
Newspaper	20.5
Television	19.3
National NGO group	13.9
Local NGO group	11.5
Internet	3.6

Source: Household survey, Marigat, 2011.

Table 10 above indicates that about 50% of the respondents have heard talks/discussions on climate change from radio sources. The other formal sources are equally reported here as sources, but a small fraction of the community gets information from them.

2.8 Hypothesis test for knowledge differences by demographic characteristics

$\mathbf{H_{O}}$: Local experiential sources of knowledge on weather and climate change do not differ with education level, age, and gender.

$\mathbf{H_{A}}$: Local experiential sources of knowledge on weather and climate change differ with education level, age, and gender.

Using Exploratory Factor Analysis, the 18 sources of knowledge (formal and informal) were reduced into fewer unmeasured (latent) factors to the best linear combination of variables.

This yielded three groupings of sources kinship, formal and traditional. The Table 11 below shows which sources were grouped together.

Table 11: Principal Components of the knowledge sources

Factors (with (overall Cronbach's Alpha value)	Best linear combination of variables (Rotated Component Matrix[a]			
	Variables	1	2	3
KINSHIP (.675)	Peer group	.689		
	Immediate family	.757		
	Relatives	.733		
	Elders	.570		
TRADITIONAL (.826)	Community ceremony		.767	
	Loiboni		.797	
	Loomanyit		.820	
	Loonamuka		.677	
	Loolakir		.696	
FORMAL (.742)	Government sources			.697
	Radio			.623
	TV			.778

Newspaper	.778

Extraction method: Principal Component Analysis; [a]: Rotation converged in 5 iterations

By One-Way-Analysis (ANOVA), educational level groups were analyzed to determine whether they differ in the use of three grouped knowledge sources (kinship, traditional and formal) in weather and climatic forecasting (Table 12).

Table 12: ANOVA results for the comparison of different knowledge sources by education level of respondents (n=331)

		Sums of squares	**df**	***F***	**Sig.**
KINSHIPSOURCES	Between groups	4.759	3	1.087	.356
TRADITIONAL SOURCES	Between groups	76.495	3	12.849	.000
FORMAL SOURCES	Between groups	23.222	3	15.699	.000

Education levels: 1: No education=117; 2: Primary level=146; 3: Secondary level=43; 4: Post-secondary education= 22 *($p<.05$).*

Use of kinship sources did not differ by education of respondents (Table 12). The use of traditional and formal sources differed significantly with the education level of the respondents.

Table 13: Comparing means of the indices of traditional and formal knowledge sources (derived from PCA loading factors) by education levels of the household survey respondents (n-331). Means with different superscripts differ statistically (p<.05) using Bonferroni multiple comparison tests

Knowledge source		Education categories of the respondents			
		No education	Primary	Secondary	Post-secondary
Traditional	N	70	90	30	14
	Mean	3.65^{a}	2.79^{b}	1.87^{c}	2.37^{bc}
	SE	.136	.17	.23	.42
Formal	N	70	90	30	14
	Mean	1.08^{a}	1.34^{a}	2.01^{b}	2.05^{b}
	SE	.04	.07	.19	.32

SE= Standard Error of mean.

Table 13 shows that respondents with more education use more formal knowledge sources, while respondents with less education use more traditional sources of knowledge.

Table 14: ANOVA results for use of different knowledge by ages of household survey respondents (n=331)

Knowledge source		**Sums of squares**	**df**	***F***	**Sig.**
KINSHIP	Between groups	4.551	3	2.035	.109
TRADITIONAL	Between groups	11.754	3	2.635	.050
FORMAL	Between groups	7.662	3	3.244	.022

Age groups: 1=18-35years; 2=36-55years;3=>55years (p<*.05*).

The results show that the use of kinship as a source of knowledge is not affected by age of an individual. This means there is free consultation and sharing of knowledge among relatives irrespective of their age differences. However, results for the use of formal and traditional sources show that ages of respondents affects one choices in the use of traditional and formal sources of climate knowledge. Possible explanations to these are given in details in discussion section.

Further test to compare means were done where there are significant difference in the age categories in the use of knowledge source.

Table 15: Comparing means of the indices of traditional and formal knowledge sources (derived from PCA loading factors) by age categories of the household survey respondents (n-331). Means with different superscripts differ statistically (p<.05) using Bonferroni multiple comparison tests

Knowledge source		Age categories of respondents by years		
		18-35	36-55	>55
Traditional	N	80	68	54
	Mean	2.45^{a}	2.89^{a}	3.61^{b}
	SE	.16	.19	.18
Formal	N	80	68	54
	Mean	1.58^{a}	1.35^{ab}	1.19^{b}
	SE	.10	.087	.09

SE= Standard Error of mean.

Table 15 shows that people above the age of 55 years use more of the traditional sources of knowledge while the younger people use more of the formal sources of knowledge.

Table 16: ANOVA results for use of different knowledge sources by gender of household survey respondents (n=331)

Knowledge sources		**Sums of squares**	**df**	***F***	**Sig.**
KINSHIP	Between groups	.992	1	1.303	.255
TRADITIONAL	Between groups	1.882	1	1.249	.265
FORMAL	Between groups	.022	1	.027	.870

Gender categories: 1: males; 2: females *($p<.05$).*

The results from the above Table 16 shows that gender does not affect one's choice of the knowledge sources to use, whether kinship, traditional or formal source. Both genders can seek climate knowledge from any of the three available sources.

3.0 DISCUSSION

3.1 Nature and sources of local IK used by Ilchamus in relation to weather and climate change

This study's results established that the Ilchamus community use many and a diverse local indigenous knowledge and formal sources on weather and climate. Even though the use of formal knowledge sources has increased recently within the community through its educated members and available technological sources, such as radio and television, the use of formal sources are still low. The common traditional sources this study found are stars-gazing, intestines reading, fortune-tellers (*Loiboni*) and to a lesser extent shoe-readers (*Loo-namuka*). The custodians of these knowledge systems are the local "*experts*" who use a number of physical environmental and biological variables in combination to come up with a holistic body of knowledge on climate and weather monitoring systems. These findings partly inform my first research question that sought to know what the Ilchamus community knowledge on weather and climate is. Many of the household respondents claim that they use their own experiences to make their decisions and complement it with experts' opinions. The local experts, too, indicated that they regularly consult other experts, some of whom are from their community, while others are from neighboring communities. The results here also indicate that many people have heard about climate change, mostly from local sources like their leaders, rather than from technological sources. The results support the second opening hypothesis for this study: "*The Ilchamus community has diverse formal (non-traditional) and informal (traditional) sources of knowledge on weather and climate change".*

3.2 Local weather/climate observed indicators and season's calendar (*lapaitin le lari*)

Through years of experience in the same environment, the Ilchamus have come to identify certain physical (biological and non-biological) indicators as well as cultural beliefs with weather patterns. They keenly observe these indicators to forecast likely future weather. They observe many changes in these indicators, many of which they perceive to be negative changes and associate them with change in climate. The observed changes are normally interpreted by *experts*, while those with interest, get to learn and do self-interpretation. Consultation among various *experts* was acknowledged for comparisons purposes. This finding supports the third hypothesis, which stated that the Ilchamus community observes a number of environmental (physical and biological) indicators for weather and climate forecasting by practical experience. The results also partly support the first hypothesis of the study that: "*The Ilchamus community has diverse experiential sources of traditional knowledge system".*

Other studies have shown that local people construct their weather forecasting. For example Orlove *et al*., (2010); Wolf & Moser, (2011) and Howe *et al.*, (2013), found that farmers observe clouds to tell if rains are nearby. Ziervogel (2001), Jiri *et al.*, (2015) and Chisadza *et al*., (2013), found that indigenous farmers have both environmental indicators and cultural beliefs used in climate forecasting. For example, birds and insects, like bees (Mengistu, 2011 and Ziervogel, 2001); people mentioned the 'squawk of the *Makara*' bird as being indicative of rain in the coming days while winds that blow from a certain direction were thought to bring rain. They also observed plants flowering at certain times and frisky animals as indictors of imminent rain (Mengistu 2011; Ogalleh *et al*., 2012; Wilken, 1982; Pepin, 1996; Orlove *et al.*, 2010). Similar indicators in this study are found among the Ilchamus. We found here that different indicators and specialty are used by different "*experts.*"

Local knowledge and experience has also been used to identify and name different seasons on what constitutes an indigenous seasons' calendar. Local knowledge has many descriptions of weather patterns that are acknowledged and named. For example, Yoruba people of Nigeria noted that generally two seasons were named but within this large category, numerous sub seasons exist (Osunade, 1994). Similar to this study, the Yoruba people also define seasons according to the prevailing characteristics of the seasons. These seasons are important because they are the guiding elements on the Yoruba people's productions systems decision-making tools. In Darfur, Sudan, there are more than 25 different names of famine, each describing the different characteristics of the famine, drought severity, and hunger levels (Materer *et al.*, 2001). The naming of the seasons is indicative of what to expect or what will happen. For example, among the Ilchamus, the season around January/February is called "*Naingok,"* which means the breeding season for cattle and goats. However, it was found out from the experts that, since many seasonal indicators have changed over time (sub-section 3.3 below), the seasonal calendar is almost losing its proper interpretation. Seasons for rainy and dry periods have changed; hence names of the local calendar no longer correspond to what conditions used to be.

3.3 Changes observed over the years and trends of change

This study found that local people are aware of changes and variability in weather and climate, including variation in seasonal forecasts. They expressed that unexplained variability has made their forecasting difficult, but they were unanimous that local climatic conditions have changed. They listed a number of indicators and signs to support their claims, such as rise in temperatures; for example, as one elder woman said "*the heat we feel is because the sun has come closer to the earth than it used to be.*" Other concerns raised include rains that come when least expected, disappearance of local medicinal plants, poor quality and lack of pasture grasses, reduced number of livestock (in poor health conditions) on their land, and many diseases both to livestock and humans, mountains once observed to yield signs of coming rains are no longer reliable. The land is invaded by many kinds of shrubs and weeds. The people have no idea how the change came about. Similar findings were acknowledged in a related study done on farmers' perception and knowledge of climate change in Ethiopia, Mengistu (2011).

Environmental change has followed a negative trend. Temperatures soar, rainfall has become uneven, unreliable, and less over time. Pastures have been lost due to drying up of wetlands and invasions by mesquite. Livestock numbers have been declining due to loss of pastures, diseases and competition with other production systems like crops and settlements. Water bodies have dried up and former permanent rivers are now seasonal. This is attributed to less rainfall in the highlands and upstream competition for water use for irrigation, and human population increase. Also formal education has been thought to have negatively affected traditional ways of life due to less regard for old ways of living and young schooled members do not consider TK as a useful body of knowledge system to use in comparison to formal knowledge systems.

Reviewing local perceptions about change, some people believe that the negative changes they observe are due to punishment from "god" because they have allowed other tribes to settle on their land and bring in cultures that are bad to land as one elder woman said, "*Eichoo apa Ilchamus ilmangati metijinga atua wote. Ninche oetuo aitongu nkuluponi aang naropili apa ake*" ("Ilchamus have allowed 'foreigners' to settle in their land and have brought bad omens to otherwise previously peaceful good smelling soils"). The "foreigners" are also associated with cutting down natural vegetation and replacing it with weedy shrubs, which have no foraging value (many of the "foreigners" cultivate crops). The community also has observed that among the wildlife, birds that were observed to indicate when the rains are due, warn them of enemies, and predict availability of food have all migrated away in search of better food and nesting sites in the highlands.

3.4 The meaning and implications of weather and climate change to production systems and livelihoods

Results indicated that local people are concerned about some clear weather and climatic changes observed in the indicators. Their concerns were mostly about the likely implications of these changes in their production and livelihood systems. They fear that their lives will be disrupted or lost. Livestock keeping has become very difficult due to loss of pastures through bush encroachments and competing uses of available land with crop cultivation, and human settlements.

Other observed and reported impacts of climate change include increased incidences of untreatable strange diseases, severe malaria cases, and vomiting. For livestock, they observed high incidences of livestock diseases, parasites, and reduction in production levels. These observed changes will have big socio-economic impacts to the pastoral production system and serious implication on livelihoods of the people. Any observation that deviates away for the norm is certain to bring about disharmony in planning and implementation of many of the people's routines in life. Overall perceptions and observations are that conditions are getting worse. These results are in agreement with findings reported by DFID (2004), Glwadys (2009), and Kinuthia (1997) which indicated that African climate is highly variable and unpredictable and prone to extreme weather conditions including droughts and floods. Education has also been reported to affect perception and use of TK system among the Ilchamus, specifically that education tends to reduce/diminish likelihood of the use of this knowledge system.

3.5 Local "*experts*" as sources of knowledge

Who is considered to be a local indigenous knowledge '*expert*'? Review of available literature reveals that there are limited studies done that deal with this question and more so, there are few done on indigenous knowledge that describe the means through which "*experts*" can be identified in the community (Stabinsky *et al.*, 1996, Davis & Wagner, 2003). The second question is, How are IK '*expert*s' identified? These are very crucial and legitimate questions since we cannot assume that all people are equally knowledgeable. In this research, we identified experts through consultations with traditional institutions like elders, village committees, peer groups and traditional chiefs. We assumed that this approach would identify those considered by local elders, leaders, and their peers to be more knowledgeable within each locality. Certainly peer referencing is a well-positioned technique with regard to identifying local knowledge experts (Davis & Wagner, 2003, Simpson, 2004). IK does not exist in a vacuum, nor is it exclusively generated collectively. IK is needs driven, used, and tested over time. However, only a selected few members in any community pay close attention to IK and as such, develop their carriers out of this knowledge. They become the local generators, promoters, custodians, teachers, and experts of this special community knowledge. The Ilchamus people have a strong belief that knowledge is acquired free from god, and should be given and used freely for the benefit of all people. In our discussions with focus group members, it was explained that those who possess such knowledge are "*god anointed*" because god wants them "*to serve other humanity*." They believe that if commercialized, its potency will be lost. However, those who visit "*experts*" to seek interventions or favors usually do not visit with "*empty hands*." In the order of frequency use (implying most trusted), this study revealed that Ilchamus mostly trust intestine readers, followed by foreteller (*Loiboni*) and stars readers.

3.6 Local community formal sources of knowledge on weather and climate change

This question was only administered to household heads. Individuals at the household level make daily decisions based on information they have before seeking more from friends and other sources. This study found that about 74% of the respondents make use of their intuition and experience before consulting other formal sources such as government through radio news updates (50%). The other formal sources scored very poorly.

3.7 Assessing differences in use of knowledge sources by education levels, age and gender of respondents

The level of education one has does not affect kinship sources of knowledge of weather and climate. This result implies that irrespective of one's education, consulting relatives is not affected by that education, in other words no discrimination in the use of kinship sources but education affects the choices in traditional and formal sources. It is more likely that the more formal education one has, the less he/she uses traditional sources and vice versa, i.e., the less formal education (or lack of formal education), the more one uses traditional sources of knowledge.

The age of an individual does not affect the kinship sources, but age affects the choices in traditional and formal sources of knowledge. It is more likely that the older the person is, the more he/she uses traditional sources, the younger he/she is, the less the use of traditional sources, and greater reliance on formal sources.

The results on the sources used by different genders, suggests that gender of an individual is not an issue. This implies that all genders are accessible to consult any of the three classes of sources- traditional, non-traditional and kinship. This results also is significant to women, where is many instances, they are discriminated by the society and their voices are suppressed, but from this finding, at least they can acquire climate/weather knowledge from any of the sources.

4.0 CONCLUSIONS

Knowledge and perceptions of weather and climate change can influence individual and community strategies to reduce their vulnerability to climate change impacts. Examining and documenting community and household knowledge and perceptions is important to understanding their strategies, approaches, and actions to either cope or adapt to changes in order to sustain production systems and livelihoods.

Reviewing the results from analysis on the sources of knowledge, one can conclude that Ilchamus pastoralists have access to a variety of indigenous and non-indigenous, physical and biological sources of knowledge on weather and climate that go beyond local traditional sources. The Ilchamus use a wide range of different indicators to detect and interpret environmental changes. These indicators are interpreted by local experts to give meaning, as well as by some individuals. We therefore conclude that the Ilchamus observe many weather and climatic indicators and make use of local experts to make decisions about weather response. One contradiction found here is that whereas the focus group discussions agreed that local experts were the most consulted and used sources, household survey results show otherwise. The survey findings showed that the majority of the people rely on their own experiences rather than the use of local knowledge *experts*. This difference can be attributed to the focus group composition, in which most were composed of local experts and other opinion leaders.

By use of these indicators, we can conclude that Ilchamus are able to construct their seasonal calendar used to plan for their productions systems and livelihoods. We can also conclude that Ilchamus have been able to observe a number of environmental changes and they attribute these to climate change, and these have affected their production systems and livelihoods negatively.

Finally, we conclude that sourcing local weather knowledge from relatives is not affected by ones education, but education influences the use and sourcing of local knowledge either from traditional or formal source, with those with more education sourcing more from formal sources and vice-versa.

5.0 RECOMMENDATIONS

First, given the richness of this communities' local indigenous knowledge on weather and climate, I recommend that this knowledge be recognized and used along with other knowledge systems to inform local and national climate change adaptation strategies. A national policy to recognizing indigenous people's local knowledge systems be put in place by nations/countries that hosts such populations. Such a policy can be enriched and well written if the indigenous people are consulted and participate in its drafting. This ensures that details are recorded and ownership of the policy is acknowledged by all segments of the society.

Second, I recommend further in-depth longitudinal studies of these knowledge systems, to have a deeper understanding in its entirety. This study provides an overview of local knowledge on weather and climate. Future researchers in this area of study need to spend more time documenting the kinds of knowledge possessed by different IK "*experts*" because over time, this knowledge might be lost if not documented and kept properly. Expert local knowledge adds value to science by providing detailed insights into the ultimate causes of change and by contributing a rare historical perspective.

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CHAPTER 4

HOW CULTURAL KNOWLEDGE ON WEATHER AND CLIMATE IS ACQUIRED, SHARED AND TRANSMITTED ACROSS GENERATIONS

1.0 INTRODUCTION

Our comprehensive knowledge and understanding of conventional ideas about socialization into cultural life is incomplete due to the diversity of cultural beliefs and cultural groups (Alvard 2003; Aunger, 2000; Benito & Gripsrud 1992; Kirkman &Lowe 2006; Mesoudi 2011 and Mesoudi *et al.,* 2006). Individuals are not born with knowledge on how to behave like members of their cultural groups and therefore have to acquire this over time in what Strauss (1992:9) called the "FAX model" of enculturation. In this model, Strauss theorized that acquisition of cultural knowledge is simply copied into internal structures, and that culture is learned in a way that is similar to how a fax is received. This model was contested and criticized as an unsatisfactory theory of how cultural knowledge persists over time. (Aunger 2000; BliengeBird *et al.,* 2005; Laland & Brown 2011 and Cronk 1991) posit that for us to understand this process, we have to break the process into three fundamental phases: 1) the agents of cultural transmission; 2) intra-cultural variation (since not everyone has equal access to this cultural traditional knowledge); and 3) the psychology of information acquisition since only internalized knowledge is likely to be transmitted.

It has been theorized and found that individuals do not acquire all features of culture presented to them, nor does everyone in the same social environment learn the same things or learn things in the same order (Green 2004; Wokott, 1982, Wilcott 1991). The transmission of traditional knowledge or cultural knowledge has fundamental socio-cultural importance to any society and only those individuals who master the art and are passionate about it are relied upon for effective transmission over time. During knowledge transmission over several generations, social institutions are gradually structured, crystallized, and routine ways of doing things gradually become the customary way that things are done (Gergely 2006; Ruddle, 1993).

Traditional knowledge recently has received increasing recognition among academics and policy makers in biodiversity conservation, ecosystem assessment, and ecosystem management (Heyd, 1995; Huntington, 2000; Gadgil *et al.*, 2003, Moller *et al.*, 2004, Berkes, 2012; Olsson & Folke, 2001). It is particularly valuable in situations where people's livelihoods are natural-resource dependent and closely related to ecosystem services such as pastoral production systems. In such areas, formal scientific studies to understand problems like climate change and livelihood adaptations can be time consuming and expensive and often require capacity that does not exist (Moller *et al*., 2004). The good news is that with traditional knowledge, it is possible to gain insights into ecosystem processes and services and use these to improve ecosystem management and sustain livelihoods (Armitahe *et al.,* 2011; Byg & Salick 2009; Drew 2005; Davies & Wagner 2003 and Huntington, 2000). Traditional knowledge offers opportunities and advantages because it takes into account fine-grained, context-specific perspectives (Berkes & Folke, 2002) and adds value to less-understood and anecdotal local conservation plans by local communities (Reyers & Ginsburg, 2005) and environmental assessments (Scholes & Biggs, 2004). Traditional knowledge is generated based on people's direct interactions with their environment, and is accumulated on a trial-and-error basis through learning and feedback and interaction (Berkes *et al*., 2003; Berkes 2012). It includes cultural, social, and political knowledge held by groups as well as by individuals (Oudwater & Martin, 2003). The role of local institutions that shape the interaction of humans with each other and environment, store and add value to this knowledge and facilitate its sharing with a community are critical (Agrawal & Gibson, 1999; Agrawal, 2008, 2010 and Berkes 2012).

However, despite the opportunities afforded by traditional knowledge, many scientists are still skeptical of it. They question the validity of this informal knowledge in general because of its perceived subjectivity and lack of rigor (Bohensky & Maru 2011; Failing *et al.,* 2007; Nadasdy, 1999; Gadgil *et al.,* 2003; Pretty 2011; Singh *et al*., 2010 and Shava *et al.,* 2010). On the flip-side, many ecosystem managers with no formal scientific training are skeptical of science because often they do not understand it and on some occasions, they think it has been used politically to mask realities or manipulate the truth (Failing *et al.,* 2007;Nadasdy, 1999; Fabricius *et al*., 2006).

Based on the above arguments and concerns, both local and scientific knowledge systems should be used together to improve everyone's understanding of the environment and to promote mutual respect between the holders of such knowledge (Failing *et al.* 2007; Pretty 2011; Nadasdy, 1999 and Shava *et al.,* 2010). It has been suggested that in addition to integrating indigenous knowledge values with science, it would also be more productive and useful to bridge the gaps between them if they are to be used complementarily (Cundill *et al*., 2005 and Gadgil *et al.,* 2003).

Transmission of traditional knowledge other than local inherent factors such as culture (beliefs, norms and practices) is influenced also by other factors such as threats of traditional lifestyles through globalization and livelihood production systems faced with imminent extinction through insensitive developments in which the indigenous people have no participation (Ashenafi 2005; Lolande, 1993). If we know how these knowledge systems are transmitted, then these means they can be strengthened to ensure their effectiveness and sustainability. The long term generation and transmission of traditional knowledge about the local environment and ecosystems offers a unique historical perspective into indigenous risk adjustment options.

Like other knowledge systems transmissions, traditional knowledge transmission is no exception, and is always unevenly spread within any group of individuals and communities. Not everyone has a complete and exclusive understanding of the environment. Rural communities, such as pastoralists, different groups and individuals, understand and use landscape for different purposes (Kaschula *et al.*, 2005). This leads to the rise of local "*experts*" responsible for local knowledge accumulation and transmission, and further inquiry into how the experts transmit this knowledge they hold.

1.1 Processes of traditional/cultural knowledge accumulation and transmission

Traditional knowledge transmission has been defined as a cumulative inheritance system that allows members of a group to incorporate behaviors from other members of the group (Castro & Toro, 2004) or as the transfer of information between individuals by social interaction and learning (Aoki, 2001). Like any knowledge system, traditional knowledge is acquired through learning. Learning is shaped by everyday interactions with the environment (physical and biological). These interactions shape people's everyday skills and tasks performed. For cultural learning, this occurs through a temporal sequence that spans from childhood to adulthood. People learn from each other and learning becomes faster if the learned knowledge can be put into practice and direct contact with nature to accumulate knowledge (Reyes-Garcia *et al.*, 2009, 2010, 2013, 2016; Demps *et al.*, 2012; Claidiere & Andre 2012). Research findings suggests that people learn most any kind of knowledge during childhood and it has been found that children in subsistence societies master great quantities of empirical knowledge about their natural environment and subsistence-related skills and other simple skills before they are 12 years old (Berlin 2014; Medin & Atran 2004; Stross, 1973; Zargar, 2002). Equally, learning has been found to take place in three phases (Aunger, 2000; Cronk, 1991; Caro & Hauser, 1992; Mesoudi 2011; Mesoudi *et al*., 2006 and Perusse *et al*., 1994). Phase one is between 0-10 years of age. This is the time when individuals are innocent of many issues. Parents play a very important role. In this phase children are taught and learn simple matters like item identification, counting, knowledge of what are good and bad, or what to avoid among others. Children in this phase do a lot of imitations of what they see older people do. Phase two is between 11-20 years. This is the stage where many cultural values are acquired. In this second phase, parents play a dominant role in the enculturation of the young. Phase three is when individuals are over 20 years. It is an important stage where individuals' learned beliefs are transmitted to them from individuals outside the family.

Gergely (2006) and Ruddle & Chesterfield (1977), examining the traditional system of knowledge transmission found that learning occurs through repeated practice over time, rather than through simple observation of adults' performance. Researchers placed traditional cultural knowledge transmission at the core of human evolution and posited that it increases the adaptive capacity of humans (Gergely 2006; Boyd & Richerson, 1985, 1995). It has been suggested that genetic and cultural factors likely affect the acquisition of cultural knowledge. Genetic inheritance might be involved in the specific knowledge acquired, but genes might underlie learning capacity or speed of learning which would influence acquisition of cultural knowledge (Reyes-Garcia *et al.,* 2009).

Research findings also inform us that there are three independent modes of knowledge transmission and it takes effect in three directions: vertical, horizontal and oblique transmissions. Vertical transmission is from generation to generation by parents to offspring (Hewlett *et al.*, 2002; Lancy, 1999). This has theoretically been explained by intuition that folk biological knowledge is transmitted directly from parents to offspring (McElreath & Strimling, 2008) and has been supported by several empirical studies (Hewlett & Cavalli-Sforza, 1986; Lozado *et al.*, 2006 and Ohmagari & Berkes, 1997; Berkes 2012). In a study on transmission of cultural traits and skills among Aka in the tropical forest of Africa, (Henrich 2004; Csibra & Whiten 2006; Hewlett & Cavali-Sforza 1986) found that parents were singled out as the transmitters of 81% of the studied skills, 10% by watching others and 4% from grandparents. The study concluded, however, that vertical transmission is dominant only for highly shared knowledge and that new knowledge is mostly diffused through horizontal and oblique paths.

Oblique transmission occurs where one source (person) transmits information to many people or where information is transmitted from many people to one, as in the example where a person learns from older adults other than the parents (Henrich 2004; Scibra & Whiten 2006 and Cavalli-Sforza & Feldman, 1981). This is a common transmission mode of traditional knowledge, although not much has been documented as in the cases of experienced traditional experts (e.g. healers and fortune-tellers) outside the family that play an important role in ethnobotanical knowledge transmission (Lozada *et al.,* 2006). Horizontal transmission involves intra-generational transmission of some type of cultural knowledge beyond the parent-children line (Boyd & Richerson, 1985; Harris 1999; Tomasello 2009 and Tomasello *et al.,* 2005). In this mode, peers learn from their age-mates (Lancy, 1999; Zarger, 2002). Age peers tend to pass along extensive information to one another during their social interactions, and is easier to share such information in comparison to parent-offspring information sharing (Aunger, 2000; Cavalli-Sforza & Feldman, 1981). Studies on age peers in the transmission of cultural knowledge are also supported with studies in developmental psychology on the importance of knowledge acquisition and socialization even in schools (Bruce 2012; Shaeffer, 1996; Boyd & Richerson, 1995; Henrich & McElreath 2003; Laland & Brown 2011 and Vygostky, 1978). Time spent together with peers gives members the opportunity to share knowledge and creates a learning environment for those who know less than others even though those who know more are not necessarily experts (Armitage 2011; Davies & Wagner 2003; Drew 2005; Weisner & Gallimore, 1977; Whiting & Whiting, 1975).

The sequence of early family-based, and later more broadly based, cultural influences reflects the temporal expansion of the social universe of individuals everywhere and is probably representative of how cultural traits are generally acquired (Alvard 2003; Aunger, 2000; Mesoudi 2011), and that both cultural and psychological traits evolve similarly in response to age-related changes in the social environment.

From the above research studies and findings, one gets to appreciate that there are no uniform modes of knowledge accumulation and transmission by various communities. Therefore, it gives room for further research into specifics on how different knowledge systems are accumulated and transmitted by different groups. This study aimed to document how the knowledge held by the Ilchamus community is accumulated, shared, and transmitted over time. We know that every community has its unique knowledge systems that enable it to exploit its environment for survival, and at the same time, to preserve that environment for life perpetuation and future generations' use. Equally, knowledge related to weather and climate is an incremental kind of knowledge like any other knowledge acquired, tested, and passed to others when its outcomes are positive and rewarding.

1.2 Objective of the study

The growing interest in traditional knowledge since the 80's, 90's and 2000s indicates the need to understand how different groups of indigenous/local people acquire traditional knowledge, use and transmit it in their daily lives for future generations' use in coping, adapting, or adjusting to environmental changes like weather and climatic changes.

Therefore, the objective of this study was to document how indigenous knowledge used by the Ilchamus is acquired, stored, and transmitted over generations. This study identified important social networks and means by which local knowledge is shared and transmitted. If the knowledge is not transmitted, then it will be lost permanently and coming generations will have to start from scratch and devise their own skills and knowledge systems about how nature works and how it relates to their production systems and livelihoods.

To achieve the above objective, this study was guided by three research questions and associated hypotheses.

1. How is the local knowledge on weather and climate acquired and transmitted among the Ilchamus indigenous pastoral people?
    - I hypothesized that the Ilchamus weather and climate knowledge is acquired through social interactions and orally transmitted from generation to generation.
2. What social networks and organization structures are commonly used in knowledge transmission and do these differ by education level, gender and age?

I hypothesized that transmission of knowledge by use of different networks differs with education levels, gender and age.

3. How have transmission means and methods of traditional knowledge systems on weather and climate changed over time?

    - I hypothesized that the means and methods used by Ilchamus people to transmit traditional knowledge on weather and climate have not changed over time.

To answer the above questions, I collected household survey and focus group data about knowledge transmission, analyzed it descriptively and summarized responses to questions in relation to local knowledge acquisition, transmission, means and methods of transmission, social networks used, and changes in means of transmission of knowledge over time.

In the question 2 hypothesis, I statistically tested to compare use of networks by different structures of the population defined by three independent variables: education levels, age, and gender of household head.

1.3 Materials and methods

This section describes the background of the study sites where the data was collected and how research samples were selected.

1.3.1 Study area and sampling sites

The study was done in Kenya in 2010/2011 in four (4) administrative locations of Marigat sub-count, Baringo County, Kenya. These are the four sub-county locations where the

Ilchamus pastoralists live and practice their livelihood systems. Other locations in the sub-county are occupied by a mix of tribes, hence livelihoods systems are mixed too.

The sub-county covers approximately 1244km^2 with a total population of approximately 48,534 people (GOK, 2010). Altitude in the Marigat area ranges from 1000m to about 1200m above sea level. The study region is characterized by low overall rainfall and consistently high temperatures.

Originally, semi-deciduous woodland dominated, especially along rivers and northern parts of the Ilchamus flats, but currently the land is widely covered by mesquite. Vegetation was originally classified as umbrella thorn savanna woodland (Kiyiapi, 1994).

1.3.2 Sampling design and data collection

This study employed two methods in data collection: focus group (FG) discussions (July-August 2010 and June-July 2011) and a household survey questionnaire (Kvale & Brinkmann 2009; Maxwell 2012; Creswell 2007, 2012) between June through July to August 2011 in Marigat sub-county, Kenya. FG selection was done with the help of traditional institutions like age groups councils (*Ilamal*), local elders, opinion leaders, village headmen and government administration chiefs. The selected individuals were informed through invitation letters through their chiefs' offices with the assistance of local village headmen and area councilors. We invited at least 10 participants from each location, but those who attended varied (Table 16) from location to location.

A simple random sampling was used to select household participants so that all gender, ages, occupation, and education levels were included in the survey (Kvale 1996; Kvale & Brinkmann 2009). Four (4) field assistants were identified, recruited, and trained to assist in conducting the household survey. Secondary data were also collected from different sources: local government periodic reports, national and regional archives/reports, and some online journals to qualify anecdotal responses where necessary, and to document relevant background information needed about the study area.

1.3.3 Focus group discussion

Local participants experienced on matters of local ecology and climate-related knowledge (local knowledge experts), age, and gender variables were used to select focus group participants with the help of locational leaders and elders. Guiding questions were used to guide the group discussion (Kvale & Brinkmann 2009; Miles & Huberman 1984; Rubin 1995) (Appendix 1). In summer 2010, an initial reconnaissance FG discussion was undertaken in Ng'ambo location. The participants were divided into two separate groups; one was comprised of a mixed group (both men and women) and one that comprised only women. This criterion was chosen as a way to give women a chance to voice their concerns and share what they know since among the Ilchamus community, women are reluctant to talk in meetings where men are present.

We used the 2010 focus group meetings to get a first-hand experience and to listen to the local community to document what they know and understand about weather, climate and matters related to climate change. The data collected at that time was used to design the survey questionnaire (Maxwell 2012; Kvale & Brinkmann 2009) that was later administered in summer, 2011. The focus group guideline questions used in 2010 were also revised and improved after the discussion meetings of 2010 before they were used in 2011 focus group discussions.

During the actual data collection period, four focus group discussions (Marshall & Rossman 2014; Maxwell 2012) were held, one from each administrative location of the four selected locations. The groups comprised between 10-15 participants (Table 17). Both men and women were represented in each group. Selection of participants was stratified using gender, local knowledge expertise, and ages using the same techniques as those employed in the 2010 selection.

1.3.4 Household survey questionnaire

The household survey questionnaire (Appendix 2), was administered (Kvale 1996; Kvale & Brinkmann 2009) to 331 household heads (237 men and 94 women), representing about 10% of total household populations in the four administrative locations predominantly inhabited by the Ilchamus pastoral community. Surveyed households were selected randomly from the list of all households held by the local administration offices. Those surveyed were the household head, spouse, or any other responsible adult found in the household.

A questionnaire was administered to each household head individually to get all possible and relevant data related to this study. We asked specific and general questions about the consequences or effects of climate change on production systems/livelihood strategies as evidence of impacts of climate change. This addressed the research question: "What are the consequences of weather and climate change for pastoralists' production systems?"

Prior to the actual data collection, four enumerators were hired, one from each location. The enumerators were trained for two days. We went through the questions, one question after the other, to make sure that we all understood what the questions were asking for and that each question had uniform meaning. Later in the day, the enumerators were invited to ask questions related to either the survey and survey questions, or any other matter related to this research. Day 2, we set out to do pre-testing of the instrument to be sure that it captured the information required, and to eliminate ambiguous or redundant questions. We visited nearby homesteads to do the pre-testing exercise. Each enumerator pre-tested two households, and we jointly pre-tested two households as a team in the end. This exercise gave the enumerators an opportunity to practice what they would be doing on their own, build confidence in themselves, and get to know an approximate time to complete each interview.

The survey collected relevant data that constituted social structures used by the households to access any kind of information. The social structure list obtained in the FG discussion was used as a guide for the household survey to find out if the structures are commonly used by individuals. Each household head was asked:

1. Do you recognize any of these social networks as channels to obtain information in your community?
2. If yes, s/he was asked for each: how useful is this structure in passing information?
3. Can you list other information sources you frequently use to learn about weather, other than the listed one?
4. Can you list individuals or people with whom you discuss livestock management and other related issues in relation to weather and climatic issues?

For comparison purposes, those social networks mentioned by focus group participants were compared with the household survey to determine those structures mostly used or preferred (Table 18).

Table 17: Number of focus group and survey participants

	Focus group participants			Household survey participants		
Location	**Men**	**Women**	**Total**	**Men**	**Women**	**Total**
Ng'ambo	7	3	**10**	43	9	**52**
Salabani	10	5	**15**	47	44	**91**
Kiserian	7	4	**11**	76	24	**100**
Ilng'arua	6	5	**11**	71	17	**88**
Total	**30**	**17**	**47**	**237**	**94**	**331**

Source: Focus group discussion meetings in Kenya, 2011.

2.0 DATA ANALYSIS

Qualitative and quantitative data were used to supplement and complement each other. The qualitative data underwent two stages of analysis. The first stage of analysis involved tracing particular responses that were given to specific questions across the groups (Kvale & Brinkmann 2009; Miles & Huberman 1984; Rubin 1995). These responses were categorized as evidence of what is known about social networks and their uses on issues of weather and climate (Kvale & Brinkmann 2009; Creswell 2007, 2012 and Marshall & Rossman 2014) (thematic analysis-Appendix 3). Response concepts such as groupings within the community based on age, circumcision period, sharing of oath food (milk and meat), clan identity, and functions of each grouping were created as codes, such as family social structure, council of age-set social structure, and age-set group social structure, among others. These codes were narrowed to yield the themes in the material/data collected (Kvale & Brinkmann 2009; Marshall & Rossman 2014;

Maxwell 2012). General observations of the responses were summarized and compared for similarity and difference from each focus group (thematic comparison analysis). This preliminary coding resulted in a large number of conceptual themes/responses, many of which were immediately seen to be related to each other. These relationships formed the basis for the step two analyses of qualitative data.

The second step of analysis began by grouping together various related responses (themes- Appendix 3) to form evidence of local community responses to given questions (Kvale & Brinkmann 2009; Marshall & Rossman 2014; Maxwell 2012) . Putting together already analyzed bits of information formed the larger conceptual pattern about what is agreed and known in regard to particular discussion questions. In this analysis, we worked on tallying the results between different groups' analyzed concepts and responses. We looked at the patterns of responses, in what they consider as existing social networks, their usefulness in knowledge transmission, ways of transmission, and what has changed over time in modes of knowledge transmission. The focus group discussions were summarized and key points were used to provide thick descriptions of the overall study findings for each variable and question that was analyzed.

Statistical Package for Social Science (SPSS version 14.0 for windows) software was used for household survey data analysis. The data was coded and labeled into the SPSS software. A total of 331 questionnaires were entered for this analysis. Descriptive statistics were used in analyzing, summarizing, and describing sample data. Percentages and frequencies were calculated as per the number of times respondents acknowledged a social network as in use, and how useful a particular structure was to the household.

To test the research hypothesis that the independent variables (gender, age, and education level) would lead to differing use and perception of social network, I compared the relationship between gender, age, and education with the use and perception of a network using chi-square (X^2) statistics. A cross-tabulation was performed to test the relationship between useful responses of a network by independent variables: gender, age, and education levels. Results for the test were summarized in the respective tables 23, 24, and 25. Where household heads were asked open-ended questions, their responses were summarized in tables and used to provide an explanation to specific questions asked.

Finally, results from both focus groups and household surveys were compared on what the two categories of information/data tell us about the concept that was under study/analysis. Whereas the qualitative analysis gives the descriptive text of the responses, the quantitative data gives the distribution of concepts across the sample population, which by extrapolation, can be taken to represent the community position on the concept under study. This comparison of concepts across materials gathered through different research methods often enlarges our understanding of the concepts being studied.

3.0 RESULTS

Results are presented and discussed in four sections: specific means of information sharing/teachings and transmission; general means of traditional knowledge transmission; social networks in use for knowledge transmission; and changes in means of transmission over time and test of hypotheses.

3.1 Specific ways of teaching local knowledge and sharing information (Knowledge acquisition process)

These results are mostly based on focus group discussions. Ilchamus elders regularly meet under some special elders' tree (*Ilchani le barasa*) designated as meeting places (each village has its elders' tree). Deliberations, decisions reached and agreements are made and sealed here. Social issues such as disciplinary cases are heard, determined and ruled here. In sittings where key community decisions are made, at the conclusion when agreements are reached, the elders will summon their warriors (*Ilmuran*) to inform others about what has been resolved and agreed upon. For example, when drought is imminent and pastures and watering points are drying up, elders may want warriors to appoint some among them to scout out and look for good pastures and sources of water so that the community can be advised. The scouts will report back to the elders as per the agreement. Not all *Ilmuran* go to meet the elders, but a few selected ones (*Ilamal*). They will be informed about the elders' decisions, and then they are blessed (*nemaiyiani)* to go ahead and implement or travel to where they are sent by elders. The same methods are used in matters to do with scouting for security. *Ilmuran* can also be sent to deliver some key messages to wherever the elders want the message to reach. It could be within the community or at times to other tribes. *Ilmuran* may choose to delegate some local assignments to *Ilayiok* (uninitiated boys). The above were found to be true and corroborated by all the four focus groups.

On matters of weather according to focus group discussions, there are no formal means of teaching such knowledge. Instead they are shared informally by the herdsmen at the watering points and in elder's free-for-all meetings or during ceremonies and ritual events. The information can also be shared between friends informally, or interested individuals can go out to seek information from the *expert* knowledge holders. Among such meeting points, there are always some experts among them expected to inform others what they have "*seen*" lately either from the stars or intestines.

The *Loiboni* (fore-teller/fortune-teller or witch-doctor) will formally call the community to a ceremony when he foresees (dreams) a serious matter that might result in negative impacts to the community, such as disease outbreaks, drought, or an attack by an enemy. A ceremony and rituals are performed under the guidance of the *loiboni* to ward-off the bad omen from the community or performed to appease gods to yield rains. Different rituals are performed to heal/block different calamities or for different purposes. The *loiboni* will call first a council of elders and experts to explain to them what he has seen (dreamt), and then he proposes to them the kind of ceremony/rituals to be performed. Facilitating elders (*saali)* considered "*pure*" (*Ilpaiyiani oo-cho*) will identify a homestead in one of the villages the *loiboni* will have identified where the ceremony/ritual will be performed. The elders will go out and inform the general public what the *loiboni* has shared with them and call over everyone to participate in the ceremony or else something bad might happen to those who ignore it. Offertory prayers (*lasar*) and blessings (*maiyian)* will be performed by the elders (both men and women). This is one event among others where rich local knowledge is shared among all those who partake in the ceremony.

Among these many rituals performed in different villages, usually *experts* (men and women) are invited, and community members will get an opportunity to ask them questions about what they "saw" and seek their explanations, or provoke them to tell what to expect in the coming days in terms of rain, politics, security matters and diseases, among other social issues of their concern. Rain making ceremonies are a good source of information from the elders and other local knowledge expert members of the community. They challenge each other and compare notes and agree on many matters of concern.

Elderly women and mothers have the responsibility of educating the young girls and newly-married women. On other social welfare community matters, elders (men) will make decisions, and call elder women to pass the information along, who in turn will pass it to young women through informal community women meetings. The same process is used to pass information to young men. Elders will call representatives of the young men and pass to them what was decided, and the young men, in turn, will pass the message to their peers in their meetings (*barasa oo Ilayiok*) or in their night dances.

3.2 General means of traditional knowledge acquisition and information transmission

The following were findings and results as explained by the focus group discussion elders. Folklore (*nkatini oo sinkoliotin*) was found to be an essential component of general knowledge and information transmission and sharing among members of the Ilchamus community, especially in early ages of a child's growth and development. But the elders, key informants, or local knowledge experts, and other members of the focus group discussions, also pointed out that at later stages, knowledge and skills about weather and climate change are not taught in formal ways. Instead their ways of learning and sharing are by exposure to different practices performed in ceremonies or at household settings. This approach can be equated to "*Learning by doing.*" Asked exactly how this is done, one elder woman explained:

> *"Nkerai-ai kaajoki rei, koree apa Ilchamus, koree pee eiuni nkerai naa kedol nkerai neas menye anaa ngotonye, metaa koree peiyie abulu, netum sii ninye ataasa anaa enatodua loo-menye anaa noo-ngotenye eas. Koree duo too kule katitin naa kiutaki neikunaa teneas nikintodol ajo kera tarush*". (My child/son I am telling you, historically when an

> Ilchamus child was born and grows up, it is expected for that child to observe what the father or the mother does and how they do it so that in his/her days, they are expected to do the same, although some taking long to learn are taught and directed to do chores correctly, so we did not have any other formal ways to teach them).

The acquisition of skills and learning processes start as early as the child learns to walk and talk as explained by participants. Children are both a passive and active population involved in communal ceremonies and rituals since they are exposed early in life to these skills through observation. It was explained that children usually accompany their parents, especially mothers, wherever community ceremonies and rituals or any traditional activities are performed. Children are not given any verbal instructions on what to do, but as their mothers and other participants in a ceremony sing and perform certain rituals, the children are later encouraged to imitate these in their daily children play activities in their villages. You will find children in villages that, in small groups, congregate during the day or early evenings to perform some imitations of activities they saw their parents perform at the previous ceremony. Other than parents and community functions, we learned that children get early life trainings from their grandparents, too on everyday tasks. Elderly grandparents particularly play an important role in teaching folk songs, narrating stories, and telling riddles during the day when the children were left with them while parents go out to look for food or look after livestock. Through songs and folk-tales, children learn early in life some of the beliefs, attitudes, and relations of the community towards nature and taboos. As an example, some of the riddles used by grandparents are to teach children about nature and its names:

> "*Eike te kiraraita*" (It hangs nowhere very far) – response: the moon (*lhapa*)
> *"E dorop anashe ngutunyi, neitiolo atushumusho*" (your Aunt is too short, but knows to brew) - response: a bee (*Ilmarreni*)
> "*Lekeek isiet*" (The eight trees) – response is to name eight different species of trees by names in quick succession.

> “*Lekweny isiet*” (the eight birds) – response is to name eight different species of birds by names in succession.

As children reach herding ages, they form peer groups. Boys and girls form separate peer groups. In these groupings, while in the fields herding, they perform mock ceremonies and rituals where girls imitate and perform the roles of mothers and boys imitate the roles of fathers by directing how the ceremonies are performed. What they saw and learned in the previous community ceremonies are further reinforced and perfected in such peer group activities. As examples of how they imitate, it was explained:

> “*Koree apa tenepo nkera airitisho, inie oishi etume rishata naasie nkiguran enye medolita ntoiwo, koree ntoiyie neas naas noo-ngotonye, neas sii niche laiyiok nadol loo-menye eas”.* (When children are in the field herding, this is the place and opportunity they use to do the plays where grown-ups cannot see them. Girls do as they saw their mothers, while boys imitate their fathers).

Girls will mostly learn to sing rain-making and ritual songs, and to cook, sweep and clean the floors, and they model dolls out of wet mud. They also learn how to dance and perform some mock rituals, while in peer groups boys on the other hand learn how to sing, herd, fight and defend their livestock against wild animals. In relations to pasture conditions and water, they learn how to scout for the best quality forage and water drinking points for their livestock. The boys are a source of pride to their fathers when in the evening they drive home animals that are gut-filled and none are missing from the herd; “*mimunyak anaa loata laiyioni lenya orau nkishu aa pooki,”* (“You are not as lucky if you do not have a son who brings livestock from the field when none is missing.”) Such boys will always discuss with their fathers where they grazed that day and the conditions of the pasture in terms of other livestock herds and levels of crowding, water situation and security, and pasture density in relation to meeting cattle forage needs. Gradually, the boys take charge of where and when livestock should be moved in consultation with their fathers as dry conditions set in or as conditions improve from the drought.

Specific knowledge-skills, such as the reading of stars and intestines, is acquired and perfected based entirely on individual interest and passion as the boys grow into adulthood. It is not surprising to see *experts'* family members very uninterested, while members from other families might take advantage of and keen interest in learning such skills. However, it is common to have experts introduce these skills to their children and encourage them to learn by taking active roles, like accompanying their parents where ceremonies and rituals are performed. As one expert narrated:

> *"I learned these skills through my late grandfather. But now in my own family, one of my sons barely 20 years old and my second wife are almost outshining me."*

In his home, as explained, the old man (*expert*) habitually involves his family in whatever he does. While slaughtering an animal, usually a goat or sheep for family food or for visitors, he invites and encourages his children, especially the boys, to assist him to do the skinning while he explains the various parts of the body, how meat is separated, and different entitlements of meat to the household (what meat is for men, women, children, and which parts are shared by all). When reaching for the offal, he will remove and spread the small intestines and start to show and explain what different veins and arteries represent and mean in terms of weather conditions, water bodies, rivers, health of the people and many other social attributes. They claim to "read" the intestines and understand what the intestines mean. An interested wife will also be present to watch and learn from her husband. In such a family, all those who pick up the skill fast will be encouraged to learn more and get to understand and interpret on their own. Girls are not encouraged to show interest. Furthermore, adolescent girls are not allowed to go close to their dads and vice-versa. As an expert summarized:

> *"Melelek ena siai, keyiu iltungani ngen oleng te ikonoto, amu ninye ake oidip ataiyiolo siai oo manyit, naa laiyiok naake oidim ena siai*" ("This is not an easy task as it requires someone born with interest and keen enough to understand the reading of intestines, and it is only boys who can handle such.")

Reading of stars (stargazing) is done in early evenings after the sun sets and through the night until the morning star rises around 4am-5am. Early in the evening when the skies are clear, experts start by identifying different stars by names, their position, and then monitor their movements across the skies. These details are noted as a means of interpreting the stars' implications for different seasons. Over time, the people who show interest will eventually accumulate the knowledge and master the art of reading stars.

These kinds of knowledge systems are provided by the experts freely just like any other traditional knowledge system, although it is wise to carry some token of appreciation for the expert, especially if one visits the expert with intention of learning something, or has a specific question that he/she wants answered. To learn this knowledge, one does not necessarily have to come from the experts' family; any person with interest can be taught. In fact, the Ilchamus have a belief and attitude that: "*A son/boy who has no father (from a single parent) will always be more keen and wiser than one who has both parents."* This saying is used to show that single parent children will always pay attention to advice given to other children by their fathers, and since he does not have one, he will always be keen to listen what their friends are told, while those with fathers tend to ignore such advice knowing that they are always accessible to such advice whenever they need it. They say:

"Ingen anaa laiyioni le Nkoliai" (You are as wise as a son of a widow).

From the above illustrations on how indigenous knowledge about stars and reading of the intestines is acquired and passed, similar methods and approaches are used for transmitting expert knowledge on the meaning and interpretation of singing birds in different seasons and locations/places, seasonal migrations, movement of swarms of bees, birds and other terrestrial mammals such as baboons and monkeys.

Women, on the other hand, have exclusive and clear roles to train, nurture, and equip girls with the necessary skills both on how to take care of their homes (milking, cleaning, fetching water, firewood collection, and food preparation) and in rain-making ceremonies and rituals. Women's roles in rain-making, offertory prayers, and land cleansing are skills acquired early in life while growing up. The Ilchamus believe that long droughts or disease outbreaks are a result of man disrespecting god and defiling the land (soil); therefore, it is only the women who can talk to god and ask for forgiveness and to bless the land (soil) again (*Aitoropil enkop*), so that rains can come and diseases can be cured or chased away. Accompanying their mothers to all functions exposes girls to the roles of women in this community. At home, while herding or fetching water and firewood, girls are always engaging in singing and practice what they hear from their mums, as mums listen and correct them. They are also taught about family values and respect for their peers, fathers, other women, and men when married off. Ilchamus woman are proud when their daughters are married and are able to bring forth their families and are active in community ceremonies such as rain making and land cleansing offertory prayers. Women in the focus group meetings agreed that a woman who cannot perform offertory prayers has no value to herself, her community and her family: "*Nyoo apake peiyie eitobira nkai ntomonomi, mara kejo peeku ne nkomono?, inie peiyie eji iyoo ntomonok"* (Why did god make a woman if not to perform prayers and intercede? That is why we are called "*ntomonok,*" meaning "of the prayer ones.")

Other than family training, boys and girls also learn by actively participating in public community ceremonies. Children found to show mastery, interest, and commitments are usually chosen to lead and guide community rituals with guidance from old experts. Participation occurs where peers propose their colleagues to be included out of their experience and interests. These individuals gradually accept to take more community responsibilities, and with time, become experts to be relied upon by future generations. These cycles continue with coming generations and age-sets as they mature and get recruited into the elders.

We learned that after every round of community rituals, members and experts usually discuss the past activities performed and evaluate (lessons learned through outcomes) if they were successful. This is the basis for either revision of the practice or continuing the practice as in the past ceremony. In essence, Ilchamus experts and elders frequently revise their practices based on the outcomes of the past experiences. If ceremonies and rituals are held and the outcomes were favorable, then the same can be repeated. Those who performed it will have to recall exactly how they did it. If by any chance some parts are changed, then, they consider this a new way of doing things *(Ilkereti ng'ejuk*) and will be accepted and adopted if its outcomes are favorable (i.e. nothing bad follows after its performance). They usually support their action of the past ritual by saying: "*Amaa naa tene-meiba iyiok neaku nyoo peiyie kintoki aiyia ai oitio?"* (If it does not hate us, why do we have to look for another way?)

The *Loiboni* (fortune-teller or witch-doctor) knowledge on climate changes among other social issues is an inherited kind of knowledge system. Those born of particular familial lineage will be the only ones who possess it through inheritance. They claim that their knowledge comes by way of dreams. Interestingly, only males are allowed to carry on and practice these skills. When the wife of a *loiboni* is expectant, the *loiboni* is able to see through dream (invisible fights at night with the fetus) if that pregnancy has these powers. They either terminate that pregnancy by way of unexplained miscarriage or the child is born with some minor deformities (such as pinched ears or poor eyesight) especially when the progeny is that of a female. Such females when born have minimal powers of foretelling. When married and pregnant, and thought the child they carry has *loiboni* powers, pregnancy it is terminated before term. When not successful, such children are the kind born with deformity like a pinched ear explained as the work of loiboni clipping the powers. This belief is acknowledged by many members of the Ilchamus community.

3.3 Recognized traditional social networks and organizational structures used in knowledge sharing and information transmission

In this study, we wanted to find out the existing and recognized social networks/organization that people commonly use while sharing information and through which channels local knowledge can be transmitted. During the focus groups, participants listed a number of social networks they recognize. These networks are formed for different purposes and uses. Their usefulness and participants' trust in them as a source of accurate knowledge varies. While some are permanent, others are temporary and are only used for a given short time and die off. Some have strict rules of engagement, while others are loosely formed; some are formal and others are informal (Table 18). All the network types were identified through the focus group meetings and discussions.

Table 18: Social networks and organizational structures identified though focus groups discussions (n=4)

Social network	**Membership**	**Purpose**	**Rules of engagement**
Immediate family (*Enkang')*	All immediate family members: parents and their children	Family unity, security and wellbeing for each member	No strict rules, family respect and norms. Everyone to follow what has been agreed.
Relatives/clan *(Nkirenyi*)	Familial blood relatives. No automatic membership if not interested.	Clan unity, security, gets to know each other and wellbeing for all. Help in times of stress.	No rules, but expect to keep clan issues within the clan members.
Friends (*Ilchoreta)*	Any society member, who shares some interests, could be neighbors.	Socializing, security and company, business links like farming, herding among others.	No rules, but there should be mutual respect to each other's' views.
Peer group (*Inchiling*')	Members of the same age group and live close to each other, or neighboring villages.	Socializing and company. Share common interest and eat together most of the time.	No rules, entry and exit at own convenience.
Age-set group	All those who were initiated in the same	Culturally recognized age-set group. Play an important	Rules are strictly followed.

(*Ilporor*)	period into the same generation set.	role in generational transition, make important binding rules and share the same age-set name given during the graduation ceremony (*Unoto*). Determines the community success and future.	Those who violate will be punished (practices some kind of graduated sanctions).
Council of men elders (*Ilamal loo-ilpaiyiani*)	Selected by community based on their experiences and wide knowledge on various issues. Have to be good speakers, wise, and mature. Each age-set is represented in this group.	Community think-tank. Their opinion and views on social matters are taken seriously. Violators might be ex-communicated or cursed.	Rules are strict, confidential matters are discussed and only part of that is made public when they deem it necessary and safe.
Council of women elders (*sirit oo ntomonok*)	Elderly married women and widows.	Perform community ceremonies and rituals, they administer discipline to men who misbehave and guide newly married girls. They also pass information from	No permanent strict rules, but are crafted as need arises. They can punish their members who leak secrets.

		elders (men) to other women.	
Age-group council (*Ilamal loo-ilporor)*	Members selected from each age-set (they later graduate to council of men elders).	Guide the age-set in crafting rules of engagement with elders and other members of the community. Devise sanctions and determine how the age-set will carry out its functions as members of the wider Ilchamus community	Strictly enforce traditional rules and *Ilamal* code of ethics. .
Youth group (*Lelero)*	Loose membership.	Formed if there is need to assist elders in doing certain chores for example help feed people in ceremonies or funerals.	No rules, but are expected to be disciplined and respect for community directives.
Council of boys (*Ilayiok)*	Un-initiated boys only.	Herding, and perform any assignments as directed by council of elders and warriors (*Ilmuran*).	Temporary rules effective as long as they are still un-initiated. Once initiation is done, the rules become

			obsolete.
Village committee *(Ilpaiyiani loo-ilkijiji)*	New phenomena with formal administration by central government. Members identified by community members, and appointed by the local area chief.	Help in administration at grassroots. Advise local administration on community needs and views on various matters. Meetings held in the villages with presence of assistant chief.	Government rules, can invoke Chiefs Act under which they operate. A formal Act of parliament of Kenya.
Locational committee *(Ilpaiyiani loo-Ilcheni)*	Like the village committee, but bigger membership representing each sub-location.	Like village committee. Ratifies what is decided in villages and their meetings are held in chiefs office. The chief chairs these meetings.	A legal Chiefs' Act of parliament of Kenya.

Source: Focus group discussions, Marigat sub-county 2011.

During the household survey, respondents were asked whether they are aware of and can identify these networks in their villages. Their responses are summarized in Table 19 below. This study did not try to establish why certain social networks are identified more than others; it only wanted to know which social networks are used in information transmission in this community.

Table 19: Social networks identified by household survey respondents (n=331)

Social network	**% that identified this group**
Relatives (Clan) (*Nkirenyi)*	96.4
Age-set (*Ilporor*)	96.4
Village committee (*Ilpaiyiani loo ilkijiji*)	94.3
Council of elders (*Ilamal loo-ilpaiyiani*)	93.7
Age-set council of elders (*Lamal loo-ilporor)*	93.4
Locational committee (*Ilpaiyiani loo-Ilcheni*)	92.7
Family (*Enkang')*	86.7
Council of boys (*Ilayiok*)	85.5
Friends (*Ilchoreta)*	78.5
Peer group (*Inchiling'*)	69.5
Women elders (*sirit oo ntomonok*)	66.8
Youth (*Lelero)*	63.7

Source: Household survey, Marigat 2011.

From the above Table 19, one can conclude that all the social networks as suggested by the focus groups are well understood and identified by the respondents.

Respondents were also asked to rate these social networks according to their usefulness in knowledge/information sharing and transmission (Table 20). There were those respondents who could not identify any network, neither can they comment about their usefulness or otherwise. Note from the table that as the level of identity and usefulness drops down, the percentage of those not sure of the use of the group increases.

Table 20: Ranking usefulness of the social networks by household survey respondents (n=331)

Social network group	% of respondents who find the network is useful	% of respondents who do not find the network useful
Age-set council (*Lamal loo-ilporor*)	90.0	5.7
Age-set group (*Ilporor)*	88.8	6.9
Council of men (*Ilamal loo-ilpaiyiani)*	88.8	6.9
Locational committee	88.5	4.8
Village committee (*Ilpaiyiani loo-ilkijiji)*	87.0	5.1
Relatives (*Nkirenyi*)	76.7	12.1
Family (*Enkang'*)	73.1	9.4
Friends (*Ilchoreta)*	67.7	10.0
Peer groups (*Inchiling')*	58.9	12.7
Council of women (*sirit oo ntomonok)*	52.7	20.6
Council of boys (*Ilayiok)*	47.3	16.1
Youth group (*Lelero*)	43.3	20.6

Source: Household survey, Marigat 2011.

Other than the above list of knowledge and information sources, respondents were asked in an open-ended question to specify other sources/networks of information about weather and climate that they often use in their daily lives. These are other independent sources/networks (not mentioned by focus group members) that many of the respondents identify as sources used more frequently. Table 21 below is a summary of these other sources consulted.

Table 21: Additional networks used by household survey respondents (n=331) to inquire about weather/climate conditions

Source used	% of respondents who use this source
Spouse	23.6
Friend	11.2
Neighbor	7.3
Veterinary officer/scout	4.5

Source: Household survey, Marigat sub-county 2011.

The table above depicts some minor sources identified by some household heads as sources of knowledge of weather and climate. Though few, but they are trusted by those who identified them.

Livestock management is one of the primary activities for many members of this community, except those who said they did not own any livestock. This production system is highly affected by changes in weather and climatic conditions. Household respondents were asked, “In relation to your livestock management decisions, who do you consult for decisions about where livestock would move, graze in the season or watering points”? Table 22 is a summary of who is consulted in decisions making.

Table 22: People commonly consulted by household survey respondents (n=331) when making decisions related to livestock management

Persons consulted	% of respondents who consult this source
Own decision	32.9
Spouse	20.8
Relative	18.1
Herdsman/boy	11.8
Veterinary officer/scout	6.9
Neighbor	5.4

Source: household survey, Marigat 2011.

Results from the above table show that people tend to rely mostly on their own knowledge to make necessary decisions that affect their livelihood production systems.

3.4 Testing for differences or similarities in the use of various networks by gender, age and education levels

I hypothesized (**H_0**) that the perceived use of different social networks for knowledge sharing and transmission would not differ based on the respondent's gender, age, and education level. I used Chi-square analyses to test the use association between a network and demographic characteristics in hypothesis, (**H_A**): The perceived use of different social networks for knowledge sharing and transmission differs with gender, age, and education level.

To facilitate data analysis and testing of the hypothesis, test variables (social networks) were recoded such that useful of a network items were on a "Yes=1, or No=0" response nominal scales (original scales: -2=very unuseful; -1=not useful; 1=useful and 2=very useful).

Chi-square (X^{2}) statistics were used to test the relationships between different networks and the independent variables and those found to have a relation were subjected to further correlation statistics tests for their association.

Table 23: Results of Chi-square (X^2) tests of the relationship between perceived usefulness of a network and gender of household survey respondents (n=331)

Social network	% Male	% Female	X^2- value	df	*p*-value
Family	70	81	4.000	1	.046
Village committee	90	81	4.404	1	.036
Locational committee	92	80	9.851	1	.002
Relatives	77	76	.107	1	.744
Friends	68	68	.010	1	.920
Peers	61	54	1.176	1	.278
Age-set group	89	88	.036	1	.849
Council of elders	89	88	.036	1	.849
Council of women	51	56	.705	1	.401
Council of age-set (*Ilamal*)	91	87	1.144	1	.285
Youth group	46	37	1.991	1	.158
Boys (*Ilaiyiok*)	50	42	1.764	1	.184

Significance level: *p*=.05. Source: Household survey, Marigat 2011.

From the above results (Table 23), gender influenced use of only 3 social network variables (family, village committee and locational committee) ($p < 0.05$). Women are more likely to consult and rate as useful the family network, while men are more likely to consult and rate as useful village and locational committees compared to women. The other nine social networks where there were no significant difference means both men and women can access each network equally without much difference in their rating level.

Table 24: Results of Chi-square (X^2) tests comparing household survey respondents' (n=331) assessment of the usefulness of a social network by respondent age category. Data are the percent of respondents in each age category

Social network	% 18-35yrs	% 36-55yrs	% >55yrs	X^2- value	df	*p*-value
Relatives	87	74	68	10.765	4	.005
Friends	79	66	57	10.738	4	.005
Peer group	68	57	51	6.795	4	.033
Council of men elders	89	88	91	.576	4	.750
Age-group council (*Lamal)*	80	97	93	18.905	4	.000
Youth	55	40	36	8.898	4	.012
Locational committee	88	85	95	5.481	4	.065
Family	81	69	69	5.617	4	.060
Age-set group(*Lamal*)	88	88	91	.912	4	.634
Council of women	63	51	45	6.520	4	.038
Boys (*Ilaiyiok*)	51	49	40	2.167	4	.338
Village committee	87	85	90	1.615	4	.446

NB: Significance level: *p*=.05. Source: Household survey, Marigat 2011.

From the above results (Table 24), use of 6 independent social network sources (relatives, friends, peer group, age-set council, youth, and council of women) differed significantly by respondent age. The results confirm the basis for which each network is formed. These are customary social networks to serve certain interest groups/ages. Relatives are used by immediate family and clan members, friends are for close-knit group who associate each other, peers also are for a specific group with common interest and share together their information, same as the age-set council (*Ilamal*). Youth too share among themselves as do the council of women. We, therefore, reject the null hypothesis based on the six sources.

Table 25: Results of Chi-square (X^2) tests of the relationship between usefulness of a social network by household survey respondent's education level (n=331). Education levels: 1=no education; 2=primary level; 3=secondary level, 4=post-secondary

Social network	1	2	3	4	X^2- value	df	*p*-value
Relatives/clan	66	80	88	82	9.679	3	.022
Age-set (*Ilporor*)	92	90	77	86	7.575	3	.056
Family	71	75	79	55	5.244	3	.155
Friends	62	70	79	59	5.587	3	.134
peers	52	65	61	46	6.158	3	.104
Council of elders	87	92	88	91	1.595	3	.661
Council of women	54	56	52	36	2.840	3	.417
Age-set council	92	90	88	86	1.158	3	.763
Youth	39	46	51	50	3.994	3	.262
Boys (*Ilayiok*)	45	50	45	46	.715	3	.870
Village committee	86	88	84	90	1.174	3	.759

Locational committee	87	89	91	86	.539	3	.910

NB: Significance level: *p*=.05. Source: Household survey, Marigat 2011.

Education level influenced use of only 1 network, the relative/clan social network. Respondents with more education are less likely to use the relative/clan social network. The use of social networks is not affected by education.

3.5 What has changed over time in the traditional systems of knowledge transmission?

Within this community, this study found not much change over time in the ways knowledge is transmitted among its members. When asked to compare it with the past, they responded "*eitu kidoliyiiok ilpaiyina anaa nkitoo ajo nyoo naiwatwate, ntoki nikitoduaa, naa intea ltungana le taata lemekure iyieu nining'iyiook Ilpaiyiani.*" (To us elders, we have not seen any change on how to teach you, but we have realized that it is you the young person who has changed because you do not listen to me.) However, the elders, opinion shapers, and experts raised a numbers of issues about which they are not at ease with the younger generation. They complained of general disregard of indigenous knowledge by the young people, especially after they attain some level of formal education. They complained that educated young people become big headed, rude and disrespectful. They attribute this to effects of education on their sons and daughters' attitudes towards traditional ways of doing things. They believe that formal education is influencing young boys' and girls' attitudes and perceptions about traditional ways. They complained that young educated people perceived the traditional ways to be inferior, unprogressive, and archaic to modern life.

From the focus group discussions, it was clear that the young educated generation prefers listening and taking advice from formal sources other than elders. They prefer these sources rather than listening to those considered wise elders who have long experience about local social-political life of their community. Since the Ilchamus traditional knowledge system and culture are based on and revolve around livestock keeping, young people of the current generation are rebellious when it comes to responsibility in caring for and herding livestock. Young people hold some level of contempt to this just as they do to IK related to weather and climate. Members of the young generation think that local *experts* are a bunch of unreliable information peddlers because their knowledge cannot be proved. Skeptically, they question that, if at all this indigenous knowledge is so potent, why are the holders still living in abject poverty yet they claim they can tell what the future holds. A common phrase quoted by younger people in the discussion meeting about their elders was, "*Nyoo dei ejoki iyiok kulo jamaani, naijo etanya dei apa iakuku miloyoni okuna kishu inyi, anaa ilkule oreren oat sii ninche nkushu too ilchampai"?* ("What are these elders teaching us now, why have they not become millionaires with your knowledge on cattle keeping like the ranchers since you all keep livestock?") Younger informants equate the local herders to commercial ranchers around the country who practice modern ranching, hold titles to their lands, and can secure bank loans to develop their businesses.

4.0 DISCUSSION

Local knowledge can shed light on environmental changes including weather and climate changes for ecosystem and livelihood planning. This calls for a better understanding and assessment of where such knowledge is located in a community and how it is transmitted among its members (Chalmers & Fabricius, 2007).

Transmission of indigenous knowledge among generations in any society is a complex and fundamental process embedded within the deep socio-cultural structure (Ruddle, 1993). It is this structure that determines the intricacy and methods of the transmission process rather than the environment, whether in biological or physical environment. The process of knowledge transmission itself is culturally driven and not haphazard or unstructured regardless of the methods of knowledge acquisition used. Among the Ilchamus, their daily interactions and discussions on issues such as animal husbandry, human health, livestock health, security situation, and weather conditions are all a learning and sharing process. This knowledge is orally transmitted over time. This finding confirms my research hypothesis that indigenous knowledge among the Ilchamus is orally transmitted. We also find that there are many social networks and structures used in information and knowledge sharing among the Ilchamus. Some networks are very specific about their roles, while others are more general, sharing all kinds of knowledge systems, including those related to weather and climate. This finding answers my first research question on methods the local knowledge is acquired and transmitted among its members.

The findings here agree with prior studies. Indigenous knowledge is held both by individuals through which they share as members of groups and groups (Green *et al.,* 2010; Leclerc *et al.,* 2013 and Prober *et al.,* 2011). In order, therefore, to gather useful information about local knowledge, it is important to identify and talk to local *experts* (Berkes, 1999). These individuals within a community specialize in the use of a particular knowledge-source resource, such as a traditional rain forecaster who uses stargazing and "*reading*" of intestines. The general hypothesis that knowledge is evenly distributed among the community is, therefore, not supported by the findings of this study. The majority of the members of Ilchamus community depend on what the local knowledge experts tell them, but they make decisions on what to do based on their own experiences. Even though many of the people are aware of this knowledge, many of them cannot correctly interpret the indicators used. Some constantly consult the experts, while many others just do not even bother to find out what the situation will be in the coming days or months. From this study, many of the respondents claim to use their own experience, but when asked to explain what different indicators mean, they quickly shift that task to experts whom they consult to confirm their own predictions.

The uneven distribution of local knowledge suggests that individuals' decision-making in relation to climate change and its impacts is not uniform. This study revealed that different social networks are used by different organizational structures. This means there is differential in knowledge transmission. Specifically, women are likely to access fewer sources of knowledge because many social networks comprise mostly men, and women are less likely to consult them.

An effective way to share weather and climate forecasting knowledge among community members may be through informal means, specifically by strengthening the most useful and recognized local networks such as the council of elders and age-set groups (*Ilporor*), and promoting those used by women, or by devising some formal institutionalization of these groups where all genders and ages can access them. In situations where scientific research suggests pastoralists' indigenous knowledge transmission system are patchy or non-existent, the local people and communities have continued to rely on their indigenous knowledge systems of weather forecast to make decisions that influence their livelihoods (Leach *et al.,* 1999; Kyagaba, 2004; Mapinduzi *et al*., 2003; Palmer & Wadley, 2007; Angassa & Oba, 2008; Roba & Oba, 2009). The findings show that there are clear, specific, though informal, ways in which knowledge is taught and transmitted to others. Key among these is folklore, which plays a very important role in early developmental and growth stages of a child, while later in life, social networks, and knowledge experts play their different roles. Knowledge is freely shared among all community members both at individual and community levels. Ceremonies and ritual activities provide learning platforms where what is believed is put into practice. In such situations, experts and non-experts openly share all they know since they agree on how certain ritual functions would be performed.

With time, and as external influences through educated people penetrate into the community, and elders die out of natural attrition, traditional ways of doing business will decline, even though to date they are still being used and preserved. I found that old methods of transmitting knowledge have not changed, but the attitude of younger generations has. No single society is static; rather, societies and communities are dynamic, able to learn modern ways and change according to what suites them at any moment. Therefore, as they learn new systems, it is likely that old systems will either evolve to adapt the changes into innovative new ways, or at worst, get eroded. These changes are accelerated by the coming generations who will have more exposure to external influences, and hence have access to more choices. Findings from this study indicate that not much has changed in the Ilchamus ways of information transmission, despite the external forces. Elders and experts discuss in passing the youth’s negative perceptions of traditional knowledge systems, but the elders assert that they will not abandon their traditional ways of living no matter what the youth believe.

From the hypotheses tested, it was found that gender, age and education influence to some degree which social networks are consulted and used. This can be explained by looking at those networks, basis on why and how they are founded. There are networks formed based on social criteria (gender, age), so they are specific to the people that interact with them. The findings did not support the hypothesis that there are no significance differences in the networks used by men and women, people with different education levels and different ages in the community.

5.0 CONCLUSIONS

In conclusion, I found that knowledge is passed to a "learner" early in life as he/she partakes in various functions. Parents and grandparents, too, play this early life role, while in teenage stages, peers play more of a role through acts of imitation. As individuals mature, knowledge is incorporated into the community both through age-set and directly due to their diligence and interest in traditional activities. These conclusions are in agreement with the research hypothesis put forward that knowledge on weather and climate change is orally transmitted from generation to generation by means of social interactions and networks. These findings also support findings of other earlier similar studies. Indigenous knowledge accumulation is based on one's interests, relevance of its uses, and past experiences. Given the various means of knowledge acquisition and transmission, it is safe to say that knowledge transmission in the Ilchamus community seems to agree for the most part to what Hewlett and Cavalli-Sforza (1986) termed vertical (parents/grandparents to children and elders to youth), horizontal (among the council of elders, peers and council of age-set), and oblique ways of transmission (*experts* to council of elders, *experts* to age-set council, age-set council to elders and vice-versa).

The Ilchamus indigenous knowledge system, however, is faced with challenges. Young people, especially those formally educated, are not paying much attention to indigenous knowledge. Even though the formal education erodes traditional values, many household heads still think formal education of their children is good and they all support it. It is because through experience, they have seen households where educated and employed sons/daughters are doing fine economically and so everyone wishes the same for their children. But they are equally concerned that this formal education is eroding their cultural values and makes those with education view the culture and those who practice it negatively. Their wishes are that, even with education, we should not turn our backs on our cultures. They argue that without culture the community would lack identity. That culture is the glue that has kept them unique and allowed them to survive over generations.

This study and its findings are important to our understanding of how local knowledge is acquired and transmitted among its users. It provides a baseline of information on indigenous climate knowledge transfer. Ik is only meaningful when others can benefit from it. Users of traditional knowledge can pass on coping and adaptation practices to future generations and the knowledge can be tested over time as conditions change.

6.0 RECOMMENDATIONS

First, I recommend more research on various modes of knowledge transmission with the aim of identifying those that are effective and need to be strengthened for future use in the face of apathy shown by educated members on this knowledge system. Second, I recommend formal institutionalization of social networks used in knowledge transmission to give them legitimacy within the communities in which they are used. They can also be reference points for researchers. For example, social networks and organizational structures are important mechanisms for knowledge transmission. If they can be formally institutionalized and recognized as knowledge conveyor belts, knowledge retention and sharing can be assured. The same institutions can be used when documenting a community knowledge system.

Finally, although IK is widespread within the Ilchamus community and traditional methods of transmission are still in use, the change in the younger generations' views towards IK and traditional ways of life and livelihoods could lead to the future loss of this knowledge. In order for IK to be perpetuated within the community for future uses, it must be seen as useful to the younger generations. Therefore, I recommend measures be taken to promote the use and applications of IK in daily lives among the Ilchamus so that it can gain support from such young people. This can be achieved through documentation of the knowledge systems, and possibly introduction in school curriculums where local children are taught traditional ways of life in comparison with modern ways.

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CHAPTER 5

LIKELY IMPACTS OF CLIMATE CHANGE ON PASTORAL PRODUCTION SYSTEMS, LIVELIHOODS AND TRADITIONAL COPING AND ADAPTATION PRACTICES

1.0 INTRODUCTION

Pastoralism has been variously defined. Nori *et al.*, (2008), defines it as: "A *complex livelihood system seeking to maintain an optimal balance between pastures, livestock and people in uncertain and variable environments,"* while Huho *et al*., (2009) defined it as: "*A form of agriculture in which people make their living by tending herds of animals*". Evidence suggests that pastoralism all over the world developed in direct response to cycles of long-term climate change and variability as a means of coping with increased unpredictable environmental changes (Berkes 2012; Galaty & Bonte, 1991; Brooks, 2006; Smith, 1992; Fratkin, 1997).

Pastoral livelihoods depend on land-based resources, which are heterogeneous and dispersed over time and space, tied to seasonal rainfall patterns, which vary through time. The lands in Africa where pastoralists commonly live are characterized by an overall erratic, unpredictable rainfall pattern. With climate change, models predict an increase in extreme events associated with increased irregularity and decreasing predictability of rainfall especially in east Africa (Cooper *et al.*, 2008; Funk & Brown, 2009; Funk *et al*., 2008; Funk, 2010; Verdin *et al*., 2005). The impact of climate change in east Africa is predicted to be highly variable toward the middle of the 21st century, hence the urgency to design adaptation strategies (Agrawal, 1999; Agrawal, 2008, Cooper *et al*., 2008; Galvin *et al*., 2004). Most of the region will become drier, with considerable reduction in the length of growing seasons (Cooper *et al.,* 2008; Funk, 2010; Galvin *et al.,* 2004; IPCC, 2007). Such changes will have profound impacts both to the ecosystem structures and functions that pastoralists depend on and to the livelihoods of the communities living in these areas. Thus, coping with change as an essential first step in adapting to future climate change will be part of the challenge (Cooper *et al*., 2008). Others argue that pastoralists' vulnerability to climate variation has more to do with inappropriate policies hampering livestock mobility and access to critical livestock resources than as a consequence of shifting rainfall patterns (Agrawal, 1999; Davies & Bennett, 2007; Nori & Davies, 2007). Kenya's climate change response draft policy recognized the inevitable impacts of global climate change and came up with policy guidelines that seek to steer the country and address various social and economic sectors in response to anticipated changes (GOK, 2010). Specifically, it is recognized that the pastoral sector is likely to experience pressure from increased livestock pests and diseases, as well as loss of pastures. These impacts will potentially result in community conflicts, loss of lives and livelihoods, and migration (GOK, 2010).

It has been suggested that for this system and the environment to be sustained, it would be wise not to invest in costly technical solutions, but rather to effectively strengthen pastoralists capacity to claim their rights and livelihoods so as to cope with and adapt to climate variability (Adger *et al*., 2003; Agrawal, 2010; Brooks & Adger, 2005 and Nyong *et al*., 2007). Scoones (2004) noted that since climate change involves a high degree of uncertainty, then perhaps the best response is to embrace the consequences of the uncertainty and rethink responses accordingly. Climate change is certainly happening, but the type and extent of change is uncertain because the nature of climate-ecosystem interaction is non-linear. Thus, the best approach to respond effectively to the consequences of climate change is to constantly reexamine and revise responses.

The study area (Marigat sub-county of Baringo County) is characterized by frequent droughts, which sometimes can be very severe, based on records dating back into centuries (for example, see Homewood & Lewis, 1987). The local population, using their indigenous knowledge systems, has developed and implemented local coping and adaptation strategies that have enabled them reduce their vulnerability to past impacts of climate variability. However, this knowledge is rarely considered in the design and implementation of modern coping and adaptation strategies (Nyong *et al.*, 2007). The objectives of the study were to document indigenous knowledge and describe how a pastoral community used this knowledge in response to climate-related adaptation and to recommend how this knowledge could be used in the future in coping and adaptation practices.

While the importance of indigenous knowledge has been recognized in many spheres, such as implementation of sustainable development projects, ethno-medicine, agriculture, fishing and other knowledge spheres, much work remains to incorporate this knowledge into climate change coping and adaptation strategies for pastoral communities in Africa and elsewhere (Mercer *et al.*, 2007; Stigter *et al.*, 2005 and Valdivia *et al.*, 2010). Incorporating indigenous knowledge into climate change response policies can lead to the development of coping and adaptation plans that are cost effective, participatory, and sustainable due to the synergies (Nyong *et al.*, 2007; Robin & Herbert, 2001; Hunn, 1993). It is worth noting that much of the current work on options for adaptation has tended to devote greater attention to technological and infrastructure alternatives for reducing vulnerability and enhancing adaptive capacities at the expense of attending to social or institutional alternatives (Agrawal, 2008; Davies & Bennett, 2007; IPCC, 2007).

1.1 Defining local coping and adaptation practices and their relevance

Coping includes short term management strategies developed to buffer against the uncertainties and is an essential first step in adapting to future climate change. For example, over generations, in arid areas where rainfall variability impacts strongly on livelihoods, farmers, households, and communities have developed a number of coping strategies to buffer against the uncertainties induced by year-to-year variation in pastures and water supplies (Cooper *et al.*, 2008). Such coping strategies are risk-spreading in nature and are designed to mitigate the negative impacts of poor seasons (Agrawal, 1999; Cooper *et al.*, 2008; Mengistu, 2011; Smit *et al.*, 1999; Smit *et al.*, 2000). Some of the coping measures are short term, while others are long term and can deal with increased and more severe shocks (Mengistu, 2011; Orindi & Murray, 2005). These traditional coping strategies provide an important lesson for how East Africa can better prepare for and adapt to climate change in the future (DFID, 2004; Kangalawe *et al.*, 2011). For example, the pastoral groups have dealt with recurrent droughts and other extreme climate events in a number of ways, including social networks and trust mechanisms (role of local institutions), switching between capital assets, and migration to other areas with livestock, or at times, migrating out of the system to urban areas to look for work until droughts have passed (Agrawal, 1999; Cooper *et al*., 2008; Davies & Bennett, 2007; DFID, 1999; DFID, 2004). However, there is still a need to enhance the ability of such communities to cope better with the constraints and opportunities of present day climate variability (Cooper *et al.*, (2008).

In contrast to coping, adaptation strategies are long term approaches that enable individuals, households and/or communities, to adjust to the impacts of climate in their respective local areas when coping is not sufficient (Galvin *et al*., 2001; Nyong *et al*., 2007; Olmos, 2001; Orindi *et al*., 2007). In the context of developing countries, an adaptation is a strategy adopted to reduce the impacts of environmental or social change on local resources (Batterbury & Forsyth, 1999; Kangalawe *et al*., 2011; Smit *et al.*, 1999; Smit *et al*., 2000). Adaptation to climate change can also be seen in the evolutionary ecological sense to mean any response that increases the community or population's probability of survival in response to changes due to climate change (Agrawal 2010; Berkes 2012; Homewood & Lewis, 1987). Socially, adaptation has been defined as an adjustment in social or economic systems made in response to actual or expected climate effects (Adger *et al*., 2003, 2013 and 2014; Crate 2011; Galvin *et al*., 2001; Galvin *et al.*, 2004; Huq *et al.*, 2003; Smit & Pilifosova, 2001; Smith *et al.*, 1996; Smit *et al*., 1999). Such strategies will include management decisions in use of resources like grazing lands, migration, and herd-splitting, keeping multiple-species of livestock and types and breeds of livestock adaptable to local environments. Adaptation strategies can also be distinguished from coping mechanisms in accordance with the terminology commonly used in anthropology (Fulton *et al.*, 2011; Ostrom 2015 and McCay 1978) and the development literature (Davis 1993; Singh & Titi 1994), where coping mechanisms are taken to mean a bundle of short-term responses to situations that threaten livelihood systems, whereas adaptation strategies are the ways in which individuals, households, and communities change their productive activities (diversification) and modify local rules and institutions to secure livelihoods (Berkes & Jolly, 2001; Little *et al.*, 2001; Smit *et al*., 1999). These two types of strategies (coping and adaptation) are not mutually exclusive, but rather may overlap across temporal scales, and coping mechanisms may develop into adaptive strategies over time. Coping mechanisms are more likely to emerge at the individual and household levels, whereas adaptive strategies are likely to emerge at large spatial scales since they mostly relate to variables such as cultural values (Berkes & Jolly, 2001). Success at each level depends on resources available, exposure time, and vulnerability of the systems (Smit *et al.*, 1999; Smit *et al*., 2000).

Adaptation strategies are multiple and can be used interchangeably as the situation requires. However, there are a number of limiting factors that may hinder effective adaptation strategies for pastoralists. Such factors include poverty, limited technical capacity, and lack of support. A lack of policy frameworks is one case of failure to support options (Crate 2011; Galvin *et al*., 2001; Michaelowa, 2001; Yohe, 2001; Wilbanks *et al.*, 2003). There is, therefore, an urgent need to build the capacity of such groups if sustainable social and economic development is to be achieved in all regions. Recognition of and building on local knowledge should be a first step to mobilize such capacity (Adisa & Adekunle 2010; Bello *et al.,* 2013; Geoffrey 2011; Ndiweni 2013; Nyong *et al.,* 2007; Rivera-Ferre *et al.,* 2013; Phillips & Titilola, 1995). Any external or internal meaningful attempt at implementing adaptation strategies to reduce vulnerability of pastoral groups to the impacts of future climate change should start by examining how, in the past; these communities successfully overcame their vulnerabilities and coped. Building on indigenous knowledge systems can offer a great window of opportunity for effective adaptation strategies that pastoralists know and know how to use (Nyong *et al*., 2007; Orindi *et al*., 2007).

Agrawal (2008) suggests that local institutions play an important role in coping and adaptation strategies to climate change, especially in the local settings, where their effectiveness depends on the local and extra-local institutions through which incentives for individuals and collective action are structured. The impacts of climate change are likely to be especially severe in social and ecological contexts of arid and semi-arid regions where livelihoods are often already stressed and additional adverse biophysical and social changes can be overwhelming. The poor and natural resources-dependent rural households will bear a disproportionate burden of adverse impacts (Kate, 2000; Mendelsohn *et al*., 2007; Ribot *et al*., 1996 and Thomas & Twyman, 2006).

Therefore, historical experience and knowledge about adaptation possibilities is critical to future policy formulations regarding adaptation because the nature of climate change impacts continues to be uncertain (Agrawal, 2008, Morton, 2007, and Thornton *et al*., 2009).

1.2 Why studies in socio-ecological coping and adaptation practices are important?

Human coping and adaptation to climate change is one area that remains critical and needs to be sufficiently studied (Adisa & Adekunle 2010; Bello *et al.*, 2013; Berkes & Jolly 2001; Adger, 2010). As we accept the fact that climate change is a reality, it is only recently that work on human response through adaptation has been taken seriously (Berkes & Jolly, 2001; IPCC, 2007; Moss *et al.*, 2010; Smithers & Smit 1997), and still not much has been devoted to the question of adaptation by different groups perceived to be more vulnerable (Wilbanks & Kates, 1999). Quoting from Wilbanks & Kates (1999), Berkes & Jolly (2001) agreed that there is still a grave mismatch between the local knowledge needed for adaptation and what is done globally to generate knowledge about climate change, its impacts, and responses to concerns. This is observed in poor responses and associated societal costs related to such events as droughts, famines, and floods, among others. There is, therefore, the need to carry out place- and livelihood-specific analyses of impacts and adaptations to climate change so as to build our capacities to respond effectively. Climate change impacts will unfold at the local levels where adaptive responses are critical (Adger, 2010; Rivera-Ferre *et al.*, 2013; Ndiweni 2013; Holling, 1997; Wilson, 2006). This is the level where implementation takes place by the local practitioners and peasants. These are the groups thought climate change will have greater impact on.

Understanding the dynamic interaction between nature and society requires case studies related to places and cultures through research designs where researchers and local stakeholders interact to define important questions, relevant evidence, and possible responses (Bello *et al.*, 2013; Berkes & Jolly, 2001; Geoffrey 2011). Pastoral production systems are place-specific and culturally situated livelihoods. We need to undertake appropriate research among groups that practice this lifestyle if we are to adequately prepare them to an eventuality due to climate change. The best way to go about this is to engage them directly and learn from the past how they resolved issues associated with periodic fluctuations in resource availability as weather and climate changes through both social strategies, for example, "stocking friends," (Berkes 2012; Bohensky & Maru 2011; Homewood & Lewis, 1987; Pretty 2011) and ecological strategies.

1.3 Benefit of using IK adaptation strategies along with formal adaptation strategies

Western science and IK have great potential to complement one another to enhance our understanding of weather and climate change. For example, many development research projects in rural areas are rooted, developed, managed, and funded by external resources with the hope of impacting people's lives positively. Unfortunately, many of these projects do not take into account the local people's culture, knowledge systems, and their priority needs, resulting in low participation and success rates (Obudho, 1983; Otiso & Owusu 2008; Sabatier, 1986; Nyong &

Kanaroglou, 1999; Nyong 2007; Woodley, 1991). Due to many projects with this approach and resulting failures, there has been growing interest in incorporating local knowledge and traditions to increase project participation rates and provide environmentally sustainable development. Climate change coping and adaptation projects can learn from the experience of other development projects and try to avoid past pitfalls. Indigenous knowledge has to be accepted as a legitimate knowledge system like other sources to be used along formal western sciences that relate to natural resource management and climate change adaptation studies among others where necessary.

A number of factors drive the importance of accepting indigenous knowledge. First, indigenous knowledge can add value to climate change adaptation studies because it increases overall understanding of the environment by letting the people express their own views, beliefs, values and practices. This allows improvement of the existing adaptation processes to climate change by incorporating local traditional practices within the cultural context, and providing decision-making processes that are based on locally- observed indicators and their relationships in the environment (Adugna, 1996; Ajibade & Shokemi, 2003; Nyong *et al.,* 2007; Woodley, 1991). Second, indigenous knowledge has many similarities to scientific methods; many ideas in indigenous knowledge are now seen as appropriate and deep in content (Agrawal, 1995, 2002; 2010; Tynjala, 1999). Third, indigenous knowledge systems provide a means for participatory approaches (Huntington *et al*., 2004; Moller *et al.,* 2004; Mosse, 2001). Fourth, indigenous knowledge systems to some extent broadly share the same guiding principles with the sustainable development framework of 3E-concerns: Economy, Equity and Environment (Berkes 2012; Berkes *et al*., 2000; Davies & Ebbe, 1995). Fifth, indigenous knowledge systems can facilitate understanding and effective communication between the local people and climate scientists, and thereby enhance the rate of dissemination and utilization of climate change adaptation and coping strategies (Huntington, 2000; Dewalt, 1994; Riedlinger *et al*., 2001; Nelson *et al*., 2007; Nyong, *et al.*, 2007).

However, caution is necessary. Not all indigenous practices and principles are beneficial to sustainable development, nor can all indigenous knowledge provide the right solution for all problems (Bebbington, 1993; Leach & Means, 1988; Howard & Widdowson, 1996; Murdoch & Clark, 1994; Nyong *et al*., 2007; Rahman, 2000, and Riejntjes *et al.*, 1992). Therefore, there is need to scrutinize IK for its appropriateness just as we do any other technology. When evaluating IK, it is also important to take into account local evidence of success and the social and cultural context in which the practices are embedded.

1.4 Objective of the study

The growing interest in indigenous knowledge since the 1980s to date is indicative of the need to gain further insights into how different groups of indigenous/local people, in this case the Ilchamus agro-pastoralists, use their local knowledge in their daily lives to cope and adapt to weather and climatic variations. Many studies in climate change and its effects show that Africa is highly vulnerable due to factors among them poverty and poor response mechanisms (Boko *et al.*, 2007; Crona *et al.*, 2013; Egeru 2012). Thus, the problems of climate change need to be addressed using different and varied approaches to achieve effective mitigation, coping and adaptation strategies (Speranza *et al.*, 2010 and Lata & Nunn 2012). One such approach is how indigenous/traditional knowledge can contribute to climate change monitoring, coping and adaptation.

Therefore, the objective was to document the historic and current coping and adaptation mechanisms that Ilchamus use in response to changes associated with weather and climate.

To achieve the above objective, this study endeavored to answer the following three broad research questions:

1. Are the Ilchamus aware of the possible weather and climatic change conditions and their consequences?
2. What are their perceived possible consequences of weather and climate change on their production systems and livelihood?
3. What are Ilchamus' response practices (local coping and adaptation practices) in reaction to weather and climate change?

To answer the above broad research questions, the study was guided by two broad hypotheses, which were answered through the collection of relevant data that were descriptively analyzed and summarized as responses to questions on local knowledge about awareness of possible consequences due to weather and climate change, and coping and adaptation practices.

Hypothesis 1: The Ilchamus are aware about possible consequences of weather and climate change.

Hypothesis 2: The Ilchamus are able to address the consequences of climate change through many indigenous coping and adaptation strategies in a timely way.

1.5 Materials and methods

This section describes, in brief, the background of the study sites and how research samples were identified and selected, and where and how the data was collected and analyzed.

1.5.1 Study area

The study was done in Kenya in 2010/2011 in four (4) administrative locations of Marigat Sub-County, Kenya. The study's focus group discussion participants and household survey samples were drawn from these four locations. These are the locations the Ilchamus pastoralists live and practice their livelihoods. The other locations in the sub-county are mixed livelihood systems.

The Marigat Sub-County covers approximately 1,244km^2 with a total population of approximately 48,534 people (GOK, 2010). The study region is characterized by low overall rainfall and consistently high temperatures. It experiences low and erratic annual rainfall which varies between 500mm to 750mm, with a mean annual rainfall of 650mm yr^{-1} and a potential evapotranspiration rate varying between 2000mm and 2800mm per month (mean annual pan evapotranspiration of 2576mm) (Ngaira, 2006; Snelder & Bryan, 1994; Sutherland *et al.,* 1991). The coefficient of variation for annual rainfall is about 28% (Rowntree, 1991).

The area is generally flat with relatively fertile soils of coarse loam and clay. Originally, semi-deciduous woodland dominated, especially along rivers and northern parts of the Ilchamus flats, but currently the land is widely covered by mesquite (an invasive exotic weed). Vegetation was originally classified as umbrella thorn savanna woodland (Kiyiapi, 1994).

1.5.2 Sampling design and data collection

Data was collected using two methods: focus group discussions and a household survey questionnaire (Kvale & Brinkmann 2009; Marshall & Rossman 2014; Maxwell 2012). Data was analyzed accordingly to answer research questions and test the hypothesis. Qualitative data was analyzed descriptively (Miles & Huberman 1984; Rubin 1995; Maxwell 2012 and Creswell

2007, 2012, 2013), while quantitative data was analyzed both descriptively and statistically by use of SPSS statistical software.

During the actual data collection period, focus group discussions were held between July-August 2010 and June-July 2011, and household survey questionnaires were done in June through July to August 2011. Stratified sampling using expertise in local knowledge, gender, and age was used in selecting focus group participants with the help of traditional institutions such as peer groups (*Ilamal*), local elders, opinion leaders, village headmen, and government administration chiefs. Simple random sampling was used in selecting household participants. Secondary data were also collected from literature reviews.

1.5.3 Focus group discussion

Local participants experienced on matters of local ecology and climate-related knowledge (local knowledge "*experts"*), age, and gender variables were used to select focus group participants. Guiding questions were used to direct the group discussion (Rubin 1995; Maxwell 2012; Kvale &Brinkmann 2009; Miles & Huberman 1984) (Appendix 1). In summer 2010, initial reconnaissance focus group discussions were undertaken in Ng'ambo location. The participants were divided into two separate groups; one mixed group (both men and women) and one comprised of only women. This criterion was chosen as a way to give women a chance to voice their concerns and share what they know since among the Ilchamus community, women are reluctant to talk in meetings where men are present.

I used the 2010 focus group meetings to get a first-hand experience and hear from the local community what they know and understand about weather, climate, and matters related to climate change. The data collected then was used to design the survey questionnaire that was later administered in summer 2011 to randomly selected household heads. The focus group guideline questions used in 2010 were also revised and improved after the discussion meetings of 2010 before I used them in 2011 focus group discussions.

In the actual data collection period, four focus group discussions were held, one from each administrative location of the four selected locations. The groups comprised between 10-15 participants (Table 26). Participants were selected using a stratified sampling technique.

1.5.4 Household survey questionnaire

The survey questionnaire (Appendix 2) was administered (Kvale 1996; Kvale & Brinkmann 2009; Marshall & Rossman 2014 and Maxwell 2012) to 331 household heads (237 men and 94 women) representing about 10% of total household population in the four administrative locations predominantly inhabited by the Ilchamus pastoral community. Households were selected randomly from the lists of all households held by the local administration offices. The survey collected relevant data that constitute household practiced production systems, knowledge about possible consequences of weather and climate variability, and the possible/actual local response mechanisms (coping and adaptations), and when they do respond to such changes (before or after changes have occurred?). In the event that their traditional production systems are failing/collapsing, or untenable, what alternative production system or ventures do they opt to (adaptation practices).

For ground-triangulation purposes, responses from the focus groups were compared and contrasted with those provided by the household survey. These provided the results with a rich text explanation of the possible responses of how this pastoral community responds to possible changes in weather and climatic changes.

Table 26: Number of focus group and survey participants

Location	Focus group members			Household survey members		
	Men	Women	Total	Men	Women	Total
Ng'ambo	7	3	10	43	9	52
Salabani	10	5	15	47	44	91
Kiserian	7	4	11	76	24	100
Ilng'arua	6	5	11	71	17	88
Total	30	17	47	237	94	331

Source: Focus group and household survey, Marigat, 2011.

The above Table 26 is a summary of those who participated in focus group discussion and household survey during the field study 2011 in Marigat sub-county, Kenya.

2.0 DATA ANALYSIS

Both qualitative and quantitative data were collected and analyzed accordingly. Both data were used to provide the results as they supplement and complement each other. The qualitative data underwent a two stage analysis. First stage analysis involved tracing particular responses to specific questions across the groups. These responses were categorized into unique codes as evidence of what is known about the consequences of climate change, response actions, coping or adaptation options. General responses were summarized and compared for similarities and differences among focus groups.

The second step of analysis began by grouping together related codes to form common responses to given questions. Lumping together these bits of information formed the larger conceptual pattern about what was agreed for a particular concept. In the analysis, I worked on potential tallying of the results between different groups. I looked for the patterns of responses, in what they consider as a consequence, their response action(s), what local coping and adaptation strategies were used. The focus group discussions were summarized and key concepts were used to provide thick rich description of the overall study findings for each variable and question analyzed.

Statistical Package for Social Science software (SPSS version 14.0 for windows) was used for household survey data analysis. The data were coded, labeled, and entered into the SPSS software. Descriptive statistics were used in analyzing, summarizing, and describing sample data. Percentages and frequencies were calculated as to the number of times respondents acknowledged a consequence, and how they responded to changes, and what actions do they undertake to mitigate possible destabilization of the system or as alternative response (to cope with or adapt to).

Where household heads were asked open-ended questions, their responses were summarized in tables and used to provide an explanation to specific questions asked. Finally, results from both focus group and household surveys were compared and contrasted to inform about the concept that was under study/analysis.

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3.0 RESULTS

3.1 Awareness and knowledge of the consequences of weather and climate change

Both focus groups and household survey respondents were asked to indicate what environmental indicators they perceived or observed to have changed in the last 20 years (Table 27); what their current livelihood production systems (Table 28). How production systems have been affected by the climatic changes? (Table 29). Which specific production indicators they observe regularly to know that their livelihoods production systems are affected? (Table 30).

Focus group participants listed a number of changes they have observed over time. I categorized the changes observed into social and ecological/environmental changes. Among the social changes, they observed that human population over time has been increasing, putting pressure on limited resources available. With population pressure on land, came poverty and strange, unknown diseases. The focus group participants also lamented about how external influences have affected their culture. Specifically, formal education has contributed to erosion of their traditional values. The young generations who have acquired modern education are disrespectful of traditional ways of doing business in the community. Traditional values and beliefs are no longer adhered by majority of the young people (see Chapter 4). Participants were also not happy about government interference in their traditional ways of life. This has caused disharmony about which rules to follow when enforcing communal rules, whether to use conventional government rules, which they consider inhumane, or those designed locally, since they are negotiated and violators can always bargain their way out or be forgiven. They are against jailing/incarcerations to correct wrongdoers as required by government regulations. The above sentiments and feelings were expressed bitterly by one elder, who said:

"*Laiyioni lai kidolita dei iyook ajo meekure etii Enkop ene. Amu koree peeku nkiyiotin nikkiu ninche nemekure ening enejo loo menya, nikintoki ajua inia? Mara nikijo kindaa!! Eee mataa, kitangamutua naa masomo, nimikimba, kake teneaku ninye naitungaa iyiook ilkuak lang, intae inie peekidol nibayaya!"* (My son, I am telling you, as elders we see no more future. When our own children whom we sired cannot listen to us, what else can we say? We see the end of the world has come! So, education came and we received, it is good, but if that education deprives us our culture, then it is up to you the young people to judge, for us elders, we will watch to see how far you will go!)

On the ecological/environmental changes due to increase in human population, they expressed concern over the destruction of natural vegetation, cultivation of all available land, grazing all over the pastures, and the difficulty to enforce traditional rotational grazing systems. Because of this, a lot of soil erosion is taking place, as more and more vegetation is lost. They lamented that land is no longer "healthy" because people disrespect traditional ways of managing it, and there is an increase in many diseases:

"*Meekure apa aa-nkop-ang napa nikitubulakita iyiook amu inchoo apa ilkule oreren metijingu, naa ninche naa dei oetio aitongu enkop, nepuonu moyaritin oo- nkeyatin nimikiata apake Ilchmaus nkai natogore are kinyala enkop neyau ildeket lenya"* (The land is not the one we grew up knowing because we have allowed other people to invade it, pollute it, and that is why we have seen many kinds of diseases Ilchamus never knew, some of them have no cures- it is curse from god.)

Due to these changes, their livestock declined in number, livestock health deteriorated, and production levels dropped over time. Other observed changes include timing and amount of seasonal rains, poor distribution of rain (it rains when not expected sometimes accompanied with destructive floods, and no rains when needed), permanent rivers have become seasonal; long, severe, and frequent droughts; loss of native medicinal plants; invasion of fields and pastures by foreign invasive weeds (locally they call them "*kasia*"- which means rubbish); frequent crop failures; the local lake has become very shallow due to siltation, less water flowing into the lake every year (this situation has changes since due to unexpected heavy rains in catchment areas during the years 2012/2013 and the lake broke its banks and displaced villages around it), while at the same time, some rivers draining the lake were blocked or diverted in catchment areas.

Specifically, they were concerned about recent successive droughts that resulted in great loss of livestock. As a result, some families were rendered stockless and opted to abandon pastoralism altogether. Droughts were recalled of the 1979, 1984, 1989, 1994, 1999/2000 and 2009 that accelerated poverty, degraded land, and led to loss of vegetation. Many families that lost their livestock in these droughts remain stockless to date, while younger men and women went to urban centers to seek jobs to support their families. In the same period, massive crop failures also occurred. These claims and figures were given and corroborated during the Ng'ambo location focus group discussions by local opinion leaders and a veterinary scout who was a member of the focus group.

When asked about their possible explanation for land degradations, focus group participants enumerated the following causes of degradation:

1. Overgrazing. Before the 1979 drought, there were about 40,000 head of cattle owned by the community. After the 1979 drought, about 10,000 (25%) cattle survived, but the herd increased fast, so that by 1984, there were again about 40,000 cattle on the land.
2. They also complained that they have no control over the number of livestock individuals can keep despite limited size of land.
3. Drought has become a cyclic phenomenon and causes a lot of losses and land degradation. They claimed that they build their stocks for a period of about 4 years, and then in the 5th year, drought sets in and wipes them out.

4. Sheep population is another cause of degradation. Sheep contribute to overgrazing because they graze to the last blade of grass.

The household survey respondents were asked to identify those environmental indicators they perceive to have changed negatively (Table 27) and how they affected their production and livelihood systems (Table 29).

Table 27: Environmental indicators household survey respondents (n=331) reported to have changed negatively over the last 20 years

Environmental indicator	% respondents saying this has changed
Rainfall	96.7
Vegetation	89.4
Temperatures	87.3
Water availability	79.2
Winds associated with rains	71.9
Livestock diseases	68.9
Stars predictive capacity	58.0

Source: Household survey, Marigat 2011.

The Table 27 above is a summary of those environmental indicators that households claimed to have changed negatively. From the table, quite a good percentage of the respondents believe that the environmental indicators used to tell whether the climate will be good or bad have changed to very unpredictable levels and their directional change are to the negative trend. Majority of the respondents agree that change has occurred in their land.

Table 28: Primary current income sources of household survey respondents (n=331)

Income sources	% households who depend on the source
Mixed (Livestock and crops)	50.8
Casual workers/charcoal	13.4
Crops only	10.3
Formal employment	7.7
Shop business/petty trade	2.1

Source: Household survey, Marigat 2011.

Other than the four key primary production systems (Table 29), currently few families have ventured into other mixed, non-indigenous livelihood support systems as sources of food and income. Household heads were asked to indicate if they depend on other sources of income. Results shown in Table 28 above.

Table 29: Negative effects of environmental changes on production systems reported by household survey respondents (n=331)

Production system	% respondents who reported a negative effect on production system
Livestock production	92.5
Rain-fed crops	85.8
Irrigated crops	83.4
Fishing	46.1

Source: Household survey, Marigat 2011.

Respondents were asked to indicate how environmental changes have affected their indigenous production systems. Many of them indicated that the effects have been very negative on them. See Table 4 (Chapter 3) on the percent of those who agree that their production systems have been affected negatively.

Respondents were asked to indicate in order of priority those environmental variables they consider in decision making related to management of their livestock (Table 30). These indicators, among others, are used in combination and independently to make decisions about migration, herd-splitting, and selling livestock.

Table 30: Indicators used by household survey respondents in decision-making on livestock management (n=331)

Indicator	% respondents who use this indicator
Temperatures	91.5
Pasture health and availability	89.7
Water availability and sources	87.9
Crops success and yields	79.8
Livestock health conditions and diseases	70.7
Animal gut-fill	68.9
Natural vegetation conditions	61.2
Winds direction	54.1
Stars	53.0
Security	40.8
Moon position (goes along with stars)	40.5
Wildlife movement and migration	40.2
Sun position	39.0

Source: Household survey, Marigat 2011.

3.2 Responses to perceived and observed weather and climatic changes

Respondents were asked to indicate whether they undertake any action in anticipation of or response to observed changes, and if so, when these actions are undertaken. About 81% of the respondents indicated that they undertake some kind of response if they anticipate changes in weather. This question was specifically tailored to find out whether advance knowledge triggers a response to avoid heavy losses or if people treat such information with skepticism. When given the choice as to when to actually act/respond, 48.5% of the respondents said before the conditions are bad, 20.9% act when conditions are at hand (when undergoing hardship conditions), while about 12.7% said they will act based on outcome of the change. The advance response is best illustrated by one elder's comments:

> "*Laiyioni lai kaajoki, koree iyiook anaa too ilmakui, enkishu ang ikichil raposhoi oo-ilpapit. Koree pee kimenu, nikinteru ngatan too ildonyo pee kindur manyat!"* (My son, from our grand-fathers, we constantly observe our cattle "stomachs" (gut-fill level), hair and if we notice a change, we send our warriors to explore on the hills where we can migrate for better pasture.)

3.3 Local coping practices

To identify coping strategies, focus group and survey respondents were asked about decisions frequently made to respond to changes. What actions do they undertake to mitigate the effects of weather and climate change on their production systems and livelihoods? Finally, respondents were asked what traditional coping strategies they perform in relation to community rituals, and what are their roles. Both groups were in agreement about their local coping strategies and practices.

Given that many families practice livestock keeping, household respondents claim that crop farming is one of the coping strategies they opt for and has become one of their primary income sources. About 86% of the households practice this along with livestock keeping. To them, crop farming is both a coping strategy and an adaptation practice. They claimed that when they settled in this area, they had livestock, but raiders took them all. Then a bird brought to them a seed of millet and dropped it in one of the clan's homesteads, called "*Ilkap*i." Since then, millet has been part of their cultural crops, used in ceremonies to bless and cleanse the land, in addition to being food. It is also used as yeast in local beer brewing (*piitan*). Later, livestock were acquired when hostilities subsided when white settlers took charge of security and administration. Millet was then used in barter trade for livestock with different neighboring tribes.

> *Koree apa peiyie eitayu nkai Ilchamus, neisho nkiteng. Kake koree te aikata, neaku ilmangati kumok oleng neoru iyiook inkuchu ang, nejo enkai mainguaa intea peshao, neisho iyook loikempe (ntapa). Ninye taa kiyetuo tesiadi amir aitam nkishu to kule oreren*" (When god created Ilchamus people, he gave them a cow, but later other tribes attacked us and took them, then god dropped to us a grain of millet, which we later exchanged for cattle from other tribes.)

Keeping of different kinds of livestock is practiced as a coping strategy. This ensures a supply of milk and other family needs in case one type of livestock are unproductive, sick, or affected by drought. Droughts affect different kinds of livestock differently. While cattle and sheep are vulnerable to scarcity of grass, goats are only susceptible to lack of browse.

Other coping options include migration in search of pastures and water. This is a recent practice in this community. Their land used to be a land of plenty year round, but recently, changes were observed that led to frequent droughts, shortage of water in rivers and shrinking of natural pastures. As human population increased, land seemed to shrink; migration became an option to seek better pastures. The focus group discussions revealed that long distance migrations were never an option among the Ilchamus due to hostilities from the surrounding tribes. Later, migration was practiced just by a few families who had strong ties with members of other tribes. Such ties enabled those families to loan out part of the livestock to "stock friends" in distant lands to ensure security until the rains come back. Those who migrate too far on their own were vulnerable to cattle rustlers and other livestock thieves. A majority of the community members move their livestock between neighboring villages, which span about a radius of about 10-25km depending on availability of pastures and set temporary satellite camps in these villages. However, these movements in a radius of about 10-25km can still be classified as migration since they spend more than 4-5 months away from their permanent settlements.

Herd-splitting, as reported by both groups is a practice where herders divide their herds into small groups for ease of grazing and management, is not as common a practice now as it used to be in the past, but is still practiced by a few families. A number of factors were given by focus group respondents as contributing to less herd-splitting. Among the factors are lack of dispersal areas to graze different herds, shortage of labor, schooling, competing livelihoods such as urban wage employment, and security (cattle rustling). The majority of families, instead, join together (communal pooling) when drought is severe. This helps in sharing labor (each family takes care in turn, or jointly hires a helper) and security since young boys who used to herd are now going to school. Pooling resources allows for close families to share the responsibilities of herding, while freeing young boys and girls to attend school, and also allow some parents to seek wage labor in urban centers to supplement livestock income.

Traditional rain-making ceremonies and rituals are frequently performed to cleanse land so that it can rain again. Informants believe that rains fail to come either because gods are annoyed or something wrong has been done. Therefore, they believe that some rituals have to be performed to please some super-natural spirits that control rains (Table 32).

> "*Enkai Ele- Kodoom, titammono iyie peeyie ingeru iyiook! Kinchoo iyie kuna kule oo-ena laita enker pee intadoiki iyiok ilkiyio linono. Nkai Oo-ilketa tasaru nkera oo-ntomonok amu iyie openy kitomoono pee isaru iltungana linono"* (God of Lekodoom, we are asking for forgiveness! We give you this milk and oil of sheep

> so that you release your tears (rain). God with anger, save children and women because you are the only one to save your people).

Faced with likely dire consequences due to weather and climatic changes, household respondents were asked to indicate the kind of decisions and actions they undertake to reduce or minimize losses in their production enterprises (Table 31).

Table 31: Local coping practices used by household survey respondents (n=331)

Coping strategy	% respondents using this strategy
Diversify sources of income/livelihoods	74.6
Sell excess animals	70.1
Migration	68.9
Local provision of security in grazing areas	55.6
Seek government help/relief food	52.9
Non-governmental relief food supply	46.5
Split the herds and pooling	45.0
Loan out livestock to stock-friends	34.1
Community ritual for rain-making	34.1
Hire labor	18.4
Feed livestock on supplements: *Prosopis* and *Cactus*	17.5
Buy hay from market	11.2

Source: Household survey, Marigat 2011.

Ilchamus perform some traditional coping rituals regularly as ways of asking their gods to send rains when conditions become too tough to bear. Table 32 is a summary of such rituals: by who performs the ritual and why they are performed:

Table 32: Traditional ceremonies/rituals performed for rains and land cleansing as listed by focus group participants (n=4)

Ceremony/Ritual	**Who performs this ceremony?** 1=women only, 2=men only 3=Oloiboni, 4=men and women, 5= All community, 6= uninitiated boys	**Why performs the ceremony?** 1=rainmaking. 2=land cleansing, 3=offertory to please god, 4=to keep away diseases and other calamities like famine and attacks, 5=pray for barren woman to bear children
Nkipooto e nkop	Oloiboni and community	Rain-making, land cleansing, offertory and keep way bad things from happening
Sachata e nker	Men and women	Rain-making, land cleansing, offertory and keep way bad things from happening
Sayata/Aasai e nkai	Oloiboni, men and women	Rain-making, land cleansing, offertory and keep way bad things from happening
Ntasim Eloiboni	Oloiboni, men, women and community	Rain-making, land cleansing, offertory and keep way bad things from happening
Ntasim E reteti	Men and women	Rain-making and keep away bad things from happening
Sayare	Uninitiated boys	To make barren women conceive

Lutoro E nkiteng	Oloiboni, men, women and community	Rain-making and land cleansing
Ntapata E nker	Oloiboni men and women	Rain-making and land cleansing
Enkitoropiloto E nkop	Men only and oloiboni	Land cleansing and keep away bad things from happening
Ntasim E nkima	Men and women	To keep away bad things from happening
Ntasim sirwa	All community	To make barren women conceive
Nker naitodokini e nkare	Women only	Rain-making, offerings to gods and keep away bad things.
Ntasim naisuaki kule	Women only	Offering to gods.

Source: Household survey, Marigat 2011.

3.4 Adaptation practices (internal/local and external interventions)

Respondents were asked to indicate whether their current production and livelihood systems are traditional/indigenous or new practices. Whichever the systems, they were asked whether the system is vulnerable to climatic and weather changes. In the event that their production and livelihood systems are failing due to weather and climatic changes, they were asked to indicate which alternative livelihood production systems they would opt for. In situations where external humanitarian and livelihood interventions were provided, they indicated external sources, which they think, help them to cope or adapt to climatic changes and reduce their vulnerability.

Among the common adaptation strategies that focus groups reported were crop farming (rain-fed and irrigation), casual labor in urban centers and farms, charcoal burning, shop/petty trade, and fishing. Focus group participants strongly argued in support of schooling/educating children as an adaptation strategy due to imminent loss of the current livestock keeping because of climate change, insecurity, and interference of their culture, all of which will lead to loss of their current livelihoods. Those with education get employment and education is not affected by drought, meaning it is an investment whose benefits are life-long. It is not affected by drought, which is known to takes away all your stock and renders one hopeless. The Ilchamus, therefore, encourage and invest in the education of their children with the hope that those who gain education will have better sources of income than livestock.

Household head respondents were asked to list their current production systems and sources of livelihoods, and indicate whether the current systems are traditional or a new system to them (Table 33). If the current production system practiced was new, respondents were asked whether they adopted the system due to climate change or other reasons. Finally, respondents were asked if the current practice of livestock keeping (pastoral system) fails, what alternative livelihood are they likely to engage in.

Table 33: Current production systems practiced as sources of income by household survey respondents (n=331) as traditional or new systems of production

Production system practiced	% respondents who practice this system	% respondents who practice as traditional system	% respondents who practice as a new system
Crops farming	88.5	79.2	7.9

Herding	86.4	84.0	1.8
Charcoal burning	60.7	6.0	54.5
Casual employment/labor	47.4	24.5	22.1
Depend on relatives	40.5	36	3.0
Depend on government and NGOs food supply	32.3	11.5	20.2
Depend on well-wishers	14.8	10.3	3.9
Self-employment	12.7	7.3	5.4
Shop business/petty trading	12.4	3.9	8.8
Sell local beer	11.2	6.9	4.8
Engaged in formal wages	9.1	3.3	6.3
Fishing	7.6	6.0	2.7

Source: Household survey, Marigat 2011.

For those respondents who indicated that their production systems were new to them, they were further asked why they practice it now. Table 34 below summarizes the responses.

Table 34: Reasons given by household survey respondents as to why the system is a new system of production

System of production	% respondents who said is due to climate change	Reason given for practicing the system
Charcoal selling	44.4	• To get income for family • Earn a living • Availability of charcoal trees/shrubs • Government permits cutting of *Prosopis* shrub • To remove *Prosopis* from our land/my farm • I have nothing else to depend on
Casual labor	19.0	• To raise/generate more income • Lack of formal jobs • Hardship • I have the skills • An opportunity available • I have no livestock
Depend on government/non-government supply	19.0	• Cattle raiders took all my livestock • Famine and drought situation • Food for work program • I am too old

		• I have nothing else to depend on
Crops farming	6.9	• Increase in population more food is needed • Cattle cannot meet all my needs • To get income for other development • There is plenty of water • Has good income, more than cattle
Shop business/petty trade	5.1	• Seen an opportunity • Available capital • Generate income • Not affected by drought • I have no livestock • I took a government loan to start
Self-employment-livestock trade	4.5	• Seized an opportunity • Raise school fee • Increase income for development • Government youth funds • Has a lot of profit
Cattle keeping	3.6	• My family used to be poor • I found employment so I bought livestock • I took some loan to buy them

		• Available land and pasture • Source of quick wealth • To get community recognition
Well-wishers	3.6	• Old age • Too poor
Selling local brew	3.3	• Raise money for school fee • Too old to do other manual jobs • To earn a living/income • It is food for elders
Relatives	2.7	• Too old to work • I am poor
Fishing	2.4	• No other food available • Living near the lake • I have no livestock • To raise money to buy other foods • Raise school fees • There is external ready market
Formal employment	0.9	• Attained requirements/qualify/necessary skills • Availability of vacancy • Government appointment

Source: Household survey, Marigat 2011.

The household respondents were also asked what they will most likely do if livestock keeping is no longer feasible or possible due to climate variability. Table 35 gives a summary of these possible adaptation strategies and the likelihood that respondents would undertake them.

Table 35: Adaptation strategies household survey respondents practice (n=331)

Adaptation strategy	% respondents using this strategy
Crops farming	91.2
Casual labor	64.1
Charcoal burning	62.9
Depend on relatives	49.1
Government help	44.7
Shop/petty trade	41.9
Non-governmental help	37.1
Formal employment	18.2
Well-wishers	16.4
Local beer	14.3
Do nothing	1.8

Source: Household survey, Marigat 2011.

Other than internal/household adjustments to changes, respondents were asked to indicate other sources of support they have received so far from external sources such as the government and non-governmental organizations that operate in their area. This question was asked since the focus group discussions had reported that the community frequently receives support from the local and national government and from non-governmental organizations when situations become too unbearable and threatens the lives of the people. This was reported that although some assistance is available to people, it usually comes as a rescue/emergency response option when the conditions are dire. Even though focus group participants appreciate this kind of help, they complain that it is normally too little too late. Probed further on what they do when conditions are bad, some claimed (16.4%) that they visit those they think are better off and ask for assistance of any kind, mostly children's' food. This was reported as assistance from well-wishers. The gift/assistance is voluntary and it comes in forms like food or cash.

Three questions were put to the household heads:

- Ever received any assistance from the local/national government? If yes, what form of assistance?
- Ever received any assistance from local/national non-governmental organization? If yes, what form of assistance?
- When your production system breaks down, where do you first seek assistance?

Results show that 67.7% and 60.4% of the respondents have received some form of assistance from the local/national government and local/national non-governmental organizations respectively. The specific kinds of assistance received are summarized in Table 36 below. Table 37 is a summary of where respondents said they will seek assistance first when needed.

Table 36: Kinds of assistance household survey respondents (n=331) receive from government and non-governmental sources

Kind of assistance	% respondents who received from government	% respondents who received from non-governmental organization
Food	62.8	50.5
Veterinary services	22.7	0.9
Medicines	20.0	11.5
Livestock buy-offs	15.1	2.4
Tents	12.1	26.9
Water	9.7	12.1
Cloths	7.6	22.4
Hay	2.4	0.6
School fee	?	12.7
School uniforms	-	12.1
Crop subsidies	?	4.2

Source: Household survey, Marigat 2011.

From the above table, it is clear that most assistance is humanitarian in nature. As earlier reported by focus groups, since the assistance comes too late, all they do is provide some food rations to the hunger stricken families, a few veterinary services, and buy-off of the already too weak animals.

Table 37: Sources from which household survey respondents (n=331) seek assistance when living conditions worsen

Source of assistance	% respondents who seek assistance from this source
Immediate family	82.8
Friends	62.2
Relatives	56.2
Neighbors	55.0
Local government	24.0
Non-governmental organizations	23.6
National government	20.8

Source: Household survey, Marigat 2011.

Evidence obtained from the above Table 37 shows that even though government and non-governmental organizations do provide some help, they are not the first entities that the community seeks assistance from. This is attributed to past experiences where these bodies were slow in their response. They take too long to provide the needed assistance.

4.0 DISCUSSION

4.1 Awareness and knowledge about the consequences of weather and climate change

People observe a number of environmental indicators that give hints about variation or changes in climatic and weather. The environmental factors include temperatures, vegetation, water availability, rains, and pasture conditions, winds, and prevalence of diseases. Change or any deviations from the norm of these indicators have a consequence in people's lives and production systems. People pay close attention to their immediate environments and they react in ways that try to maintain stability or restore livelihood to its original form. Pastoralists live and practice their livelihoods in mostly very variable environments. Over time, they have come to associate their local weather and climatic knowledge with certain environmental changes with certain undesired outcomes. Over time, they have devised local means of coping with such changes, and in extreme cases, devised adaptive practices. Some of these practices are proactive while others are reactive. In this survey respondents listed actions they take to counter the effects of climate/weather change. However, only about a half (48%) of the population take such coping measures before weather effects occur. They are aware that non-action is more costly than coping actions, but a number of times make decisions too late. When asked why they wait too long to take corrective actions to save their production systems, they claimed they have no choice as one key reason and lack of capacity to undertake new ventures. This study also found that the community can respond in many ways to counter the negative outcomes associated with climatic changes. These actions are taken either individually or as a community, facilitated by local institutions such as communal rituals (*Ntalengo/ntasimi*), and advice from council of elders, which is enforced by warriors (*Ilmuran*), among others.

Results from this study show that the Ilchamus are mostly aware of the possible variations in the weather conditions and associated consequences to their livelihoods through long experience in this environment. This finding supports hypothesis one, which stated: "The Ilchamus are aware about possible consequences of weather and climate change to their production systems and livelihoods". Such information and knowledge can be used along with scientific information in complementary ways to support local coping and adaptation practices before situations get out of hand. Regular exchange of information between the local community experts and climate/meteorological scientists could improve community preparedness to take coping measures or implement adaptation strategies to reduce losses. This local knowledge on consequences can be used in exchange forums, where local people and scientists will learn from each other, and with time, confidence and trust is built. By this approach, indigenous knowledge could attain recognition and use by scientists, at the same time, communities will benefit from advanced scientific knowledge.

4.2 Local responses due to anticipated environmental/climatic changes

A large majority of the respondents (81%) (see above section 4.2: responses to perceived and observed weather and climatic changes) indicated that they are likely to take actions before environmental changes are severe, but only about 50% reported that they actually did take action in anticipation of climatic changes or before situations were too harsh. This 50% actual response could possibly be explained by looking at other compounding factors that play a role on how people respond to anticipated changes. Socio-economic factors like poverty, availability of alternative livelihoods, fallback livelihoods, past experiences, local institutions, and national policies may influence how people respond to likely anticipated future risky situations. Studies such as Roncoli *et al.*, (2002a) found out that pastoralists do not use forecast to support decisions on livestock management, but rather their decision are based on outcomes of the rains. Others like Speranza *et al.*, (2010); Egeru (2012) pointed out that reasons why pastoralists do not respond on time are due to high rainfall variability characteristics over time, lack of resources lead to lack of preparedness, lack of awareness as barriers to adaptation and cultural impediments. These were also supported by other findings (e.g., Galvin *et al*., 2001, 2004; Little *et al.,* 2001), showing that pastoralists' adaptations to climate change are mostly reactive and vary according to different socio-cultural set-ups of pastoral society. This finding partly supports hypothesis 2, which stated: The Ilchamus are able to address the consequences of climate change through many coping and adaptation strategies in a timely way.

Results from this study show that Ilchamus pastoralists depend mostly on two major livelihood systems: livestock and crop production. Both of these are climate-sensitive production systems. This could possibly also explain their response to changes. Because these two systems are prone to changes, people may wait for too long before they seek alternative preventive actions since their options are limited. In addition, they hope that conditions might in a way improve before too long, making them hesitant from taking early actions.

4.3 Coping practices

Findings show that the Ilchamus practice a number of coping practices in relation to weather and climatic changes that occur frequently in their area. Focus group discussions and household surveys confirmed that, though there are limited coping practices, they have utilized three systems to eke out a living in environments referred to as hard and unstable.

1. Herd-splitting and migration are conventional coping practices among many pastoralists around the world (Fernandez-Gimenez & Le Febre, 2006; Fratkin, 1986:267; Luseno *et al*., 2003; Swallow, 1994 and Western *et al.*, 2003). These practices are acknowledged but just a handful of Ilchamus families still practice them. According to elders, these are families that have large herds and are polygamous.
2. The Ilchamus practice herd-pooling (section 4.3 above: Local coping practices). Ilchamus pool livestock together and migrate during hard times as a way of maximizing labor

efficiency and reducing the costs to individuals taking care of their livestock. This cushions weak and underprivileged members of the community (widows, poor households, and disabled community members). Each household will contribute a moran or a boy as part of their communal service towards the required herdsmen who will take care of livestock. This practice is also facing constraints because boys are sent to school and young men seek urban employment opportunities, or engaging in activities like crop irrigation farming.

3. Another common cultural coping strategy reported by this community is the rain-making rituals/ceremonies, which in essence are offertory prayers to please their mountain gods and spirits to send rains.

4.4 Adaptation practices

Adaptation to climate change is adjustment of the system to accommodate the impacts of climate change (Adger, 2006; Berkhout, 2012; Paavoli & Adger 2002 and Tacoli 2007).

> Adger *et al*., (2012) observed that "*Responding to climate change is about adjusting to risks either in reaction to or in anticipation of changes arising due to changing weather and climate*."

These adaptations are novel practices undertaken to support, supplement, and/or replace the existing livelihood systems. This section highlights the Ilchamus pastoralists' adaptation practices based on past experiences and knowledge they possess in order to reduce their vulnerability to possible impacts of climate change. These findings have some close similarities to what researchers found (Speranza 2010; Egeru 2012; Roncoli *et al.,* 2002) that pastoralists have the ability to observe/study and integrate a number of indicators (rainfall, temperatures, winds and pasture conditions) and information sources (local experts and social networks) before arriving at certain decisions. At the same time, these many sources may complicate their decisions since none of these sources can certainly claim to know exactly what will happen, but rather they rely on some probabilities. As one elder clarified;

> "*Eee, ikining oisiake nejoki iyiook kulo oibinok lang, kake, Enkai duo ake naas anaa eneiyieu ninye"* (yes, we do as advised by our foretellers, but at the end, only god does as it pleases).

A fortune teller was asked by this researcher about the certainty of his claims and his answer was very candid:

> "*Koree nanu naa kadom nejo lakir oo manyit, kaki, masipu duoo pii amunkai sii naitodol nanu kuna pooki pee aliki ilkulikee, kaki ninye naa dei ake openy naitiolo neitass, iyiok, kake koree ake ninye anaa naiyiolo malamita ake oleng sipata"* (I can only see and interpret what the stars and intestines say as god shows me, but I cannot certainly claim all to be, but only god knows what will happen, but over time, what I have been predicting, has been very close to reality).

The approximate 50% level of advance response reflects the fact that though indigenous knowledge is important in decision making, there are other factors that influence the local herders' decisions on how to respond. Studies have shown that pastoralists late or lack of response are due to a number of compounding factors that play a role on how people respond to anticipated change. These are social-economic factors (poverty, lack of alternative livelihoods, local institutions, national policies, lack of awareness as barriers to adaptation, cultural impediments), environmental factors (high rainfall variability characteristics over time and changing climatic conditions) (Egeru 2012; Galvin *et al* 2004; Little *at al.,;* Roncoli *et al.,* 2001; and Speranza *et al.*, 2010). Our knowledge of these factors will assist both the research scientists and policy makers to intervene and take the right measures. A combined effort of policy makers and scientists can assist in this level through recommending clear policies that empower pastoral groups, while the scientist can look through the strategies and come up with best combination points with other conventional strategies.

Policies that need to be in place may include national policies concerning migration over land, land tenure systems, and national security, among others. Poverty, population pressure, insecurity as reported by the focus groups strongly determine herders' capacities to take preventive measures against possible impacts of climate change to reduce their vulnerability. Examining some of the support systems that are meant to help communities go through hardship conditions (such as government policy support, technical support like feeds water, and veterinary services, security and provision of timely information by technical department), this study's findings show that the kind of assistance given by either the government or non-governmental organizations, though appreciated, is not sufficient and the timing is poor.

5.0 CONCLUSIONS

From the results of this study (Chapters 3 & 5), it has been demonstrated that the Ilchamus are aware of the possible weather and climatic conditions and their consequences to their livelihood production systems. They are also aware about coping and adaptation mechanisms in response to climate change even though less than 50% of them do take actual pro-active measures to secure their livelihoods early enough. The other half's inaction could possibly be interpreted to mean delayed responses are due to limited fallback activities and alternative livelihoods systems, so they take great risk by holding onto what they have hoping environmental conditions improve before they lose their properties. A good number of the respondents said that they take response actions late, when conditions are already biting and are getting worse day-by-day, or sometimes after counting losses. They explained that they usually hope conditions will improve soon before it gets worse, only for them to find they are in situations where they cannot rescue themselves anymore. Other reasons are lack alternative livelihoods to opt into or lack of capacity to venture into other production systems or sources of income. The most important conclusion in this study is that people clearly know the possible consequences of climate change, and that coping and adaptation practices are widely known, even though not many of them have the capacity to use them on timely basis.

6.0 RECOMMENDATIONS

There is need for further research to determine reasons why people aware about the consequences of climatic changes still do not take actions in advance. Second, I recommend a longitudinal research on differences over time on those who respond on time and those who fail to respond to determine the effectiveness of local coping and adaptation strategies. Third, I recommend a research on climatic indicators used by the Ilchamus and compare their usefulness in decision making along with what conventional scientists use. Four, I recommend for a policy in the use of local coping and adaptation strategies data and information along with conventional data and information as obtained from meteorological centers for comparison purposes and improve response mechanisms. Finally five, I recommend for local-scale policies that promote the use of local knowledge, practices and experiences in livestock keeping, water resources management, land use planning among others.

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CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

1.0 CONCLUSIONS

This study set out to address three key objectives: 1) document Ilchamus indigenous local knowledge on climate and weather, 2) describe how this knowledge is acquired, stored and transmitted, and 3) investigate how this knowledge system is used by Ilchamus in their daily decision-making processes in relation to coping with and adapting to climate change. In this Chapter 1, first summarizes the main findings of Chapters 3-5 in turn then Chapter 6 discuss the main conclusions of the dissertation as a whole, and closes with recommendations for research, policy and practice.

In Chapter 3, I documented the nature and sources of Ilchamus knowledge about weather and climate. Findings supported the hypothesis that Ilchamus pastoralists use diverse indigenous and non-indigenous sources of knowledge on weather and climate. Ilchamus rely on many physical and biological indicators to inform their knowledge of weather and climate, such as temperature, rainfall, wind, water, humidity and vegetation. Respondents also observed changes in the environment such as increased diseases, drying of pastures and water sources, and migration of bees, birds and baboons, among other changes. They associated these changes with climate change. Further, these changes were seen to have negative impacts on livelihood systems through declines in livestock and crop production, increased frequency of diseases and disappearance of wild fruits, nuts and vegetables. Survey respondents relied more on local traditional knowledge sources such as personal experience, local knowledge experts, fellow herders and social groups, than on non-traditional sources, such as the local radio stations, television weather forecast and newspapers. However, use of information sources differed with respondent education and age, with older and less educated respondents using more traditional and informal sources and younger and more educated respondents using more formal information sources.

In Chapter 4, I examined how traditional knowledge is acquired and transmitted within the Ilchamus indigenous pastoral community. Ilchamus people share their knowledge through their daily interactions and discussions on issues such as animal husbandry, human and livestock health, security situation and weather conditions. Folklore and informal intergenerational transmission are the most important ways that children and youth learn indigenous knowledge. Adults rely on social networks and organization structures to learn and transmit knowledge. However, the usefulness of different networks varies with gender and age but not education level. While there are many social networks, the majority are made up of men only (age-set, peers, council of elders, age-set council, village committee and locational committee), and only one is dedicated to women only (council of women). Women's groups are set for specific tasks, terminate once the task is accomplished, while men's networks are long-lived, and are mostly exclusive to men. Certain networks are exclusive to specific ages (age-set, peers, youth, boys council of elders and friends), so older men have their own, while middle-age and young boys have their own. This finding suggests that different communication strategies and networks must be used to communicate climate change knowledge, coping and adaptation measures to different social groups within the Ilchamus community. The means of indigenous knowledge transmission have remained unchanged over time; however, younger and more educated people tend to value formal education and external knowledge sources over local indigenous knowledge and lifeways.

This may lead to a future loss of this knowledge if measures are not taken now that ensure that indigenous knowledge is valued by younger generations and to document and continue to share and use existing IK.

In Chapter 5, I explored the impacts of weather and climate change on pastoral production systems, and Ilchamus use of indigenous knowledge about consequences of climate and weather in decision-making to mitigate or adapt to impacts of climate change. The findings in Chapter 3 demonstrated the presence of local knowledge about climate among the Ilchamus pastoralists, and documented observed changes and their impacts on production systems. Chapter 5 provided further depth on the impacts of climate change on livelihoods and documented Ilchamus coping and adaptation practices related to weather variability and climate change. Coping strategies include traditional pastoralist strategies such as mobility and herd pooling. Adaptations focus on livelihood diversification, with increasing emphasis on cropping and charcoal production. An important long-term adaptation strategy is to provide children with formal education so that they can make a living in a different way that is not directly dependent on natural resources. Findings in Chapter 5 support the hypothesis that the Ilchamus are aware about possible consequences of climate change on their livelihoods, and familiar with indicators of environmental change. However, less than half of the population responded to anticipated changes in the environment by using indigenous coping and adaptation strategies in a timely way. This lack of timely response may be due to lack of capacity to respond, due to poverty, or to other barriers such as misguided policies or development interventions. Findings also show that Ilchamus know well coping and adaptation strategies and they support formal education as a long term adaptation solution to environmental changes including climate.

In conclusion, I found that the Ilchamus have a rich indigenous knowledge on weather and climate. This knowledge is acquired through life-long interactions with the physical and biological environment. Through keen and regular observation of the surrounding environment, the Ilchamus are able to accumulate indigenous knowledge on many factors, climate and weather among them. This knowledge is shared and transmitted among its members by several means. Early in life, parents and grandparents pass this knowledge through folklore and story-telling. Later is life, social networks and organizational structures play an important role in knowledge transmission. Most social networks are gender specific and only one out about 12 social networks is dedicated to women, while the rest are for men. Although the means of knowledge transmission have remained in force overtime, knowledge transmission to the next generation faces challenges. Younger and educated people hold negative views of local indigenous knowledge and this may pose a serious threat to its existence and use in future. Another issue of concern is that despite the existence of this rich body of knowledge in the community, many Ilchamus families do not apply it in a timely manner. The majority of people do not respond proactively to secure their livelihoods in the face of likely impacts of climate change on their production systems and livelihoods.

In closing, my research contributes to the science of climate change and indigenous knowledge in the following three ways. First, existing research demonstrates that climate change and its impacts are a reality, however, the rate of change and extent of impacts on specific areas' ecosystems and livelihoods are uncertain (Schlenker & Lobell 2010; Thornton *et al.*, 2009; IPCC 2007; Pimm *et al.,* 2014; Pereira *et al.,* 2010). One of my study objectives was to document Ilchamus traditional knowledge of weather and climate among the Ilchamus and the impacts of climate change that they observe and experience at a local level. The results of this study contribute to refining our understanding of how climate change is taking place and the impacts it is having in specific places, in this case, the Ilchamus pastoral community.

Second, recent research shows that indigenous knowledge can be used to help understand and interpret ecological processes and climate change broadly (Agrawal 2010; Riedlinger & Berkes 2001; Berkes *et al.,* and McLean *et al.,* 2012). My study endeavored to further show how IK in a specific region can contribute to climate change science by documenting specific environmental observations in detail and their interpretation as the Ilchamus community observe and use them to inform their decisions in relation to livelihood production systems.

Finally, global climate change has raised new challenges to pastoral production systems in the world (Hessen *et al.,* 2008, IPCC 2007; Funk *et al*., 2008; Williams & Funk 2010), with data showing that higher temperatures will likely outweigh the effects of enhanced rainfall, resulting in a net negative effect due to high evapotranspiration rates. As a result pastoralists may lose key resources like grazing areas due to long dry spells. These changes call for localized means of coping and adapting. My findings show that the Ilchamus have already devised and used a number of adaptation strategies to respond to the negative impacts of climate change they are experiencing now. In summary, my study contributes to the intersection of climate change and IK science by documenting the impacts of climate change at the local level and how the Ilchamus use their IK system to cope with and adapt to the impacts of climate on their production systems. This knowledge can now be used to augment western science to understand impacts of climate change in the local area.

2.0 RECOMMENDATIONS

Research on the roles of IK in mitigation of and adaptation to climate change is receiving increasing interest from different fields of study. Over the last two decades, IK has gained increased attention as a source of local information on climate change adaptation and ecology, and its value for informing natural resource management and policy has gained recognition world-wide. Nevertheless, this growing body of literature still has some gaps to fill; especially documenting specific case studies where coping and adaptation are taking place in local settings. Local indigenous knowledge is area-specific adaptations and therefore, one cannot make broad generalizations from findings from one location and community to applications to other settings.

Based on this observation and the limited focus of my study, I therefore make the following recommendations. First, I suggest that similar research among other pastoral groups be undertaken to document their knowledge on weather and climate. Second, I recommend further detailed research among the Ilchamus on a broader and deeper range of historical cultural knowledge systems that include both social and economic systems, production and livelihoods, among others. Third, I recommend research on how better to use these indicators and regularly update for any observable changes. This knowledge can be used for better decision making in the management of natural resources. Fourth, I recommend research to understand trade-offs between an increase in formal education as an adaptation strategy and use of indigenous knowledge as a valuable adaptation. Fifth, I recommend research to determine the effectiveness of indigenous methods of knowledge sharing with the aim of strengthening them and encouraging their use. Sixth, I recommend research on why people are not responding in time to changes despite knowledge they have on the likely impacts on their production systems due to weather and climate change. Seventh, I recommend longitudinal studies on differences over time in those who respond on time and those who fail to respond to determine the effectiveness of local coping and adaptation strategies. Finally, I recommend research to determine the usefulness of climatic indicators used by the Ilchamus in decision making compared with what the conventional indicators scientists use.

Based on the research findings, I make the following recommendations for natural resource management and practice. First, I recommend use of local coping and adaptation strategies to develop and enrich strategies for local pastoral development, resource allocation and land use planning. Second, I recommend documentation of specific case studies where coping and adaptations are taking place in local settings both for comparison and to inform broad coping and adaptation policies. Third, I recommend development practices that encourage use of indigenous knowledge systems for decisions-making processes in adaptation. Fourth, I recommend organizing special community events that showcase traditional modes of passing information like community ceremonies and rituals, and inviting to these events special guests and educated people from the community to learn the about the value of their traditional culture and practices. Fifth and finally, I recommend archiving Ilchamus indigenous knowledge in a form that is retrievable for future generations who might want to trace back their ancestry and inform themselves.

In closing, I offer the following policy recommendations. First, I recommend the use of tribal languages among the local TV and radio stations and local FM stations dedicated to indigenous pastoral groups to communicate information on weather forecast and climate. This will allow older illiterate listeners an opportunity to learn what the government is saying about weather, and to compare it with their local information from the experts. Along with this, I recommend special programs where local knowledge *experts* are granted airtime in the stations to discuss various issues of concern to the local people, values and importance of local knowledge. Second, I recommend strengthening of informal local social institutions in law for effective use and legitimize their functions and roles. They will be useful to researchers, policy-makers and community when planning for adaptations to climate change strategies. Third, I recommend local-scale policies that promote the use of indigenous knowledge and practices in livestock keeping, water use management, and land use planning. Fourth and finally, I recommend that local coping and adaptation strategies and indigenous knowledge be used along with conventional scientific data obtained from meteorological centers to inform adaptation planning and climate change responses.

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APPENDIX 1: FOCUS GROUP DISCUSSION QUESTIONS

Focus group discussion questions

Ladies and gentlemen, I take this opportunity to welcome you to our focus group meeting. I hope you have all received the invitation letters that I send to you through your leaders, as attested by your attendance to this meeting. The objective of the meeting is to find out more about your community knowledge of weather and climate, its impacts on your production systems, your traditional coping mechanisms and adaptations. What you do to reduce the negative impacts of climate change.

First, I would like to introduce myself. My names are Clement Isaiah Lenachuru. I am currently a student at Colorado state university, USA. I am carrying out research in your area and community in relation to issues of climate change, its impacts on your livelihood and find out your coping and adaptation mechanisms.

As members of this focus group you were chosen because of your wide knowledge and experience in the issues affecting your community. As focus group members, it is expect that you respect each other, each one is free to express himself/herself without interruption or intimidation, no answer is wrong and no answer is better than the other, instead we are here to learn from each other. We expect minimal interruptions, if one has a point to make or clarification, let us agree that he/she raises her hand for chance to be given.

We hope that our conversation will help you to think about how you and your community can better prepare for future impacts of climate change. The results of our research will also be provided to government and donor organizations in order to help them develop policies and programs that can support herders/pastoralists and improve your ability to cope with future climate change events.

Before we start the discussions, we would start with brief introductions.

Thanks you very much.

Introduction by each participating member:

Names:

Village:

Age group/set name:

Livelihood (herder, farmer, fisherman, business man/ woman etc.):

Focus group discussion questions (General guide):

1. Please tell me as much as you know in general about weather and climate in your area

   Talks about temperatures, rainfall, seasons, winds etc.
2. What factors contribute to weather and climate? (ask from the above factors)
3. What changes over time have you noted/observed/experienced in the above factors of weather and climate in this area?
4. Have these changes in any way affected your production systems/livelihood strategies?
5. What are some of the changes you have seen/experiences in your livestock production systems that have made livestock keeping easy or difficult?
6. Do you attribute any of the changes to climate change?
7. How information about climate change is passed?
8. How is this knowledge stored? (who are the custodians?)
9. If faced with unpredictable or changing weather and climate, what would your community do to cope with it or adapt to it?

10. As a community, what are some of the indicators used to fore-warn of the likelihood of drought or famine looming or a change in weather?
11. Following on the above questions, what specifically to you do in relation to:
    - Pastures use and management?
    - Migration between camps (wet and dry season grazing areas)
    - Conflicts over the uses of pastures by different groups and tribes?
    - Water points use and management?
    - Diseases outbreaks and control mechanisms?
    - Movements from permanent homestead and satellite camps?
    - Security matters?
    - Food security for people?
12. As a community, do you have a coordinated system of decision making about managing of your livestock and grazing lands? How are these coordinated?
13. Please tell me, do you have community formal rules and regulations? Who formulate them?
14. Who enforces the community rules or decisions?
15. Please can you tell me how decisions and information about weather is shared among the members of your community?
16. Does your community hold some regular formal meetings?
    - How often do you hold such meetings?
    - What is discussed in such meetings?
17. Has any of you ever received any training or attended a training/workshop or seminar about climate change? If yes, what were you told?

18. Have there been any community-level trainings, meetings about the issues of climate changes? If yes, what were the attendants taught?
19. What issues of interest about environment would you want to share with the group?

This is the end of the survey. Thank you very much for your time and participation. Is there anything else you would like us to know or comments you would like to add?

APPENDIX 2: HOUSEHOLD SURVEY QUESTIONNAIRE

Household survey questionnaire

In recent years, the Ilchamus community land has experienced many physical and biological changes. These have a great possibility to impact on your production systems/livelihood strategies. I am interested to learn more about these changes and your knowledge about them as you have observed, and possible causes of these changes. I would also like to know what you are doing to cope with them, or live with them (adapt), or reduce their impacts to protect your production systems/livelihood strategies. Finally, I would like to understand your household coping strategies and adaptation mechanisms to the effects of these observed environmental changes.

It will take approximately 60 minutes to complete this survey, and I would like to thank you in advance for your cooperation and time to respond. All your responses will be kept confidential. Your participation is highly appreciated.

The study is conducted by Colorado State University, USA with financial support from International Ford Foundation Fellowship.

PART I: KNOWLEDGE AND INFORMATION ON WEATHER AND CLIMATE CHANGE

Q1. There have been talks and discussions in relations to climate change in recent years. Please tell me if you have ever heard of these talks or discussions (Check one applicable).

☐YES **☐NO**

Q2. If you have heard of these talks, please can you tell me the sources of this information? (Please mark (✔) each that apply).

Local leaders meeting	
Family member	
Peer group meeting (*ilporor*)	
Other herders	
Friends	
School	
Government meeting/workshop/seminar	
Local non-governmental organization	
National non-governmental organization	
Newspaper	
Radio	
Television	
Internet/computer	
Other sources (please specify):	

Q3. Concerning your understanding on climate change, what are local definitions or meanings of this term:…………………………………………………………………………………………

Q4. Which of the following best describes your level of understanding on weather and climate? (Check any one applicable).

□Very poor □Poor □Neutral □good □Very good

Q5. Given your self-assessment of your level of understanding of weather and climate, can you kindly tell me as many as possible factors that determine weather and climate? (Circle all that apply).

☐ Temperature
☐ Rainfall
☐ Water bodies like lakes and rivers
☐ Stars
☐ Wind
☐ Observations in day and night skies
☐ Vegetation
☐ Livestock numbers
☐ Human health condition
☐ Mountains
☐ It is peoples' beliefs such as bad luck
☐ Other factors (specify):

Q6. (***A***). Of the above factors (**Q5**), tell me those factors that you have observed and think have changed over the last 20 years? In addition, what kind of change have you observed in them? (Circle all that apply). (If respondent is younger than 20yrs old, ask about the last 10yrs).

Change	**Changed?**	**How has it changed?**				
Temperature	☐Yes ☐No	A lot hotter	A little hotter	No change	Colder	A lot colder
Rainfall	☐Yes ☐No	Very little	Less rains	No change	More	Heavy rains
Wind	☐Yes ☐No		Less windy	No change	More windy	

Stars	□Yes □No		Less useful for predicting	No change	More useful for predicting	
Natural vegetation	□Yes □No		Less vegetation	No change	More vegetation	
Wild life abundance	□Yes □No		Fewer wildlife	No change	More wildlife	
Livestock body condition	□Yes □No	Much worse condition	Worse condition	No change	Better condition	Much better condition
Crop harvest	□Yes □No	Much poorer	Poorer	No change	Better	Much better
Water availability in rivers , lakes and dams/pans	□Yes □No	Much less water	Less water	No change	Slight increase in water	High increase in water
Human health condition	□Yes □No	Very poor condition	Poor condition	No change	Healthier condition	Much healthier condition
Other (please specify):						

(***B***). In relation to responses above [**Q6**, (***A***)]**,** please tell me for the last 20 years how the changes you observed have affected your production systems/livelihood strategies? (Circle all that apply). (If respondent is younger than 20yrs old, ask about the last 10yrs).

Changing factor	**How each factor affected your production/livelihood system** -2=much reduced; -1=reduced; 0=no effect; 1=improved; 2=much improved				
Temperature	-2	-1	0	1	2
Rainfall	-2	-1	0	1	2
Soils	-2	-1	0	1	2
Natural vegetation	-2	-1	0	1	2
Wild life population	-2	-1	0	1	2
Livestock health condition	-2	-1	0	1	2
People health condition	-2	-1	0	1	2
Crop harvest	-2	-1	0	1	2
Level of water rivers	-2	-1	0	1	2
Level of water in lakes	-2	-1	0	1	2
Wind	-2	-1	0	1	2

Other (please specify):					

Q7. Given the changes for the last 20 years, you have indicated in [**Q6** (***A***)], in your opinion tell me if you can attribute these changes to climate? (Circle all that apply).

Changed factor	**Is climate the likely cause of change?** -2=very unlikely; -1=unlikely; 0=neutral; 1=likely; 2=very likely				
Temperature	-2	-1	0	1	2
Rainfall	-2	-1	0	1	2
Soil	-2	-1	0	1	2
Natural vegetation	-2	-1	0	1	2
Wild life numbers	-2	-1	0	1	2
Livestock health and body condition	-2	-1	0	1	2
Peoples' health condition	-2	-1	0	1	2
Crop yield	-2	-1	0	1	2
Level of water in the rivers	-2	-1	0	1	2
Levels of water in lakes	-2	-1	0	1	2

Wind	-2	-1	0	1	2
Other (please specify):					

Q8. Your community observes and interprets certain environmental indicators in relation to weather and climate. What do these changes mean to your production system/livelihood strategies? (Circle all that apply).

Parameter	**Observed any change?**	**What it means/interpretation**
Wind	☐ Yes ☐ No	
Cloud cover	☐ Yes ☐ No	
Temperature	☐ Yes ☐ No	
Position of the stars	☐ Yes ☐ No	
Position of the moon	☐ Yes ☐ No	
Position of the sun	☐ Yes ☐ No	
Livestock body condition	☐ Yes ☐ No	
Wildlife movement	☐ Yes ☐ No	
Other? (specify):		

Q9. What are the social structures and networks that exist in your community? (Circle all that apply)

Social structure/network	
Immediate family	□ Yes □ No
Close relatives	□ Yes □ No
Friends	□ Yes □ No
Peer group	□ Yes □ No
Age-set/group	□ Yes □ No
Council of elders (men)	□ Yes □ No
Council of elders (women)	□ Yes □ No
Age-group council of elders (*Illamal*)	□ Yes □ No
Youth group	□ Yes □ No
Council of boys (*Ilaiyok)* (un-initiated boys)	□ Yes □ No
Village committee	□ Yes □ No
Location committee	□ Yes □ No
Other (please list)	

Q10. How useful are these social structures and networks in passing information about weather and climate?

Social structure/network	**How useful are they in passing information?** -2=very unuseful; -1= not useful; 0=neutral; 1=useful; 2=very useful

Immediate family	-2	-1	0	1	2
Close relatives	-2	-1	0	1	2
Friends	-2	-1	0	1	2
Peer group	-2	-1	0	1	2
Age-set/group	-2	-1	0	1	2
Council of elders (men)	-2	-1	0	1	2
Council of elders (women)	-2	-1	0	1	2
Age-group council of elders (*Illamal*)	-2	-1	0	1	2
Youth group	-2	-1	0	1	2
Council of boys (*Ilaiyok)* (un-initiated boys)	-2	-1	0	1	2
Village committee	-2	-1	0	1	2
Location committee	-2	-1	0	1	2
Other (please list)					

Q11. As the Ilchamus community, which of these local traditional/indigenous sources of knowledge do you rely on most to predict future weather/climate conditions? (Circle all that apply).

Source of knowledge	**How reliable is this source?** -2=very unreliable; -1=unreliable; 0=neutral; 1=reliable; 2=very

	reliable				
Medicine man *(loiboni)*	-2	-1	0	1	2
Medicine man(*loo-namuka)*	-2	-1	0	1	2
Medicine man (*Loo-manyit)*	-2	-1	0	1	2
Medicine man (*loo-lakir)*	-2	-1	0	1	2
Peer group	-2	-1	0	1	2
Village elders	-2	-1	0	1	2
Personal experience	-2	-1	0	1	2
Government weather forecast station	-2	-1	0	1	2
Other (please specify):					

Q12. Which of the following (traditional & non-traditional) sources do you rely mostly/frequently to learn and get information about weather and climate conditions? (Circle all that apply)

Source of information	**Frequency use to learn and get information about weather** 1=never use; 2=daily; 3=weekly; 4=monthly; 5=many times				
Peer group	1	2	3	4	5
Immediate	1	2	3	4	5

family					
Close relatives	1	2	3	4	5
Village elders meetings	1	2	3	4	5
Community rituals and ceremonies	1	2	3	4	5
Medicine man (*loiboni)*	1	2	3	4	5
Fortune teller (*loomanyit)*	1	2	3	4	5
Fortune teller (*loonamuka*)	1	2	3	4	5
Stars readers (*loolakir*)	1	2	3	4	5
Neighbor tribes	1	2	3	4	5
Personal	1	2	3	4	5

experience					
Government office	1	2	3	4	5
Meteorology station	1	2	3	4	5
Training	1	2	3	4	5
Radio	1	2	3	4	5
Television	1	2	3	4	5
Newspaper	1	2	3	4	5
Internet source	1	2	3	4	5
Other sources (specify)					

Q12 (a) Can you list all your sources of information and those you talk with about weather other than above? (list source and relations)

Q12 (b) who do you talk with about livestock management and related issues? (list the names and relations)

Q13. By observing the physical and biological indicators of weather and climate, can you tell what the weather will be like in the next few days, weeks or months? (Circle all that apply).

Daily prediction	☐ Yes ☐ No
Weekly prediction	☐ Yes ☐ No
Monthly prediction	☐ Yes ☐ No

Longer than one month prediction	□ Yes □ No

Q14. As a household head, which of the following predict a change in weather and climate?

(First, ask if they use the indicator to predict, then how frequently it is used)

Indicator	**Used?**	**Frequency of use** 0=no idea; 1=never used, 2=seldom used; 3=frequently used			
Wind movement and direction	□ Yes □ No	0	1	2	3
Temperature	□ Yes □ No	0	1	2	3
Wild animals movements	□ Yes □ No	0	1	2	3
Movement of birds	□ Yes □ No	0	1	2	3
Movement of flying insects	□ Yes □ No	0	1	2	3
Singing of birds	□ Yes □ No	0	1	2	3
Livestock body condition	□ Yes □ No	0	1	2	3
Night stars	□ Yes □ No	0	1	2	3
Position of the	□ Yes	0	1	2	3

moon	☐ No				
Position of the sun	☐ Yes ☐ No	0	1	2	3
Animals intestines	☐ Yes ☐ No	0	1	2	3
Plant phenology (flowering)	☐ Yes ☐ No	0	1	2	3
Night sky	☐ Yes ☐ No	0	1	2	3
Human health condition	☐ Yes ☐ No	0	1	2	3
Others (specify)	☐ Yes ☐ No				

Q15. Given your responses about weather and climate in the above questions, can you say with certainty that climate has changed in your area over the last many years you can remember?

Neutral	Not certain	Certain	Very certain

PART II: CONSEQUENCES OF CLIMATE CHANGE ON PRODUCTION SYSTEMS/LIVELIHOOD STRATEGIES

Q16. Given the observed changes of weather and climate, are your production system/livelihood strategies being affected? What were the consequences of these changes?

Production system	**Is it affected?**	**What were the outcomes (consequences)?** -2=very bad; -1=bad; 0=no change; 1=good; 2=very

		good				
Livestock production	□ Yes □ No	-2	-1	0	1	2
Irrigated crop	□ Yes □ No	-2	-1	0	1	2
Rain-fed crop	□ Yes □ No	-2	-1	0	1	2
Fish catch	□ Yes □ No	-2	-1	0	1	2
Other (specify please)						

Q17. Which indicators in your production system, environment and others do you observe frequently that indicate or serve as warning of a change in weather and climate?

Indicator	Observe?	Frequency of observation 0=no idea; 1=never observed; 2=sometimes used; 3=frequently used			
Livestock body condition	□ Yes □ No	0	1	2	3
Livestock gut-fill	□ Yes □ No	0	1	2	3
Crop yield	□ Yes □ No	0	1	2	3
Water source	□ Yes □ No	0	1	2	3
Pasture condition	□ Yes	0	1	2	3

	☐ No				
Temperature	☐ Yes ☐ No	0	1	2	3
Fish availability	☐ Yes ☐ No	0	1	2	3
Presence or absence of diseases	☐ Yes ☐ No	0	1	2	3
Vegetation phenology (flowers and leaves)	☐ Yes ☐ No	0	1	2	3
Security situation	☐ Yes ☐ No	0	1	2	3
Wind frequency and direction	☐ Yes ☐ No	0	1	2	3
Position of sun	☐ Yes ☐ No	0	1	2	3
Position of moon	☐ Yes ☐ No	0	1	2	3
Stars	☐ Yes ☐ No	0	1	2	3
Bird migration	☐ Yes ☐ No	0	1	2	3

Bird singing	□ Yes □ No	0	1	2	3
Wild animal migration and movement	□ Yes □ No	0	1	2	3
Other (specify)	□ Yes □ No				

Q18. In the event that you anticipate a change, do you take any action(s) in advance to reduce the negative effects of change on your production system/livelihood strategies?

□ Yes □ No

Q19. If **Yes** to the above question, when do you take this action?

□ Before the change occurs □ when the change is occurring □ after the change has occurred

□ I take no action; just wait to see what will happen and live with the results (cope with it).

□ Do not know/no idea

Q20. In relation to **Q18**, what plans/actions do you take to reduce the negative impacts related to weather and climate change on your production/livelihood systems? How often do you undertake these actions? (Circle all those applicable).

Action taken/response	**Is action taken?**	**How often the action/response is undertaken** 0=no idea; 1=never/no action; 2=often; 3=always take action			
Migrate to another area/satellite camp	□ Yes □ No	0	1	2	3
Negotiate with	□ Yes	0	1	2	3

neighbor tribe for pasture	☐ No				
Sell some of my livestock	☐ Yes ☐ No	0	1	2	3
Loan away my livestock to others	☐ Yes ☐ No	0	1	2	3
Split the herd into smaller units	☐ Yes ☐ No	0	1	2	3
Buy hay from market	☐ Yes ☐ No	0	1	2	3
Hire more labor	☐ Yes ☐ No	0	1	2	3
Rent pasture for livestock	☐ Yes ☐ No	0	1	2	3
Feed cactus to my livestock	☐ Yes ☐ No	0	1	2	3
Feed *prosopis* pods to my livestock	☐ Yes ☐ No	0	1	2	3
Seek government assistance	☐ Yes ☐ No	0	1	2	3
Seek help from non-governmental	☐ Yes	0	1	2	3

organization	□ No				
Try other sources of livelihood (diversification)	□ Yes □ No	0	1	2	3
Other (specify)	□ Yes □ No				

PART III: LIVELIHOOD SYSTEM/DIVERSIFICATION AND ADAPTATION TO CLIMATE CHANGE

Q21. What are your current household production system/livelihood strategies and/or source of income? Is the system an old community traditional practice, or a new/novel practice? (Circle all that apply).

Production system	**Do you practice this currently?**	**1=Old practice 2=New practice?**	
Livestock herding	□ Yes □ No	1	2
Crop farming	□ Yes □ No	1	2
Formal employment	□ Yes □ No	1	2
Casual employment	□ Yes □ No	1	2
Self-employment such as livestock trade	□ Yes □ No	1	2
Shop business/kiosk	□ Yes □ No	1	2
I depend on well-wishers who are not relatives	□ Yes □ No	1	2

I depend on government and NGO's free supplies	□ Yes □ No	1	2
I depend on relatives	□ Yes □ No	1	2
Fishing	□ Yes □ No	1	2
Charcoal burning and selling	□ Yes □ No	1	2
Sell honey	□ Yes □ No	1	2
Sell handcraft products	□ Yes □ No	1	2
Sell local brew/beer	□ Yes □ No	1	2
Other (please specify):			

Q22. For **only** those production systems/livelihoods/income sources that are marked as **new (Q21),** what has caused them to be introduced? Climate change related or not? (Mark for those that are only **new**).

Production system/ livelihood	**Is the system a new one?**	**Reasons for introduction?** 1=climate related; 2=other reasons		**What other reasons?**
Livestock herding	□ Yes □ No	1	2	
Crop farming	□ Yes □ No	1	2	
Formal employment	□ Yes □ No	1	2	
Casual employment	□ Yes □ No	1	2	
Self-employment such as livestock trade	□ Yes □ No	1	2	

Shop business/kiosk	□ Yes □ No	1 2	
I depend on well-wishers who are not relatives	□ Yes □ No	1 2	
I Depend on government and NGO's	□ Yes □ No	1 2	
I depend on relatives	□ Yes □ No	1 2	
Fishing	□ Yes □ No	1 2	
I burn and sell charcoal	□ Yes □ No	1 2	
Sell honey	□ Yes □ No	1 2	
Sell hand-crafts products	□ Yes □ No	1 2	
Sell local beer/brew	□ Yes □ No	1 2	
Others (please specify)			

Q23. Of the production systems/livelihoods mentioned in **Q21** above, which of them are affected by changes in weather and climate? Please tell me all those affected. (Circle those applicable).

System of production/sources of income	**Is the system affected by climate?**
Livestock herding	□ yes □ No
Crop farming	□ yes □ No

Formal employment	☐ yes ☐ No
Casual employment	☐ yes ☐ No
Self-employment such as livestock trade	☐ yes ☐ No
Shop business/kiosk	☐ yes ☐ No
I depends on well-wishers who are not relatives	☐ yes ☐ No
I depend on government and NGO's free supplies	☐ yes ☐ No
I depend on relatives	☐ yes ☐ No
I do fishing in the swamps, rivers and around the lakes	☐ yes ☐ No
Charcoal burning and selling	☐ yes ☐ No
Sell honey	☐ yes ☐ No
Sell handcraft products	☐ yes ☐ No
Sell local brew/beer	☐ yes ☐ No
Others (please specify):	

Q24. As a household, which of following coping strategies do you practice? In addition, how often do you make decisions and take actions to cope with changes attributed to weather and climate in your livestock production system? (Circle all that apply).

Coping strategy	**Practiced?**	**How often do you make this decision?** 0=no idea; 1=never; 2=sometimes; 3=always			
Migrate to satellite camp	☐ Yes ☐ No	0	1	2	3

Herd splitting	☐ Yes ☐ No	0	1	2	3
Change livelihood strategies/diversification	☐ Yes ☐ No	0	1	2	3
Sell some livestock	☐ Yes ☐ No	0	1	2	3
Loan out livestock to friends and relatives	☐ Yes ☐ No	0	1	2	3
Buy hay for livestock	☐ Yes ☐ No	0	1	2	3
Buy water for livestock	☐ Yes ☐ No	0	1	2	3
Buy feed supplements	☐ Yes ☐ No	0	1	2	3
Hire labor	☐ Yes ☐ No	0	1	2	3
Depend of government to supply hay	☐ Yes ☐ No	0	1	2	3
Depend on government to supply water	☐ Yes ☐ No	0	1	2	3
Depend on government for	☐ Yes	0	1	2	3

free food supplies	☐ No				
Depend on NGO's for free food supplies	☐ Yes ☐ No	0	1	2	3
Seek employment in urban centers	☐ Yes ☐ No	0	1	2	3
Engage in community traditional rains-making ceremony(ies)/ritual(s)	☐ Yes ☐ No	0	1	2	3
Monitor security situation before taking any decision	☐ Yes ☐ No	0	1	2	3
Other (please specify):					

Q25. If traditional ceremony (ies)/ritual(s) are mentioned in **Q24** above, who performs them, why do they perform them and how often do you depend on them to make decisions? (Circle all that apply).

Ceremony/ritual?	**Who performs it?**	**Why perform them?**	**How often do you depend on ceremony (ies)/ritual(s)?**
	1= Women 2= Elders 3= Oloiboni 4=Men & women 5=All	1= Rain making 2= Land cleansing 3=offers to gods to appease 4=Keep off diseases and calamities	1=No idea 2=Never 3=sometimes 4=all the time 5= I do not believe in

			them

Q26. In the event that the livestock production system is failing due to climate change, what other system or activity will you likely engage in? (Please circle all that apply).

Production system/activity	**How likely will you opt to engage in this system?** -2=very unlikely; -1=unlikely; 0=neutral; 1=likely; 2=very likely				
Crop production	-2	-1	0	1	2
Shop business/kiosk	-2	-1	0	1	2
Charcoal business	-2	-1	0	1	2
Local brew/beer	-2	-1	0	1	2
Handcraft products	-2	-1	0	1	2
Casual labor	-2	-1	0	1	2
Formal employment	-2	-1	0	1	2
Fishing	-2	-1	0	1	2
Honey selling	-2	-1	0	1	2
Depend on well-wishers not relatives	-2	-1	0	1	2
Depend on relatives	-2	-1	0	1	2
Depend on	-2	-1	0	1	2

government					
Depend on NGO's	-2	-1	0	1	2
Do nothing	-2	-1	0	1	2
Others (specify)					

Q27. Has the local and/or national government ever helped your household to cope with and adapt to the effects of climate change like drought, famine, and/or floods over the past years?

□ No □ Yes, the local government only (county council)

□ Yes, local and national government □ Yes, the national government only □ I do not know

Q28. What kind of help did the government provide?

□ Food □ Water □ Clothing and bedding □ Sleeping tents □ Medicine □ Hay for livestock

□ Veterinary services and drugs □ Buy off weak animals □ I don't know □ other (specify)

Q29. Has any local and/or national non-governmental organization ever helped your household to cope with and adapt to the effects of climate change like drought, famine, and/or floods over the past years?

□ No □ Yes, the local non-government organization only

□ Yes, both local and national non-government organizations

□ Yes, the national non-government organization only □ I do not know

Q30. What kind of help did the non-government organizations provide?

□ Food □ Water □ Clothing and bedding □ Sleeping tents □ Paid school fee for my children

□ Bought school uniform for my children □ Medicine □ Hay for livestock

□ Veterinary services and drugs □ buy off weak animals □ I do not know

□ Other (specify)

Q31. In the event that climate change is affecting your production system, where do you usually seek help from? (Check all that apply)

□ Immediate family members □ other relatives □ Friend □ Neighbor

□ Local government □ National government □ Non-governmental organization

□ Others (please specify)…………………………………………

PART IV: HOUSEHOLD DEMOGRAPHIC INFORMATION

Q32. I take this opportunity to thank you for your time and patience. We are almost coming to the end of this interview. I would like to ask you a few questions about your household, and I hope you can still give me a few minutes to finish this last part.

Fill in responses in the following table. (You can add more rows if necessary).

	Household member names	**Relationship to hhh**	**Gender(M/F)**	**Age (see categories below)**	**Highest Education level attained (see options below)**	**Occupation (see options below)**
1		Self				
2						
Total hh members						

Age brackets: 0: <18 yrs.**; 1**: 18-35 yrs.; **2:** 36-55 yrs.; **3**: Over 55 yrs.

Education levels: **0**: No education/illiterate; **1**: Lower primary level (class 1-3); **2**: Upper primary level (class 4-8); **3**: Secondary-F1-F2; **4**: Secondary F3-F4; **5:** Secondary F5-F6; **6**: Collage certificate; **7**: Collage diploma; **8:** Bachelor's degree; **9**: Post graduate.

Occupation: **1**: Livestock herder; **2**: Crops farmer; **3**: Mixed crops and livestock; **4:** Casual worker: **5**: Artisan; **6:** Shop keeper; **7:** Primary school teacher; **8:** Secondary school teacher; **9**:

Police force/army; **10**: Clerical; **11:** Accountant; **12**: Lawyer; **13**: Senior government officer; **14**: Other (specify)

Q32. Which location do you live? (Please check one applicable).

☐Ng'ambo **☐Salabani** **☐Ilng'arua** **☐Kiserian**

APPENDIX 3: CODES AND CATEGORIES OF THE FOCUS GROUP RESPOSES

QUESTION/TOPIC	RESPONSES	CATEGORIES	THEMES/CONCEPTS	FINDINGS/IMPLICATIONS
General knowledge about weather and climate in your area? (Temperatures, rainfall, seasons, winds (etc.).	**Summary from FGs:** -Recognize climate has changed and list evidence of changes: - as less rains than in the past -rains come when not expected -floods when rains come -our winds used for prediction are not reliable - winds are no longer common due to weedy vegetation - temperatures are extremely hot than they have ever been -we think the sun is now closer (As one lady wondered) - prolonged dry spells/droughts followed by heavy torrential rains causes a lot of damage - Damming up stream has affected	-general agreement of change -that climate factors/indicators have changed -other human causes of climate/weather change	Climate and weather change Indicators used Human activities	Diverse & many knowledge sources Observe several indicators Changes interpreted to be those of climate change Human

	water flow - there is a lot of forest destruction in catchment areas ALL GROUPS (4/4)			activities are also responsibl e
What factors contribute to weather and climate change? (ask from the above factors)	-our land is not clean/polluted due to many people invading -population increase - a lot of heat than it used to be - destruction of forests and local vegetation -waters are polluted now causing diseases - many livestock from other areas coming to our land caused degradation ALL GROUPS (4/4) - people not respecting our culture has annoyed our god -punishment from god THREE GROUPS (3/4)	-human impacts on environment like pollution and destruction of environment - overstockin g on land that is limited in capacity	Human factors Environm ental factors	Natural phenomen a but also humans activities contribute External

		-cultural disrespect has led to practices that degrade the land	Cultural dynamics	cultural are thought to contribute
What changes over time have you noted & observed/experienced in the above factors of weather and climate in this area?	-Vegetation destroyed over time -temperatures getting hotter -rains are less - soils washed away by strong winds - diseases have increased for human and livestock -crops failure and poor harvest -very hot throughout the year - droughts and dry spells are common - water upstream is blocked for irrigation grazing areas have shrunken and poor pastures - diseases both to people and livestock	-general environmental health gone down -people, crops and animals are also not healthy -loss of biodiversity -poor yields	Physical environmental changes Biological changes Changes are detrimental to livelihoods	The indicators have changed to bad level Conditions are worsening all the time Loss of natural

	- weathers conditions not predictable - many of our local species of grasses, medicinal plants, trees and vegetables have disappeared - soils are not fertile - plants/trees and food crops are diseased something that never use to happen ALL ABOVE 4/4 - Lake Baringo water has gone down (3/4) -social changes since 80's due to formal education- 2/4 -education had both good and bad sides -our children copy other cultures and disrespect ours -this has affected how we practice our livelihood production systems many wild animals have gone away or died - livestock numbers have reduced	from crops and livestock -water is scarce -social change due to education, government policies and external cultures are diluting local ones These changes have affected	Associated negative effects of environmental change Social changes Livelihood changes	vegetation Social changes are eroding traditional values Changes have effected livelihood

	-movement of bees and other insects is not predictable now -these changes are worsening every season/year EXCEPT WHERE INDICATED ALL ARE 4/4	livelihood and livelihood production systems -- environmental indicators are not reliable		negatively
Have these changes in any way affected your production systems/livelihood strategies?	-we are still practicing our traditional production systems -it is now hard to keep many livestock -crops are also not doing well - disease in both - we are also trying other ways -charcoal burning is common - we are also seeking urban jobs - we are also sending children to school 3/4 - we try also self-employment like small trade-kiosks and livestock	-traditional systems still in place - challenges are many Other production systems introduced -formal	Traditional and new livelihood Role of formal	Traditional production systems are still practiced but with a lot of problems Formal education is

	trading -schooling of our children is affecting how we practice our livelihood production systems ALL ABOVE 4/4 -there is less attention to our traditional practices by the younger, educated people- 3/4	education has been embraced -traditional practices are eroded	education	contributing to eroding traditional ways of life
What are some of the changes you have seen/experiences in your livestock production systems that have made livestock keeping easy or difficult?	-it is becoming more difficult to keep livestock -poor pastures - common droughts 3/4 -insecurity due to regular cattle rustling - livestock diseases -worms infestation and other parasites-2/4 -Poor market prices -poor water availability -disregard of the system by the educated young people -they don't like herding-2/4 -they do not believe in traditional	-livestock keeping has become hard -worried more about livelihood sustainability	Trends of change in livelihood systems Attitude effects of formal education	Livestock have reduced Are unhealthy No enthusiasm from young people to keep cattle

	knowledge sources -poor production from our livestock-less milk, poor health conditions EXCEPT WHERE INDICATED ALL IS 4/4			
Do you attribute any of the changes to climate change?	-yes we attribute many of these changes to climate change and land pollution due to human population -4/4	-climate change is the cause	Contributor of climate change	All changes are attributed to climate change
How information about climate change is passed?	-the knowledge is passed due to interest and believe -shared and taught during community functions -council of elders regular meetings in designated trees -Social long term exposure and interactions among different members like peers, herders and councils of different age-groups -active participation and interest	-knowledge is passed based on interest -social interactions are the modes	Traditional ways of sharing knowledge and information Teaching methods	Traditional ways of passing information have not changed over time Social structures

	-teaching others is not easy unless the learner is interested and persistent -knowledge passed is from reading intestines, reading the stars, reading shoes, from Oloiboni. These sources are used during community ceremonies/functions -elderly women and mothers have the responsibility of teaching young children, girls and newly-wed women. DATA - 4/4	-local experts are useful -traditional functions -gender differential in passing knowledge	Role of experts	and organization are in use Experts are key sources and custodians
How is this knowledge stored? (who are the custodians?)	-each person has his knowledge based on interest and experience -traditional knowledge is usually stored by certain families/individuals and are well known by all -four key custodians are-loolakir, loonamuka, loomanyit and oloiboni. 4/4 -nowadays people also get knowledge from government	Knowledge is stored by individuals -experts store the bulk -formal sources	Sources of knowledge on weather and climate Custody of local	Knowledge is stored by individuals and experts

	sources through TV and radio and keep to themselves-2/4		traditional knowledg e	
If faced with unpredictable or changing weather and climate, what would your community do to cope with it or adapt to it?	-traditional rituals are performed to cleanse the land to please gods to release rains (aitoropil e nkop) -crop farming. That they use to do plant millet when they settled here and the white people/colonialists brought in white maize, but abandoned later as they accumulated livestock 4/4 -migration with proper -3/4 -management and planning by elders and warriors -charcoal burning- 3/4 -split livestock depending on available pasture areas 4/4 -sell some of the cattle 2/4 -feed animals with Prosopis pods and cactus 2/4 -hire labor to assist in herding-3/4	-traditional ceremonies -diversify sources of income -different managemen t strategies on livestock	Coping strategies Adaptatio n strategies	Several traditional coping and adaptation have been developed Elders are bestowed responsibi lity to make decisions on manageme nt
As a	-temperatures are our first			

community, what are some of the indicators used to fore-warn of the likelihood of drought or famine looming or a change in weather?	indicators. When heat is constant we know things are bad -still air, no winds is another indication - loss of water and drying of rivers, ponds and lake retreating -later strong winds blowing a lot of soil when the ground has no cover as grass dry -fast drying of grass due to hot temperatures -crops fail and start to wild and dry-off -movement of wild animals from the hills towards the shores of the lake -bees move from the mountain towards the lake -baboons migrate from hills to the lake. ALL 4/4 -flowering of some tree species is an indication 3/4 -nights are clear, no clouds	-natural physical indicators -natural biological indicators	Weather & climate change forecastin g indicators and methods	Several indicators are used to warn and indicate that conditions are getting bad. They observe physical and biological indicators

	-stars disappear and go underground 2/4 -sun goes to the drought home -moon very bright at night- 2/4			
Following on the above questions, what specifically to you do in relation to: -Pastures use and management? -Migration between camps (wet and dry	--warriors have the responsibility to manage, but this is dying due to effects of formal education 1/4 -animals are controlled so that there is planned grazing 1/4 -this is planned by elders and warriors along with pastures 1/4 -watering points are protected 4/4 -few members prefer privatization of land and do away with communal ownership 1/4 -better management by individuals -we are losing our land to invaders -those with private parcels are living better 2/4 -migration is done when the animals are not getting enough per	-security in grazing areas -managemen t practices -land privatization by a few members -migration is based on	Managem ent of pastoral resources	Grazing manageme nt decision are made by elders and household heads & implement ed by warriors

season grazing areas) -Conflicts over the uses of pastures by different groups and tribes? -Water points use and management?	day 2/4 -the elders from conflict communities meet to resolve the issues 2/4 -warriors are put on standby in case a fight erupts to take charge 4/4 -During dry season, watering points are protected 4/4 -young men are appointed to look after these points in turn -those violating will be punished according to community rules and regulations -no such management when it is raining and water is plenty on land	available resources -conflicts are resolved traditionally through local rules and regulation -communal water points are protected	Coping strategy Conflict resolution mechanis m Managem ent of	Traditiona l conflict mechanis m are employed to resolve intra and inter- communit y conflicts

	4/4		pastoral resources	
-Diseases outbreaks and control mechanisms?	-in case of outbreaks, they use to isolate the herds that were sick -warriors will be appointed to drive those herds into isolation and watched to be sure they do not mix with others in the pasture or watering points or anywhere -the family herd and its owners are all moved away and only return when the herds are healed -nowadays this is not possible -no vacant land to isolate them to -all areas are occupied by people -people disregard those communal rules	-diseases are controlled by isolation of sick herds Hard to implement now due to unavailabilit y of vacant land	Animal health manageme nt strategies and challenges	Traditiona l disease quarantine methods are used These manageme nt methods are facing challenges due to lack of vacant

-Movements from permanent homestead and satellite camps? -Security matters?	-no warriors to enforce or implement the community rules 4/4 -this is also a responsibility of the elders and warriors to decide and implement -these go along with water and pasture rules and regulations 3/4 -responsibility of the warriors to protect the community and its property and assets -security scouts are sent to inspect the fields to be sure no enemies are hiding around water points, pasture and salt-lick areas -that routes used to migrate are safe for women and children to pass 3/4	Enforcement by warriors management decisions on livestock by men security is responsibility of warriors is a concern of the community	Coping and adaptation strategies Coping and adaptation strategy	land Management decisions by men and elders Security is maintained by warriors Coping means
As a community, do	-usually our community rely on the elders first as the leaders of the	-	Traditiona	Structured

you have a coordinated system of decision making about managing of your livestock and grazing lands? How are these coordinated?	community -elders have a final word in every social, political and economic aspects of our community -decision are deliberated and agreed by elders council -the warriors are called and informed of the decisions -warriors will have the responsibility to implement -lately warriors lost these powers when elder violated the rules allowing stock friends from other communities to graze their livestock in the community grazing pastures -in organized community meetings, they are informed of the decisions made by the elders -they are also informed of the rules and punishment to those who violate -the warriors identified to enforce	management decisions made by household heads and elders -warriors implement -warriors powers has been diluted by elders and local leaders rules to guide management	l ways of Managing of pastoral resources Implementation of management decisions	means of managing community resources Responsibility of making the decision is clear Implementation of these decisions is given to young men

	are identified and the public get to know them 4/4			
Please tell me, do you have community formal rules and regulations? Who formulate them?	-yes there are many community rules and regulations -these rules and regulations are guided by the council of elders and knowledge experts -each age-set council sets its own rules to guide the group -rules and regulations are used to guide the community, protect it from any harm -rules are enacted to guide livelihood systems and keep us together as a community of common interest 3/4	-existing rules and regulation	Communal rules and regulation	The community has a known governance structure with rules and regulation to be followed
Who enforces the community rules or decisions?	-these rules are enforced by warriors, elders and individuals as interested parties for the good of the community 2/4	Rules enforced	Rules enforcers	Community rules are full enforced
Please can you tell me how	-these are shared during community ceremonies/functions	Knowledge	Ways and means of	There are recognize

decisions and information about weather is shared among the members of your community?	-during informal meetings between friends and peer groups -between various social groups -within the family set-up -when one has specific issues, visits the experts to learn more 3/4	and information sharing	sharing traditional knowledge Social networks and organizational structures Community forums	d social networks and organizational structures used to pass and share knowledge
Does your community hold some regular formal meetings? How often do you hold such	-no regular meetings, but if there are issues of concern, meetings are called -elders, peers and age-groups always meet almost on daily basis 2/4	-formal/informal meetings		Communal gatherings are also channels through which

meetings? What is discussed in such meetings?	-meetings are held as the need arises -peers and elders always meet but not necessarily for a meeting 4/4 -on daily meetings, contemporary matters are discussed, especially in relation to weather, security, government reports from the chief, social matters like marriages, fights/conflicts/ceremonies -on planned meetings, the discuss the matters at hand 4/4	Meetings according to need -all aspects of the community are discussed	Forum deliberations	knowledge is passed and shared
Has any of you ever received any training or attended a training/workshop or seminar about climate change? If yes, what were you told?	-few of the elders were found among the focus group members to have attended meetings/workshops where matters of climate change were discussed -issues told were about the changing climatic conditions -about how to adapt their production systems to the changes	Trainings related to climate change	Awareness creation on climate change	The community had other external sources of knowledge about climate

	-they are also asked to share what they know about climate/weather changes- 1/4		External taught adaptation strategies	change
Have there been any community-level trainings, meetings about the issues of climate changes? If yes, what were the attendants taught?	-all the four groups talked about attending meetings where issues of general climate changes have been discussed and are told the changes they are observing on the environment are due to climate change -they also said they were taught about the need to reduce their livestock -taught about crops that are good to plant when rains are poor -been told to be careful about some animal and human disease associated with climate change 4/4	Local trainings in climate-related matters	Local awareness forums on matters climate change and livelihood strategies	Limited exposure trainings of the community to understand the issues of climate change
What issues of interest about environment would you want	The following were issues brought up by the groups: -environmental changes due to invasion of strange weeds like	Issues of concern: environment	Community livelihood	Community has other

to share with the group?	Prosopis, cactus and kasia -they also complained about insecurity and government inactivity on the matter -they talked about land sub-division in areas insecurity is a problem 4/4	al degradation Security matters	concerns	concerns that are affecting their livelihood negatively

APPENDIX 4: MAPS SHOWING POSITION OF KENYA IN AFRICA AND BARINGO COUNTY IN KENYA.

Map of Africa Map of Kenya

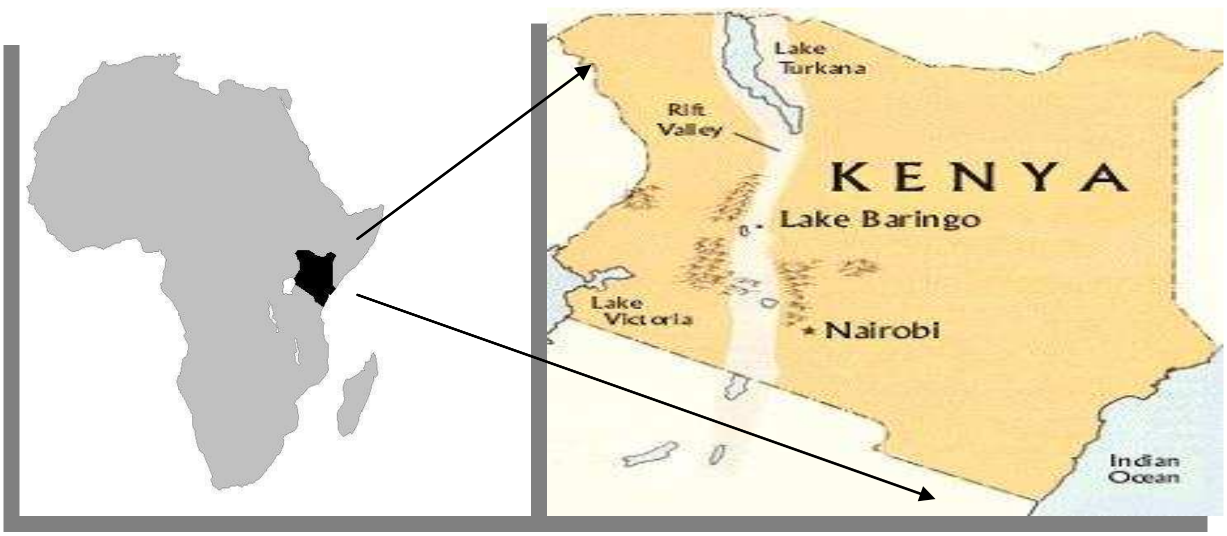

Figure 1: Map of Africa showing position of Kenya (Source: Stephen Andersson).

Figure 2: Map of Kenya showing position of Baringo County.

APPENDIX 5: FIELD RESEARCH PICTURES: Marigat, Baringo- KENYA

Figure 3: Typical hut of the Ilchamus

Figure 4: Training of enumerators in 2011

Figure 5: Focus group discussion in session

Figure 6: Researcher in the field

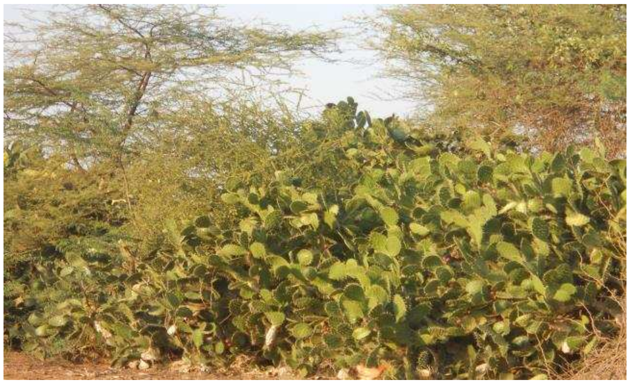

Figure 7: Cactus- an invasive weed on the land