EFFECTS OF INTRODUCTION OF PASTORALISM ON WILDLIFE CONSERVATION AND LIVELIHOODS: THE CASE OF KILIMANI AND UTETE WEST VILLAGES, RUFIJI DISTRICT

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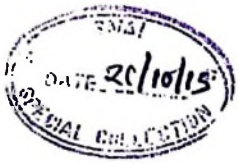

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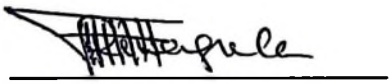
ABSTRACT

Recently, pastoralism has been introduced to Rufiji District. On one hand, the arrival of pastoralists to some places has been a blessing. On the other hand, it has brought conflicts between local communities and pastoralists. This study identified emerging conflicts, assessed existing potential effects of pastoralism on wildlife habitats and determined the effects of pastoralism on local livelihoods. Two villages were randomly selected for data collection, using a checklist and structured questionnaires administered to 149 respondents. Eight transects of 2 × 2 km, 5 quadrants of 1.5 x 1.5 m^2 were established fot recording plant species richness, abundance and diversity. Descriptive statistics was also used to generate frequencies and percentages, Shannon index determined species diversity while non-parametric (Mann-Whitney) tested their differences. The rank order of the causes of conflicts were conflicts between farmers and pastoralists (81.2 %); pastoralists and wildlife (49.2%); pastoralists of different ethnic groups (42 %), and farmers and wildlife (22.3%). Livestock depredation ranked the highest cause of conflict between pastoralists and wildlife (88.8 %) while crop damage by livestock was the highest cause of conflict between farmers and pastoralist (96%). A total of 32 plant species were identified. Highly desirable species were significantly higher ($p = 0.02$) in livestock ungrazed areas while less desirable and undesirable species were most abundant in livestock grazed areas. Shannon index was relatively higher in grazed (3.812) than ungrazed (3.055). Increased household income through trade (80%), local government revenues through tax (10%) and availability of livestock products (10%) were positive effects of pastoralism to livelihood while crop damage by livestock resulting in food insecurity to farmers was the major negative effect. Generally, the introduction of pastoralism had more negative effects on wildlife conservation and some positive effects on local peoples' livelihoods. Land use plan should be developed to balance different uses causing conflicts in the District.

DECLARATION

I, FRANCIS RUSENGULA, do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is my own original work done within the period of registration and that it has neither been submitted nor is being concurrently submitted to any other institution.



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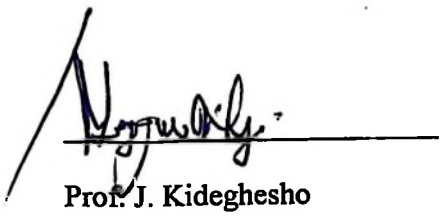

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DEDICATION

This work is dedicated to my mother, Agness Makala, my wife Mecktrida Protace and children, Jacqueline and Joachim for their being catalysts for my hard working, happiness and identity.

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LIST OF ABBREVIATIONS AND ACRONYMS

AWF	African Wildlife Foundation
BTC	Belgium Technical Cooperation
DAO	District Agricultural Officer
DC	District Council
DGO	District Game Officer
DLO	District Livestock Officer
DALDO	District Agricultural and Livestock Development Officer
GDP	Gross Domestic Product
GIS	Ground Information System
FAO	Food and Agriculture Organisation
IIED	International Institute for Environment and Development.
IUCN	International Union For Conservation of Nature
JUHIWANGUMWA	Jumuia ya Uhifadhi Wanyamapori Kata za Ngorongo, Utete na Mwasenyi
NCA	Ngorongoro Conservation Area
REMP	Rufiji Environmental Management Programme
SCBD	Secretariat of the Convention on Biological Diversity
TNRF	Tanzania Natural Resources Forum
URT	United Republic of Tanzania
SUA	Sokoine University of Agriculture
USD	United States dollar
VEO	Village Executive Officer
WISP	World Initiative for Sustainable Pastoralism
WMA	Wildlife Management Area

WTO	World Tourism Organisation

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of the Study

Land is a natural resource with a variety of uses. It is used for agriculture, conservation, livestock grazing and settlements. A study by Burnsilver *et al.* (2003) on landscape-level heterogeneity in average green vegetation, biomass production over time using Ground Information System (GIS) and remote sensing n found that some areas of the landscape are more productive than others despite the variation occurring over time. There are many important system qualities that can be concentrated in particular areas of landscape. These include not only woody cover for shelter (Coughenour, 2009) but more importantly vegetation productivity, soils with high mineral content, soil texture, high quality forage for grazing or browsing and permanent water (Lynn, 2010a) . These qualities often drive movement patterns of wild animals, pastoralists and cultivators. When and where the desirable landscape attributes for one type of land use overlap with the desirable attributes of another, then conflicts can occur. Pastoralism, agriculture, and wildlife conservation are among the competing land uses.

1.1.1 Pastoralism

Pastoralism, according to FAO (2001) is a land use system which not only provides livelihoods to many, but also provides options for the sustainable use of resources in dry lands where other alternatives are neither cost effective nor ecologically sustainable. Hesse and Mac Gregory (2006) define it as a livelihood system regulated by ecology and complex modes of social, political and economic organisation with a risk-spreading strategy well-adapted to dry land environments. Moreover, the Secretariat of the Convention on Biological Diversity (SCBD) (2010), on the other hand, defines

pastoralism as the use of extensive grazing rangelands for livestock production and an important economic and cultural way of life for between 100 and 200 million people throughout the world ,. As a reminder, Ellis and Swift initially (1988) defined rangelands as vast natural landscapes in the form of grasslands, scrublands, woodlands, wetlands, and deserts. It encompasses vegetation formations that range from grassland with or without shrubs, bush, woodland, to savannas.

FAO (2001) highlights that pastoral societies account for 66% of total African continental land area. Additionally, pastoralism is practiced in dry and sub-humid lands in the Middle East, South and East Asia, South America and Europe (FAO, 2001). Despite the widespread opinion that pastoralism is not an economically viable livelihood activity, it contributes significantly to the Gross Domestic Product (GDP) of many contries. For instance, livestock sector represents 20% to 25% of agricultural GDP across Africa; it is one of the major agricultural activities in East Africa whereby it provides about 50%, 30% and 19% of the Agricultural GDP in Kenya, Tanzania and Uganda respectively (Hesse and Mac Gregory, 2006).

In Tanzania, out of the sub sector's contribution to GDP, about 40% originates from beef production, 30% from milk production and another 30% from poultry and small stock production (Madulu and Liwenga, 2004). However, national accounts are incomplete as some of economic contributions from pastoralism are not captured. A vivid example is the *nyama choma* (grilled meat) industry in Tanzania, which is annually worth USD 2.2 million (Letara, 2006).

Apart from East African contries agricultural GDPs, pastoralism has a significant contribution to the overall GDP of many developing countries. A good example is 8.5% for the Uganda's GDP, 9% for the Ethiopia's and 10% for the Mali's. These proportions are lower than the estimated contribution of pastoralism to the economy of Central Asian countries like Kyrgyzstan, where pastoralism represents about 20% of its GDP (WISP, 2008). In sub-Saharan Africa about 16% of human population relies on pastoralism, and in some countries such as Somalia and Mauritania, pastoralists represent the majority of the population (SCBD, 2010).

Regardless of its all contributions to the national economy, pastoralism still faces a number of challenges such as loss of livestock due to robbery and disease outbreaks, increased climatic shocks, policies which hinder mobility of livestock and lack of other viable livelihood options (Blench, 2001). Other challenges include unreliable water supplies, poor leadership, depressed local economies and widespread poverty. In the process pastoralists become marginalised, and gradually cease to occupy legitimate space in the institutional dynamics of local communities(WISP, 2008).

1.1.2 Wildlife conservation

The goal of wildlife conservation is to ensure that nature exists for future generations to enjoy and recognise the importance of wildlife and wilderness (Wallace, 2003). According to URT (2007), wildlife refers to species of the wild and indigenous animals and plants and their habitats and ecosystems , as well as those exotic species introduced toand established in the wild, and that are temporarily maintained in captivity or have become established in the wild.However, conservation denotes the act of protecting and sustainably utilising biodiversity (URT, 2007). Basing on the above two definitions, wildlife conservation is the practice in which people attempt to protect plant and animal

species, along with their habitats. It is an important form of land use that generates a substantial amount of revenue and foreign exchange (URT, 2007). Different protected areas are established for the purpose of conserving wildlife. Tanzania protected area network covers 24% of the total land area. This percent includes national parks, Ngorongoro Conservation Area (NCA), game reserves and game controlled areas (URT, 2007).

In order to make wildlife conservation a form of land use that can compete with other land uses, sustainable utilisation of wildlife is practiced. The major forms of wildlife utilisation in Tanzania include game viewing, tourist hunting, resident hunting, ranching and farming. These forms of utilisation are the basis of the country's social and economic development through the provision of employment, generation of foreign currency and market for local commodities.

Tourism is a powerful vehicle for economic growth and job creation all over the world. It is directly and indirectly responsible for 8.8% of world's job (258 million); 9.1% of world's GDP (US$ 6 trillion); 4.8% of world's export (US$ 1.1 trillion); and 4.5% of world's investment (US$ 652 billion) (World Bank, 2013). Tanzania is accounting for nearly 10% of national output (GDP) and representing 40% of total foreign exchange earnings from the export of goods and services. The earning from tourism has been increasing tremendouslyfrom US $ 746.0 million in 2004 to US $ 1 288.7 million in 2008. Moreover, according to the United Republic of Tanzania (URT) (2010) the industry supported around 200 000 direct jobs and targeted one million tourists and revenue amounting to US $1.4 billion by 2010.

Despite its significant contribution to the national economy, wildlife conservation faces a number of challenges including human population growth, destruction of wildlife habitats, human–wildlife conflicts, loss of biological diversity, land use changes, and illegal off-take, just to mention a few (URT, 2007). Most of the these challenges are human induced and increase with the human population. When the human population increases, it goes hand in hand with human activities such as overgrazing, deforestation, bush fires, mining, urbanisation and cultivation which are the principal causes of habitat destruction (Mwalyosi, 1992a; Kideghesho *et al.,* 2006; Lynn, 2010b). These activities are a result of human struggle to adopt new environment, and hence development of livelihood strategies.

1.1.3 Livelihood strategies

Livelihood comprises the capabilities, assets and activities required for a means of living (Chambers and Conway, 1992). Livelihood strategies are composed of the various activities undertaken by the household to generate a living. Devereaux (1993) and Davies (1996) have divided the strategies into survival, coping, adaptive and accumulative strategies. While accumulative strategies increase consumption outcomes and stocks of assets in response to opportunities, adaptive strategies seek to spread the risk of consumption failure in response to anticipated adverse trends.

Again, while coping strategies absorb the impact of an adverse shock by drawing down assets and reducing consumption, survival strategies result to reduced consumption drastically and household assets are often extensively irreversibly eroded. Livelihood approaches lay emphasis on the capabilities of people and associate poverty with the inability of people to develop their potential and are deemed successful when the

quantity, quality and mix of assets available to a household (or individual) are sufficient to withstand adverse events without compromising future survival.

Livelihood must take into account the outcomes of the interaction of assets and activities, and the factors that govern the access. Desired outcomes might include increase in income, food and water security, health, physical security, independence, knowledge, and status or time – the inverse of various poverty dimensions (Ellis, 2000). The outcomes, in turn, will usually have a direct effect on the asset base and activities. So, in this regard, there is a cyclical relationship between assets, activities and consumption outcomes. Thus, when an area is composed of people with different land practices, each group will develop strategies to cope with the prevailing situation for survival that will be facing challenges such as availability of resources and competition that may, in one way or another, have detrimental effects to the wildlife species and their habitats

1.2 Problem Statement and Justification

Traditionally livestock population in Rufiji District has been small (Mwilawa, 2003). Recently, the number of livestock has been increased after the introduction of pastoralism to the District since the year 2007/2008. The arrival of pastoralists in the district has been welcomed in some places, while in others it has been a source of tension and conflict between the indigenous communities and pastoralists (Mwilawa, 2003).

The introduction of pastoralists to the District came after the implementation of the 2007 Eviction Order by the government of Tanzania (Mbwile *et al.*, 2012). The Order came after the realisation that there were overgrazing in the wetland due to a large number of livestock in Ihefu wetland, causing degradation which in turn led to the diminished stream flow in Ruaha River (Mbwile *et al.*, 2012). This negatively affected the hydroelectric

power generation along the Ruaha River (decreased by 50%), rice irrigation projects and Usangu Game Reserve (now annexed to Ruaha National Park) (Niboye, 2010; Mbwile *et al.*, 2012).

Studies on interaction between pastoralists, farmers and conservation have been conducted in several parts of Tanzania. These include Immigrants and their impacts on land management in Usangu Plans (Mbonile and Mwamfupe, 1997), Resource Use Conflicts in Usangu Plans, Mbarali District, Tanzania (Mattee and Shem, 2006); and Farmer-Herder Conflict in Kilosa District (Benjaminsen *et al,* 2009). However, none of these studies was done in Rufiji and particularly on assessement of effects of pastoralism on wildlife conservation and local livelihoods. Therefore, this study aims at filling this gap of knowledge by focusing on effects of the introduction of pastoralism on wildlife conservation and local livelihoods at Utete West and Kilimani West villages in Rufiji District, Tanzania.

This study is important as it generates useful information for planners and policy makers on environmental conservation and livestock development. The information from the study is also important for taking important measures towards the coexistence of pastoralists and farmers as well as pastoralists and wildlife. This will ensure combating conflicts among different groups and attaining sustainable development for farmers and pastoralists in the country.

1.3 Objectives of the Study

1.3.1 General objective

The main objective of this study was to assess the effects of introducing pastoralism on wildlife conservation and local livelihoods in Rufiji District.

1.3.2 Specific objectives

The study specifically intended to:

i. Identify the emerging conflicts caused by introduction of pastoralism,

ii. Assess the existing and potential effects of pastoralism on wildlife habitats and population, and

iii. Determine the effects of pastoralism on livelihoods.

1.4 Research Questions

Based on the above specific objectives, following questions guided the research:

i. What were the emerging conflicts in the study area as a result of the introduction of pastoralism?

ii. What were the effects of pastoralism on wildlife habitat and population?

iii. Which activities, other than livestock grazing, had emerged as a result of the introduction of pastoralism?

iv. Were there positive effects associated with these activities on conservation or livelihood?

v. How did local communities suffer or benefit from the introduced pastoralism?

CHAPTER TWO

2.0 LITERATURE RIVIEW

2.1 Human-Wildlife Conflict

Competition for resources such as grazing and water between livestock and wildlife is a major concern among pastoralists in many areas of East Africa (Mattee and Shem, 2006). Cline *et al*, (2007) assert that human-wildlife conflicts can be viewed in two contexts: 1) Wildlife behaviour conflicting with human goals (e.g. safety, satisfaction, property), and 2) human behaviour conflicting with wildlife safety and well-being (e.g. harassment, noise, direct mortality due to hunting, and destruction of habitat). Besides, the conflicts occur when wildlife requirements overlap with those of human population creating costs to both people and wildlife. For instance, livestock depredation, disease transmission to livestock and crop damage by wildlife animals have been viewed as among important sources of human-wildlife conflicts (IUCN, 2003; FAO, 2009). It is held further that human-wildlife conflicts have become more frequent and severe over recent decades as a result of human population growth which have increased competition for the available natural habitats and resources (FAO, 2009).

2.1.1 Livestock depredation

Livestock depredation has adverse effects on pastoralists – wildlife interaction as pastoralists have developed negative relationship with wildlife especially carnivores. Predation has been pointed out to cause catastrophic loss of livestock, causing economic loss and hence threatening livelihoods of livestock owners. For instance Mishra (1997) reported an economic loss of USD 15418 due to predation among the Indian-trans Himalayan communities equivalent to USD 128 loss per family per year. Likewise, Petterson *et al.* (2004) estimated livestock depredation to represent 2.6% of the herd's

economic value in Kenya ranches which incurred a loss of USD 8749 per annum. Recent studies have shown that predation has been escalating due to decline in populations of prey species of large predators, hence attracting carnivores towards domestic livestock (FAO, 2009).

Large carnivores have been noted as the principle culprits on depredation of livestock. Petterson *et al.* (2004) found that Lions (*Panthera leo*) were responsible for about (85.9%) of the attacks, followed by cheetahs (*Acynonix jubatus*), hyenas (*Crocuta crocuta*) and other small carnivores in Tsavo East National Park in Kenya. Lions and hyenas attacked mainly cattle, whereas cheetahs took smaller sheep and goats. More studies have found that not only mammalian carnivores are involved but also another group of wildlife species. For instance, Butler (2000) reported that livestock were killed by baboons, lions and leopards contributing respectively to (52%), (34%) and (12%) of the kills in Zimbabwe.

Additionally, Sillero-zubiri and Lurenson (2001) reported that crocodile killed 53 heads of cattle and 43 injuries in a single year in Jukumu Wildlife Management Area in Tanzania. Moreover, Ogada and Ogada (2004) reported that the lion was the most (35%) wildlife species responsible for killing livestock in Samburu Heartland in Nigeria. Other species were leopard (35%), hyena (18%), baboon (4%), elephant (3%), buffalo (2%), Wild dog (2%) and cheetah (1%). Due to such losses and sometimes perceived dangers, pastoralists have a long history of intolerance against large carnivores. Conflicts caused by depredation leads to retaliatory killing of large carnivores and which results in threat of loss to some species such as lions (*Panthera leo*), leopards (*Panthera pardus*) and wild dogs (*Lycoan pictus*). Today illegal persecution of predators including poisoning, shooting and trapping perhaps is still the greatest threat to these species (Muruthi, 2005).

Killing of wild animals in retaliation for human - wildlife conflict is a common reaction even though the identification of real culprits is seldom possible. This is particularly true for predators and other species. In northern Kenya, for instance, the number of predators killed by farmers has been reported to be positively correlated with the number of livestock killed by lions, hyenas and leopards.

However, Wanjau (2002) reported more crocodiles were killed in response to predatory killing they caused to people and livestock even above the number of deaths caused. In addition, Kenya pastoralists poisoned many lions in Amboseli Reserve in 1990 and speared 27 of 40 lions in Nairobi National Park in 2003 (Ogada *et al.*, 2003). Lions were also poisoned by pastoralists in Chad and in several districts of Tanzania (Packer *et al.,2006*). In Namibia over a 20 year period, on average about 60 lions per year were killed outside Etosha National Park by communal or commercial farmers (Government of Namibia, 2007). Actually, the response of human - wildlife conflict with predators normally involves not only the killing or removal of individual predators but also the reduction of the whole population .

2.1.2 Transmission of diseases

Among the costs to any community of integrating wildlife and livestock in the same habitat is disease transmission between livestock and wildlife and viseversa (McCabe *et al.*, 1992). Rabies are said to be important diseases known to be transmitted from wildlife to livestock or possibly to humans.It has been held further that wild ungulates are potentially important in the spread of several viral diseases of concern to livestock producers (Bengis *et al.*, 2002). The authors add that the pivotal role played by African buffalo as a maintenance host of Foot and Mouth Disease was identified in the 1960s, it is now fairly accepted that *Theileria parva* is a cattle –adapted variant of *Theilaria parva*

lawrenci borne by Buffalo. Infection with this organism, which is silent in buffalo, causes very high mortality rates in cattle, making farming of cattle in the presence of both buffalo and a suitable vector a hazardous undertaking (Bengis *et al.*, 2002). According to FAO (2005), 228 cattle died in 2005 from Theileriosis as a result of contacting the diseases from buffalo in Gaza Province Mozambique. In short, most diseases affect livestock to a much greater extent than wildlife (FAO, 2005).

Furthermore, other different wild animal species have been portrayed for playing potential roles in the maintenance and spread of diseases viruses. These include wildebeest for Alcelaphine herpesvirus-1, sylvatic rabies diagnosed in 33 carnivore and 23 herbivore species, endemic rabies diagnosed in yellow mongoose, bat-eared fox and jackals (Bengis *et al.*, 2002). Scavengers and predators such as spotted hyenas, jackals, lions and vultures play a big role in dissemination of pathogens by opening up and dismembering, and dispersal of infected carcasses notably anthrax the spores of which they ingest together with the tissue of the carcasses and then widely disseminate in their feaces (Hugh-jones and de Vos, 2002).

There have been exceptional cases where livestock has also been reported to transmit diseases to wildlife and causing effects on wildlife populations. For example, canine distemper virus was reported to have been introduced into the African continent by domestic dogs in the past; it has apparently crossed the species barrier in the Serengeti ecosystem causing significant mortality of lions. It is estimated that (30%) of the Serengeti lions died in the outbreak and the major decline of wild dog population in this ecosystem may in part be also attributed to canine distemper (Bengis *et al.*, 2002). It was later noted that, an outbreak of rinderpest in Kenya resulted in its transmission to wild

grazers with death rates, in the mid-1990s reaching 60% of buffalo and 90% of kudu in some areas (Osofsky *et al.*, 2005).

2.1.3 Crop damage by wildlife animals

Crop damage is the most prevalent form of human-wildlife conflict across the African continent (FAO, 2009). Previously, it was noted that this type of conflicts arises when the activities of wild animals coincide with those of people (Treves, 2007). A wide variety of vertebrates' conflict with farming activities in Africa is through raiding crops. These include birds, rodents, primates, antelopes, buffaloes, hippopotamuses, bush pigs and elephants. While elephants and buffaloes eat all food crops, monkeys and baboons eat maize and fruits; bush pigs love potatoes and ground nuts; and birds eat the seeds from sorghum (FAO, 2009; Parker, 2013). The conflict arise because when animals damage farmers' food crops upon which they rely for their livelihoods, they make harder for the farmers to feed their families (Parker, 2013).

2.1.4 Pastoralists - farmers conflicts

Conflicts between pastoralists and farmers are common in Tanzania; the drivers of conflicts are complex and many (Worldbank,1994),. However, increasing poverty due to reduced mobility, lack of alternative livelihoods, competing rights, entitlements and poor provision of basic needs, and increasing human and livestock populations all aggravate conflicts. For example, surveys by Shem *et al.* (2005) show that the existing number of cattle in Tanzania has already surpassed the normal carrying capacity of most areas. Besides, an increasing number of land conflicts are now occurring among different interest groups and various types of land use (Ojalammi, 2006). Moreover, the growth of livestock population has led to increased movement of large herds of livestock to the

areas which traditionally had few livestock, such as Mbeya, Iringa, Morogoro, Rukwa and Coast Region, creating serious land use conflicts (Sendalo, 2009).

The fundamental problem is that pastoralists require access to relatively large surface areas of land and tend to move their herds according to seasons, ecology and weather changes. Such activities almost inevitably mean that pastoralists and agriculturalists come into competition over land and water; it is this competition that serves as the base for their armed violence. The sequence of events that precipitates violence varies; it may be herders retaliating after farmers have seized some of their trespassing cattle or it might be farmers defending their land against encroachment. For instance, the bloodbath that happened in 2000 whereby more than 30 people were killed in Kilosa District was due to the conflicts between crop growers and pastoralists (Sendalo, 2009). In this, farmers claimed to be defending their land and crops against encroachment and crop raiding by pastoralists.

2.2 Effects of Livestock Grazing on Wildlife Habitat

According to McNaughton (1979), livestock and plants interact constantly within rangeland ecosystems. Heitschmidt *et al.* (1987) supplement that overgrazing pressure that accompanies an increase in the human and livestock populations causes a significant reduction in plant growth vigour, reproduction ability and poor establishment of valuable plants which leads, in turn, to a changed botanical composition and soil moisture properties. This may lead to a change in rangeland condition hence range degradation.

Rangeland degradation may be defined as the loss of utility or the reduction, loss or change of the features of rangeland ecosystem (Chrisholm and Dumsday, 1987). This includes, among other things, loss of topsoil, change in simple floral or fauna

composition or transition from a higher organic form to a lower one, and continues to decline in the productivity or biomass of the ecosystem. With this regard, there is a reduction in the density of highly preferred palatable plants (decreasers) for livestock grazing and increase in the unpalatable plant species (increasers) and invaders in the area.

While decreasers are desirable forage plants most liked and sought after by grazers, increasers are plants not readily consumed by livestock, or affected by other disturbances. The latter initially increase in abundance following disturbance; then they decline if disturbance continues. While invaders are largely weeds which appear and increase if excessive disturbance weakens and kills increasers and decreasers, are very resistant to disturbance and are usually less productive (Homewood, 2004).

As a reminder, rangelands are vast natural landscapes in the form of grasslands, scrublands, woodlands, wetlands, and deserts. It encompasses vegetation formations that range from grassland with or without shrubs, bush, woodland, to savannas (Ellis and Swift, 1988). The vegetation structure varies from 100% grass cover, through woodlands with up to 80% canopy cover to pastures within dense forest (Lambin *et al.*, 2001). For clarification, the term "rangeland" includes the spatial, temporal and ecological areascross which these habitats occur in arid and semi-arid lands, as well as the often transitory state of the systems themselves (Homewood, 2004).

A study by Chaich *et al.* (2005). found that overgrazing affects the soil moisture holding capacity that plays an important role in vegetation establishment and growth in rangelands Thus, when all these are affected, the habitat is destroyed and wildlife species lack areas for pasture and nutrients for effective reproduction. On the same line, they may

also be forced to shift or change their feeding patterns, and this may affect their physiological processes.

2.3 Effects of Pastoralism on Livelihoods

According to Mung'ong'o and Mwamfupe (2003), pastoralism plays important roles in peoples' economy and livelihoods such as the supply of meat and other animal products that people use for food and trade.

To illustrate, livestock sales are estimated to contribute over 60% of the total household income in selected pastoral communities in Kenya (Mizutani *et al.*, 2005) and up to (85%) of the Barabaig household income in northern Tanzania (Lane, 1996). Their sale can be delayed without affecting their inherent value to the pastoralists and importantly, it remains relatively simple to convert livestock into other valuable commodities either through barter or cash (Zaal, 1998; Muhereza, 2004). The risks of storing excess income in the herd are vulnerable to drought, disease and raiding. .

In addition to the direct subsistence value of goods produced through pastoral production, there is a substantial economic value of these goods at both formal and informal markets through the sale and export of meat, livestock hides and skins, and leather. Also, livestock assets perform a range of linked roles in pastoral life, a central one being a "store of value". However, pastoralists invest in their herds but do not use banks (Madulu and Liwenga, 2004) as livestock has been described as the best and often the only investment available to rural people without access to a formal reliable banking system (Muhereza, 2004).

Besides, pastoralism performs multiple roles in the pastoral economy that provide a range of benefits to individuals, families and the community as a whole as well as other groups. It further provides a persistent flow of returns to pastoralists through animal births, milk, blood, meat and fat, and opportunities to earn cash through traction and manure without reducing its value (Hesse and Mac Gregory, 2006). It helps raise agricultural productivity by providing manure, transport, seasonal labour, and technical knowledge. In agropastoral systems like those of the Karamajong, livestock manure is used to improve soil fertility in gardens and cultivated fields thereby improving crop yields (Hesse and Mac Gregory, 2006).

Pastoralism also provides employment in sales and exports of milk, livestock, hides, leather and inputs to supply chains involving informal or quasi-formal economic activities such as butchersand transporters.. Likewise, pastoralism provides inputs to a wide range of formal industries such as the meat and restaurant trade, and is very significant in the informal meat industry, including the *nyama choma* trade in East Africa. Letara (2006) identified over 600 *nyama choma* business employing 5600 people, with an estimated 25 000 dependents. It is estimated that (6.6%) of the population of Arusha receives crucial livelihood support through the meat supply chain for *nyama choma* from cattle.

Moreover, it has been statistically confirmed that the significant contribution pastoralism makes to agricultural GDP in many African economies such as Niger (84%), Sudan (80%), Senegal (78%), Kenya (50%), Ethiopia (34%), Mali (34%), and Mauritania (33%). (Rodriguez, 2008). For that matter, Hesse (2009) adds that the high productivity of livestock in pastoral systems not only supports millions of pastoralists but also contributes significantly to other sectors in national and regional economies in Africa. Pastoralism significantly contributes to the economy but unknown value is indirectly

contributed to other sectors and industries; agriculture being a key beneficiary of pastoralism (Hesse, 2009). In tourism, a vital input from pastoralism is the maintenance of grazing reserves, which provides critical dry season habitats for wildlife. As an illustration, Nelson (2009) estimated the protection of dry season grazing to contribute USD 8 million to Tanzania's northern circuit tourism industry.

CHAPTER THREE

3.0 METHODOLOGY

3.1 Study Area Selection and Criteria

This study was carried out in Rufiji District. The district is composed of four divisions namely; Mholo, Ikwiriri, Kibiti and Mkongo. Two villages of Kilimani West and Utete West from Utete and Ngorongo wards respectively found in Mkongo division were purposively selected. The selection criteria based on the presence of large number of pastoralists in the respective villages, implying that there is high interaction between pastoralists and farmers. The selection was done with the help of the District staffs from the Department of Livestock and Agriculture who knew them the best.

3.2 Study Area Description

3.2.1 Geographical location

The study, as said ealier, was conducted in two villages (Kiliman West and Utete West) in Rufiji District (Fig. 1). The district is located between 7°30′S to 8° 40′S and between 39° 50′ E to 39°40′ E along the East Coast of Tanzania. It covers an area of 133 339 km^2 of which (39.8%) for water bodies including the Indian ocean, Rufiji river and small dams. The remaining part of the District (60.2%) is the land which includes part of Selous Game.

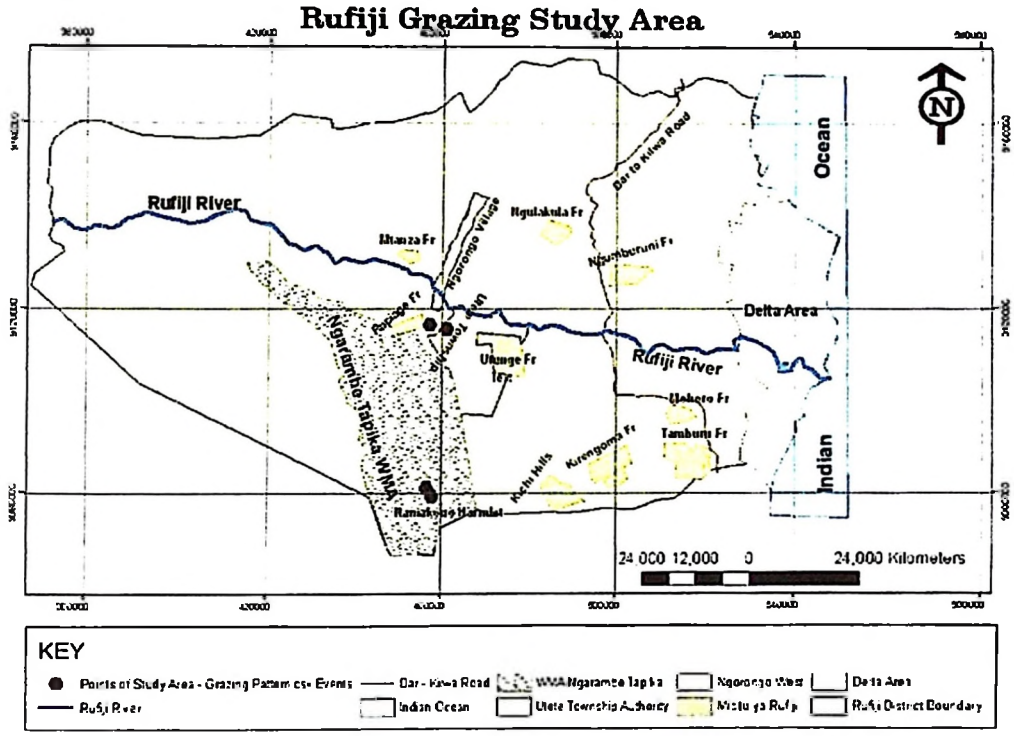


Figure 1: The study area

3.2.2 Soil and climate

Soils in Rufiji are characterised by blackish grey to grey clayey vertisols (black cotton soils) occurring along riverbanks and in pans away from the rivers. The District has two main rainy seasons with an annual rainfall ranging between 800 mm and 1200 mm. Short rains fall from October to December while long rains fall from March to June. The humidity is high throughout the year and reaches up to (90%) during the rainy seasons (Havnevik, 1993). The average annual temperature in the District ranges between 21°C and 23°C.

3.2.3 Vegetation and wildlife resources

The vegetation of the district is Miombo woodland, mangroves and coastal forests. The western part of the District is covered by Selous Game Reserve. The reserve is rich in wildlife species the majority being impalas (*Aeyceros melampus*), wildebeests

(*Cannochaetus taurinus*), hartebeests (*Alcelaphus buselaphus*), African Buffaloes (*Syncerus caffer*), giraffes (*Giraffa camelopardus*), Nile crocodiles (*Crocodylus niloticus*), hippopotamuses (*Hippopotamus amphibius*), African elephants (*Loxodonta africana*), lions (*Panthera leo*), hyenas (*Crucuta crucuta*), leopards (*Panthera pardus*), Wild dogs (*Lycoan pistols*) and monkeys (*Colobidae*).

3.2.4 Population size and ethnicity

According to the 2012 population census, Rufiji District has 217, 274 inhabitants of whom 52% are female and 48% male (URT, 2013). The District is home to several ethnic groups, the largest being the *Ndengereko* followed by *Matumbi, Nyagatwa, Ngindo, Pogoro*, and *Makonde*.

3.2.5 Economic activities

The main activity of the communities is agriculture supplemented by fishing, use of forest products, livestock keeping and petty business. According to Turpie (2000), the main crops grown in the area are rice (*Oryza sativa*), maize (*Zea mays*), Pigeon beans (*Cajanus cajan*), bananas (*Musa spp*), cassava (*Manihot esculenta*), and pigeon peas (*Cajanus cajan*). Others include mangoes (*Mangifera indica*), cashewnuts (*Anicardium ocidentale*), coconuts (*Cocos nucifera*), oranges (*Citrus sp*), pawpaws (*Carica papaya*) and sugar cane (*Saccharum officinarum*).

3.3 Research Design

Cross-sectional research design was employed in this study. This design was used as it is the most common design used in social sciences and was more useful in obtaining an overall picture. This allowed collection of information at one point at a time with regard to both the study population and the time of investigation.

3.4 Data Collection Methods

The data were collected in two phases. In phase one data collection methods were key informant interview while in phase two, the methods used were household interview. The interview was held to obtain pastoralists' and farmers' perceptions and views on different issues before and after the introduction of pastoralism. Also, vegetation survey was conducted to assess range conditions by comparing two similar areas; one with grazing activities and the other one without grazing activities to determine their differences in species richnes, abundance and diversity. Furthermore, direct observation was also used to witness issues taking place on the spot, which were helpful for this research. The detailed descriptions of the data collection are as follows:

3.4.1 Key Informants interview

A Key informant is any person who is willing to talk, accessible and have great depth of knowledge on issues to be discussed (Bernard, 1995; Katani, 1999). Key informants in this study were village government leaders, village natural resources committee leaders, pastoralists leaders, influential people (elder group), district officials including the District Game Officer (DGA), District Natural Resources Officer (DNRO), District Veterinary Officer (DVO) and District Agricultural and Livestock Officer (DALO). The interview was conducted to 30 people of different personalities and professions as stated above whereby a checklist (Appendix 1) was used. Key informants were helpful in obtaining experience pertaining to land use conflicts, resource use conflicts, economic contribution of livestock to the economy, livestock numbers, diseases and depredation incidences.

3.4.2 Questionnaire survey

The questionnaire contained open and closed-ended questions and were meant for farmers and pastoralists (Appendices 2 and 3). Both open and closed ended questions were employed to ensure that respondents have an opportunity to espress themselves freely hence give variety of information and also ensure that the informations needed are obtained as all categories are provided.

The questionnaires were first pretested to try-out and see how they worked and whether changes were necessary before the start of the actual survey . The goals for pretest were to determine the reactions of pastoralists and farmers to the questionnaire, estimate the time needed to complete the interview and ascertain whether the sequence of the questions solicited the desired information. After pretesting some of the questions for the interview were removed and some were added and rearranged to ensure that the sequence and nature of questions were good enough to provide desired information. Hence questionairre survey was useful in obtaining the positive and negative effects of pastoralism on livelihoods, emerging conflicts and the attitude of pastoralists towards different wildlife species.

3.4.3 Participant observation

Participant observation is distinguished by the fact that the observer themself form part of the situation they are studying (Kajembe, 1994). Therefore, the method was used to supplement information gathered by other methods. The method allowed to understand the real situation on the ground. In this study therefore, the method facilitated collection of data on resource use conflicts, significance of pastoralisim in the districts and village economy, relationship between pastoralists and residents and the emerging activities due to pastoralism.

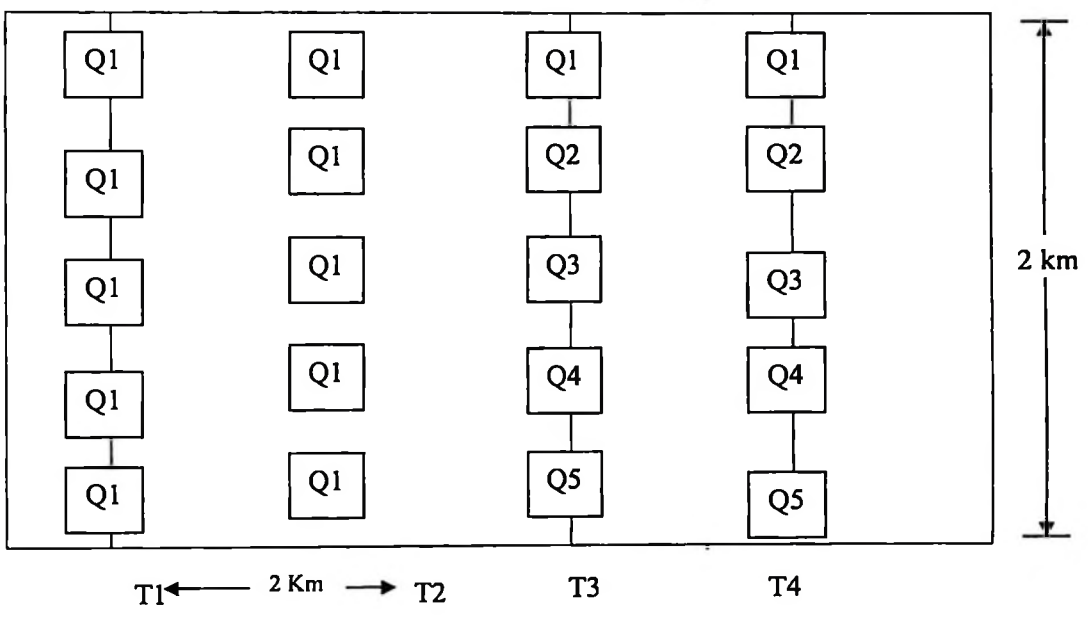
3.4.4 Vegetation survey and soil erosion assessment

Vegetation survey using line transects and quadrates was used to determine parameters of range condition such as species composition and diversity in the grazed and ungrazed areas in Utete West and Kilimani West villages. The rational to assess range parameters in these grazed and ungrazed areas was to determine the effect of grazing on the range condition. Eight transects which were 2 × 2 km were established in the two areas: four in the grazed areas and four in ungrazed areas. In each transect 5 quadrants of 1.5 x 1.5 m^2 were established (Fig. 2). Thus, a total of 20 quadrants in each of the selected areas were surveyed making a total of 40 quadrants in the whole study area. In each quadrant grass, herb and shrub species were identified and recorded. Likewise, soil erosion was determined by taking into consideration the presence of exposed bare soil, pedestals and pavements Appendix 6. Classification of grasses and other plants in the rangeland was based on the succession theory described by Dyksterhuis (1949). Accordingly, grass species were grouped into (i) highly desirable species (ii) desirable species (iii) less desirable species, annuals and perennials. The information was recorded in the range condition data form (Appendices 5).

3.4.5 Secondary data

Secondary data were collected by reviewing unpublished and published reports. These include unpublished reports from different sectors of the District such as the Wildlife, Agricultural and Livestock sectors. Other data were obtained from project reports including the Rufiji Environmental Management Programme (REMP) Project report on the range condition assessment for certain villages in Rufiji District.

Grazed area



Ungrazed area

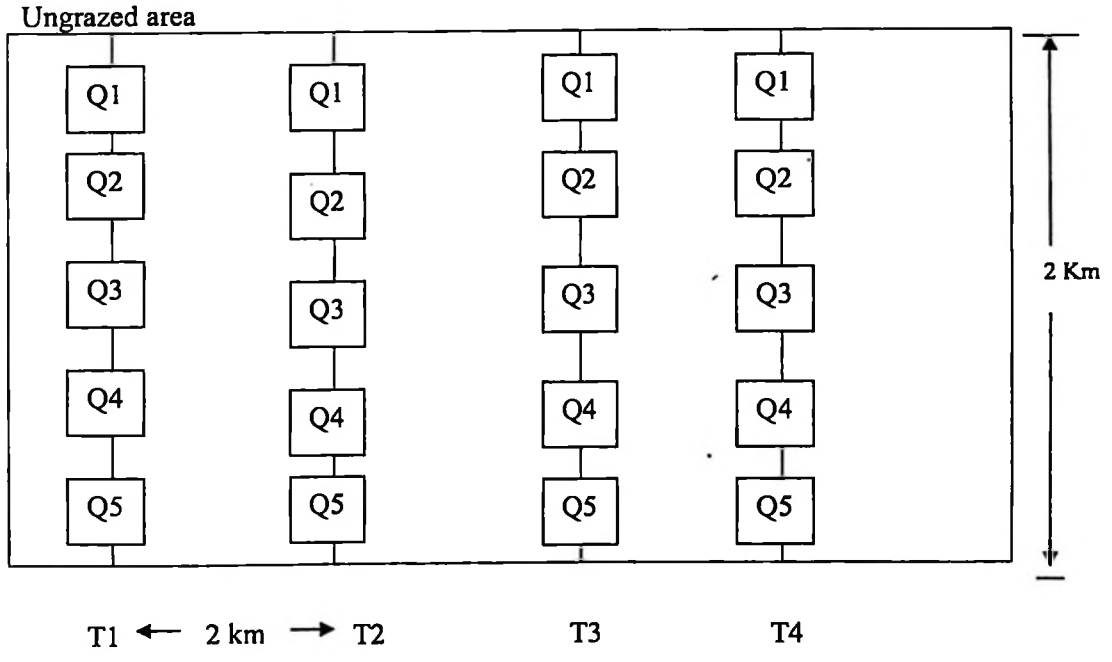


Figure 2: Plots layout of vegetation survey

Key: Q = Quatrant, T = Transect, Km = kilometre

3.5 Sampling and Sample Size

The simple random sampling procedure was used in selecting sampling units where cards containing the names of the household heads were randomly picked to determine the households that were interviewed. This technique allowed selection of a sample of the entire population in such a way that every member had an equal chance of being selected. The village population was the sampling frame, while households were the sampling unit. The sampling intensity ranged from (5%) to (9%). In connection to this, the sampling intensity of at least (5%) has been recommended to be considered as a reasonable representative sample size for particular population under study (Boyd, Westfall and Staach, 1981). The sample size was therefore 86 and 63 for Utete West and Kilimani West respectively (Table 1).

Table 1: Village population, sample size and sampling intensity

S/N	Village	Population	No of households	Sample size	Sampling intensity (%)
1	Utete West	5930	1753	86	5
2	Kilimani West	4253	700	63	9
Total		10183	2453	149	14

3.6 Data Analysis

3.6.1 Data from key informants interview and questionnaire survey

The qualitative data from the discussion with key informants was analysed by content analysis techniques. Data obtained through questionnaire survey were coded and, where applicable, those from open-ended responses were categorised and transformed to allow further analysis. Descriptive statistics such as frequency, percentage and cross-tabulation were used to summarize the data. Statistical Package for Social Sciences (SPSS version 17) and MS Excel were used as a tool for facilitating analysis of the questionnaire survey data.

3.6.2 Vegetation data

The vegetation data analysis involved determination of plant species richness, abundance, diversity and density (stem per hectare).

3.6.2.1 Plant species richness and abundance

Identified individual plant species were arranged alphabetically in spreadsheet and thereafter the list and number of species were obtained. The species abundance was determined by their relative density. Relative abundance was computed by using the following formula:

RD = 100 × number of individuals of the species/ number of individuals of all species.....(1)

Where: RD is a relative density

3.6.2.2 Grass species diversity

Shannon Wienner index (H') was used to determine species diversity of grasses in the forest. The index can be described mathematically as follows:

$$H' = -\sum_{i=1}^{S} pi \, Ln \, pi \quad \ldots\ldots (2)$$

Where;

H = Shannon–Wiener index.

P_i = the proportion of all individuals in the sample that belong to species i.

S = total number of plant species.

Ln = $\log_e$ = natural logarithm of pi (e = 2.71828).

$$P_i = \frac{n_i}{N},$$

Where,

n_i = total number of individuals in the i^{th} species

N = total number of individuals of all species

The Shannon Wiener index assumes that all the species from the community are included in the samples. The value usually lies between 1.5 and 3.5 although it can occasionally exceed 4.5 (Kent and Coker, 1992).

3.6.2.3 Plant density

Plant density was computed by using the following formula:

$$N = \sum \frac{n_i}{a} \quad \text{.....(3)}$$

Where:

N = Number of plants per hectare

n_i = number of trees counted,

a = plot area in ha.

Non-parametric (Mann-Whitney) test was used to test differences in plant species richness, abundance, diversity and density (stems per hectare) between the ungrazed and the livestock grazing areas.

3.7 Study Limitations

Several limitations were encountered during the study. These included, among others, the following;

3.7.1 Poor accessibility

Some areas were not accessible due to the geographical location, landforms, poor infrastructure or the climatic condition especially when it was raining. With this regard, other transport means including motorcycles and bicycles were sometimes used.

3.7.2 Poor Cooperation from the pastoralists

Sometimes it was difficult to get information from the pastoralists as most of them were hesitating to give information to people they did not know for fear oflivestock theft and expel from the area due to conflicts with resident farmers. This happened to most pastoralists mentioning less number of their livestock. This limitation was overcome by ensuring that in every household interviewed the head of household was asked to talk on mobile phone with the pastoralists' leaders to explain the visit before interviews.

3.7.3 Inadequate research fund

This was a challenge as the sponsor provided only 75% of the total budget. Thus, the researcher had to look for an additional fund from other sources to ensure that the research acquired sufficient data that would answer the research questions and meet research objectives.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Emerging Conflicts due to the Introduction of Pastoralism

In both villages, most of the respondents (81.2%), that is farmers (96.3%) and pastoralists (33.3%) in Kilimani and farmers (15.2%) and pastoralists (17.6%) in Utete) ranked conflict between farmers and pastoralists as the most emerging conflict in the study area. This was followed by the conflict between pastoralists and wildlife (49.15%), conflicts among pastoralists of different ethinic groups (41.2%) and between farmers and wildlife (22.3%) (Table 2).

Table 2: Farmers (n=114) and pastoralists (n=35)view on emerging conflicts as a result of the introduction of Pastoralism at Kilimani West and Utete West villages, Rufiji Districts

Imaging conflicts	% of respondents				Average Total %
	Farmers		Pastoralist		
	Kilimani	Utete	Kilimani	Utete	
Conflicts between farmers and pastoralists	96.3	15.2	33.3	17.6	81.2
Conflict between pastoralists and Conservation	0.0	43.9	25	29.4	49.2
Conflict among pastoralists of different ethnic group	0.0	0.0	41.7	41.7	41.2
Conflict between farmers and wildlife	3.7	40.9	0.0	0.0	22.3
Total	100	100	100	100	

Respondents of Utete West and Kilimani West had different views regarding the emerging conflicts. For instance, farmers (96.3%) and pastoralists (33.3%) in Kilimani West ranked higher conflicts between farmers and pastoralists compared to farmers

(15.6%) and pastoralists (17.6%) in Utete West respectively. This has been caused by the fact that at Kilimani West pastoralists bomas are closer to farmers' fields compared to Utetete, and hence crop raiding becomes inevitable. Furthermore, at Kilimani areas allocated to pastoralists for pasture do not have a reliable water source for the pastoralists to take their cattle to drink (Personal Observation). Therefore, when pastoralists take their cattle to drink some water at the Rufiji River have to cross some farm fields which results to crop confiscation; hence conflicts arise. This is justified by three different fights that occurred at Kilimani between pastoralists and farmers from 2007 to 2012 where two farmers and one pastoralist were badly injured (Sasile, J. personal communication, 2012). Thus, high conflicts between farmers and pastoralists at Kilimani West might be attributed by the fact that land use plan was undertaken before the arrival of the pastoralists and did not therefore take on board the interests, realities and concerns of the pastoral communities.

4.2 Causes of Conflicts between Farmers and Pastoralists

Most of farmers, (96%) and (71.2%), at Kilimani West and Utete West villages respectively indicated that conflicts between farmers and pastoralists were caused by crop damage by livestock (Fig.3). On the other hand, few pastoralists (17%) in Utete West village pointed out that livestock demage was a source of conflict between them and farmers (Fig. 4). Through discussion with the DGO, it was noted that, both smallholder farmers and pastoralists, especially the Sukuma who were mostly agropastoralists, cultivated different crops (such as maize, rice, millet, banana, groundnuts, cashew nuts, sim sim, potatoes and cassava). It was informed further that crop damage by livestock mostly occurred to farmers' fields. This is an indication that crop damage by livestock occurred when pastoralists deliberately grazed livestock on farms due to shortage of pasture especially during the dry season (Plate 1).

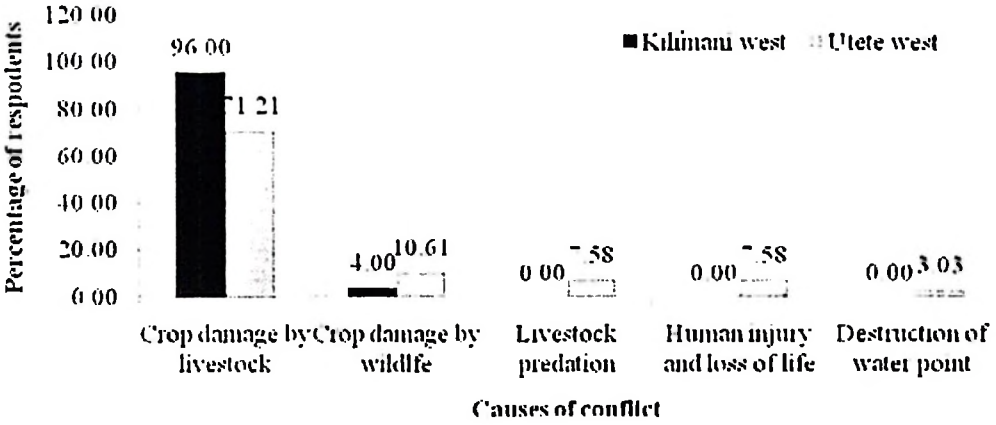


Figure 3: Farmers' views on the causes of conflicts

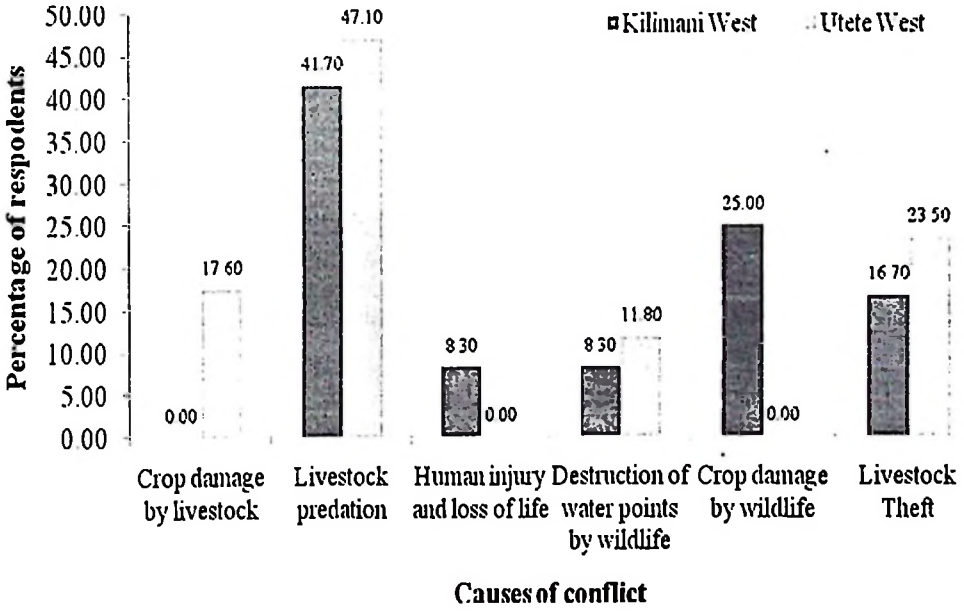


Figure 4: Pastoralists views on the causes of conflicts

Plate 1: Livestock grazing inside a cashew nut farm at Kilimani West village

In other studies, (such as Othiambo, 2008; Benjaminsen *et al*, 2009; Christopher and Scot, 2010) a contest over scarce resources was a cause of farmers-pastoralists conflicts. However, conflicts between farmers and pastoralists in this study has been attributed by some pastoralists who stay in areas that were not set aside for grazing (Appendix 4). In that case, these patoralists are so close to farm fields or areas that were set aside for grazing lack some valuable pastoralists' needs including water and good pastures. As a result, during the dry season when there is a shortage of grasses and water, pastoralists cross farm fields looking for good pastures and water from one locality to another leading to crop raids.

4.2.1 Conflicts between pastoralists and wildlife protected areas

This conflict occurs in the Wildlife Management Areas (WMAs) of Ngarambe Tapika and Juhiwangumwa and the Selous Game Reserve. It is a new type of conflict in Rufiji which was not there before the introduction of pastoralists. Most of the respondents (47.1% and 41.7% in Utete West and Kimani West respectively) pointed out that livestock depredation was the source of conflict between conservation and pastoralism (Fig. 4). As a result, a total of 437 different livestock species (cattle, sheep, goat, chicken and donkeys) from 2006 to 2011 were killed where a larger number (144 in Utete West and 129 in Kilimani West) were chickens (Fig.5). Wild animals responsible for predation of livestock in the villages were crocodiles, jackals, leopards, pythons, leopards, hyenas, bustards, lions and wild dogs from Selous Game Reserve, WMAs and Rufiji River.

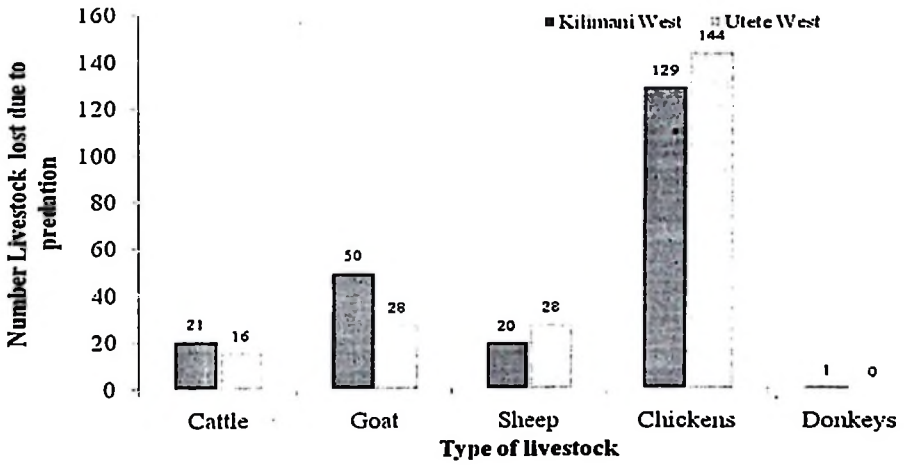


Figure 5: Number of livestock lost through predation from 2006 – 2011

Similarly, different studies (such as Holmern *et al.*,2007; Petterson *et al.*,2004; Ogada and Ogada, 2004) have revealed predation as the main source of conflicts between pastoralism and conservation, and carnivores are the main curprits.For example lions (*Panthera leo*) were responsible for about 85.9% of the attacks followed by cheetahs (*Acynonix jubatus*), hyenas (*Crocuta crocuta*) and other small carnivores.

The tendency of predators to invade and kill livestock might be attributed by the fact that, livestock are easier and more accessible prey than the wild animal prey, which have shifted as a result of grazing competition and human settlement pressure that has contributed to loss of wildlife habitat in Kilimani West and Utete West villages. A similar finding was reported by Campbell and Borner (1995) where Roan antelopes (*Hoppotragus equines*) were thought to be locally extinct in many areas of the ecosystem due to loss of their *Combretum* dominated habitats, which in turn cause the predators to lack their natural food. Thus, due to the presence of livestock, predators seem to find an alternative and easier prey, and hence use them as their most dependable food. This, according to Mishra (1997), contributes to the high loss of livestock which, in turn, affects negatively pastoralists' economy.

Livestock depredation has negative implication in wilidlife conservation as it results in the tendency of pastoralists killing wild animals especially predators claiming to be seeking defence or retaliation which results in threat to loss of some species. Today illegal persecution of predators including poisoning, shooting and trapping perhaps is still the greatest threat to these species (Muruthi, 2005). Studies by Wanjau (2002), Ogada *et al.* (2003), and Packer *et al.* (2006) have revealed that killing of wild animals in retaliation is a common reaction even though the identification of real culprits are seldom possible and sometimes are killed in response to predatory killing they caused to people and livestock even above the number of death they caused.

Similarly, in Rufiji the killing of wild animals especially predators by pastoralists who claim to seek defense and retaliation was observed. For instance, from 2006 to 2011 reported cases show that 18 lions, 4 leopards, 20 hyenas and 9 crocodiles were killed for different cases including livestock depredation (DGO personal communication, 2012).

Since research by Ogada *et al.* (2003) proved that there was a positive correlation between the number of cattle, sheep and goats killed to the number of lions, leopards and hyenas killed due to the retaliatory killing in Serengeti. This is not a good sign to conservation as it poses threat to wildlife population of some species and therefore strong measures have to be deployed to control it.

4.2.2 Causes of conflicts among pastoralists

Pastoralists (23.5 % and 16.7%) in Utete West and Kilimani West villages (Fig. 4) stated that, livestock theft was the source of conflict between pastoralists of different ethnic groups. Through discussion two Village Executive Officers (VEOs), it was noted that, the introduction of pastoralism in the two villages attracted three pastoralist ethnic groups; namely Sukuma, Barabaaig and Maasai. It was also found that livestock theft was intense between the Sukuma and barabaig. It was learnt further that the Sukuma had large herds of cattle compared to the Barabaig, but the latter confiscated the Sukuma's cattle due to jelousy.

According to Irunga (2001), while livestock plays a major role in the livelihoods of members of the Karamajong cluster, they also form the bone of contention and a major source of conflict in the region, causing fear, hatred and animosity, and often resulting in the destruction of life and property. Similarly, to Rufiji this mostly resulted to confrontations between the Sukuma and Barabaig which led to segregations as the Sukuma did not prefer to stay closer to the Barabaig rather to their fellow tribesmen.

However, the main cause of conflicts among pastoralists in Kilimani and Utete was different from other main causes in other parts of Tanzania. For instance, Odhiambo, (2008) found that conflicts among pastoralists in Ngorongoro District had been caused by

competition for access to land and pastures. Land use competition derives from the fact that the same land and natural resources that are critical to the livelihoods for one pastoralist group are also needed to support other competing users. This might be caused by the fact that in Ngorongoro pastoralist are of the same tribe, that is, Maasai or are of the tribes with similar ways of living. Nevertheless, Barabaig and Sukuma are different groups with few things in common; therefore, one group feels stronger than the other.

4.3 Potential Effects of Pastoralism on Wildlife Habitats and Population

4.3.1 Plant species richness and dominance

A total of 1426 plants were recorded of which, 728 were in grazed and 698 in ungrazed areas. The plants were of 32 different species and forms including shrubs and herbs. While in grazed areas there were 15 different species of grasses and shrubs, in ungrazed areas there were 17 grasses and shrubs (Table 3).

Table 3: Species dominance by relative density in grazed (n=728) and ungrazed (n=698) areas

UNGRAZED AREA (WMA)			GRAZED AREA (Kilimani and Utete West)		
Species composition	Relative density	Desi-Rability	Species composition	Relative density	Desirability
Paspalum spp	27.46	HD	*Panicum spp*	21.13	LD
Cynodon spp	13.73	HD	*Sporoborus africanus*	15.55	UD
Bracharia spp	10.07	HD	*Cyperus spp*	13.02	UD
Velvet spp	8.70	HD	*Paspalum spp*	12.32	HD
Cymbopogon spp	7.55	LD	*Bothriochloa spp*	11.97	LD
Sporoborus spp	5.72	UD	*Digitalia spp*	10.21	HD
Cyperus spp	5.49	UD	*Stylosanthes spp*	3.87	HD
Chloris spp	4.58	HD	*Heteropogomy spp*	3.52	LD
Erogratis spp	3.66	HD	*Urochloa politus*	3.52	HD
Commerhina benghelensis	2.76	UD	*Cyparum rotundus*	1.76	UD
Digitalia spp	2.52	HD	*Bracharia spp*	1.41	HD
Stylosanthes spp	2.29	HD	*Cida spp*	0.35	UD
Heteropogomy spp	2.29	LD	*Unknown 2*	0.35	HD
Uknown1	1.37		*Unknown 3*	0.35	HD
Pennisetum spp	1.37	LD			
Setaria spp	0.069	HD			

Key: HD = Highly Desirable, LD = Less Desirable, UD = Undesirable

It was also found that the highly desirable species such as *Pasparum spp*, *Cynodon spp*, *Bracharia spp* and *Velvet spp* were the most abundant in livestock ungrazed areas while the least desirable and undesirable species including *Panicum* spp, *Sporoborus spp*, *Cyperus spp* and *Bothriochloa spp* were abundant in grazed areas (Appendix 7).

Furthermore, the number of highly desirable plants in the livestock grazed (26) areas was lower compared to ungrazed (45) areas . On the contrary, the number of undesirable plants in thelivestock grazed (44) areas was higher compared to the livestock ungrazed (18) area (Table 4). Therefore, there was a significant difference (p= 0.02) in the level of desirability between grazed and ungrazed areas. This shows that range condition in terms of species composition has been changing from desirable to undesirable plant species in livestock grazed area while in livestock ungrazed area the composition is still stable or in its climax. According to Kisoza (2007), the dominance of undesirable (increasers) and a few less desirable and highly desirable (decreasers) is an indication that the range condition of the livestock grazing area is declining.

Table 4: Desirable species found in grazed (n=728) and ungrazed (n=698) areas

Area	Level of desirability in percentage			Total
	Undesirable	Less desirable	Highly desirable	
Grazed	45	29	26	100.0
Ungrazed	18	37	45	100.0
Total	27	34	39	100.0

4.3.2 Life forms of grass species

On the one hand, it was found that, the percentage of perennial in the grazed areas was relatively lower (56.61%) compared to that of ungrazed areas (79.39 %) (Table 5). On the other hand, the percentage of annual plants in the grazed area was relatively higher (43.47%) than that of the ungrazed area (20.6 %) (Table 5). The finding could probably

be an indication that perennial plants in livestock grazed areas have been disappearing and were being replaced by annual plants due to higher grazing pressure by livestock.

Other results (Gemolo-Dalle *et al.*, 2006; Mphinyane and Rethman, 2006) have indicated that when an area is subjected to high grazing pressure, it denotes annual plants have been replaced by perennial plants on arid and semi-arid savannas of Africa. Moreover, it has been stressed that higher proportions of annual and undesirable grasses in the livestock grazed areas indicate habitat degradation and retrogression from a climax (Mwalyosi, 1992b). Also Kideghesho *et al.* (2006) found confinement of livestock in small areas causes overgrazing, soil erosion and siltation of water bodies due to inadequate and poor quality pasture.

Therefore, it can be concluded that the number of livestock in the grazed areas of Kilimani and Utete west was relatively higher and as a result it has caused overgrazing and hence decrease of perennial grasses in the area. This also negatively affects wildlife habitats and hence population due to loss of food and shelter especially during the dry season when annual plants are always not available.

Table 5: Distribution of annual and perennial species in grazed(n=728) and ungrazed(n=698) areas of Kilimani West and Utete West, Rufiji District

Area	Nature of life form in percent		Total
	Annual	Perennial	
Grazed (Kilimani West and Utete West)	43.39	56.61	100
Ungrazed (Ngarambe-Tapika WMA)	20.61	79.39	100

4.3.3 Plant species diversity

Plant species diversity for livestock grazed and ungrazed areas were measured by Shanon and Wiener. The results for livestock grazed and ungrazed areas had Shanon and Wienner values 3.055 and 3.812 respectively; This indicates that there was high plant diversity in

both grazed and ungraded areas. According to Kent and Coker (1992) for an area to be more diverse under the Shannon and Wiener index, it has to lie between 1.5 and 3.5 of which both of the areas lie, although it can occasionally exceed 4. Furthermore, it was also found that there was still no significant difference ($p = 0.799$) on plant diversity on the livestock grazed and ungrazed areas.

This indicates that despite a large number of livestock and grazing pressure justified by differences in levels of desirable plants and plant life forms in livestock, grazed and ungrazed areas effects were not large enough to significantlly affect species diversity. However, higher proportions of annual and undesirable grasses in the livestock grazed areas indicate habitat degradation and retrogression from a climax (Mwalyosi, 1992b). Therefore, strong control measures including the establishment of livestock management strategy should be taken to ensure that in future these effects are not detrimental to the range condition.

4.3.4 Effect due to human activities

Most of farmers (95.7% and 88.9%) in Kilimani West and Utete West respectively stated that pastoralists were destroying the wildlife habitats and rangeland (Fig. 6). Settlement establishment and clearing land for agriculture were mentioned by most respondents (89.9% and 24.4%) in Utete West and Kilimani West villages respectively as the main cause of habitat destruction (Table 6).

Table 6: Peasants views (n=114) on causes of destruction of wildlife habitat

Causes of destruction of wildlife habitat	% of respondents in each village	
	Kilimani West	Utete West
Settlements established	76.0	90.0
Opening land for agriculture	24.0	10.0
Total	100	100

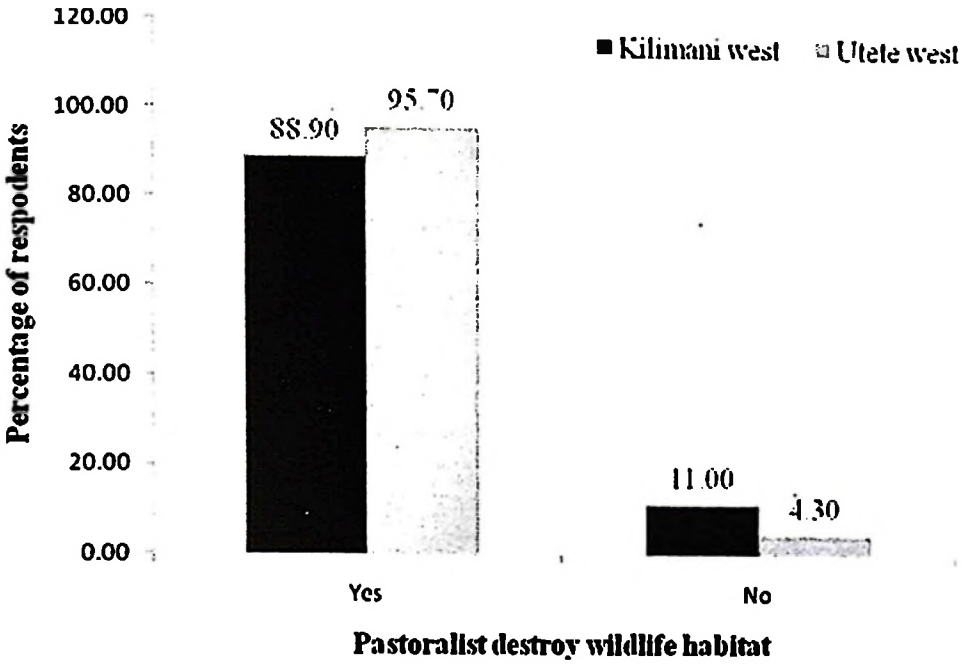


Figure 6: Perception of peasants on effects of pastoralism on wildlife habitats

During the discussion with village natural resources comittees it was noted that, the areas allocated to pastoralists for grazing were formerly used by wildlife species as habitats, grazing areas and/or breeding sites. This therefore implies that, the introduction of pastoralists to the area affected the wildlife habitat and rangeland leading to decrease of wildlife population. Common species which were informed to have decreased due to pastoralism include impala (*Aeyceros melampus*), wildebeest (*Cannochaetus taurinus*), hartebeest (*Alcelaphus buselaphus*), African Buffalo (*Syncerus caffer*), African elephants (*Loxodonta africana*), lion (*Panthera leo*), hyena (*Crucuta crucuta*), leopard (*Panthera pardus*), and wild dog (*Lycoan pistols*).

Plate 2: Pastoralists demonstrating the use of plough for land tilling in Kilimani village

This happened during the establishment of settlements and farms since some people were agropastoralists (Plate 2) and had therefore to clear large pieces of land. For instance, during the fieldwork, six families of the Sukuma tribe (agro-pastoralists) were found encroaching and establishing large farms and settlement inside the proposed JUHIWANGUMWA WMA and the Rupyage National Forest Reserve bordering the Selous Game Reserve; hence affecting a huge portion of natural forests - critical wildlife habitats and rangelands. In turn, these led to decrease of wildlife population due to local extinction or migration of the animals to other areas in search for habitat and rangeland.

Kideghesho *et al.* (2006) asserted that rural communities in western Serengeti were behind the disappearance and reduction of some animal species in areas where they were previously abundant due to increased settlement and other human activities such that animals have abandoned the highly settled areas which were previously used as migratory routes and dispersal areas.

Also, Morell (1997) attributed the disappearance of the previously healthy populations of dragons and large-casqued hornbills to loss of tree cover in the riverine forests and some bird species, such as shrikes and thrushes, were said to have moved into the park, while black and white colobus monkeys (*Colobus angolensis*), previously seen along the Grumeti River, moved further west.

Furthermore, Campbell and Borner (1995) reported Roan antelope (*Hippotragus equines*) to be locally extinct in many areas of the ecosystem due to the loss of its *Combretum*-dominated habitats. Thus, this might be one of many reasons of the reduced visibility, number and group sizes of wildlife species in most of the areas used by pastoralists in Rufiji as informed by the respondents.

4.4 Positive and Negative Effects of Pastoralism on Local Community's Livelihood

4.4.1 Positive effect of pastoralism on local community's livelihood

With this, farmers in Utete West (60.6%) informed to have benefited from the introduction of pastoralists compared to Kilimani West (39.4%) (Fig. 7). Benefits /incentives mentioned due to the introduction of pastoralism by local communities of Utete West village include increased income of household through trade , increased local government (village) revenues through paying tax enhanced availability of livestock products (milk, meat and manure), and intermarriges.

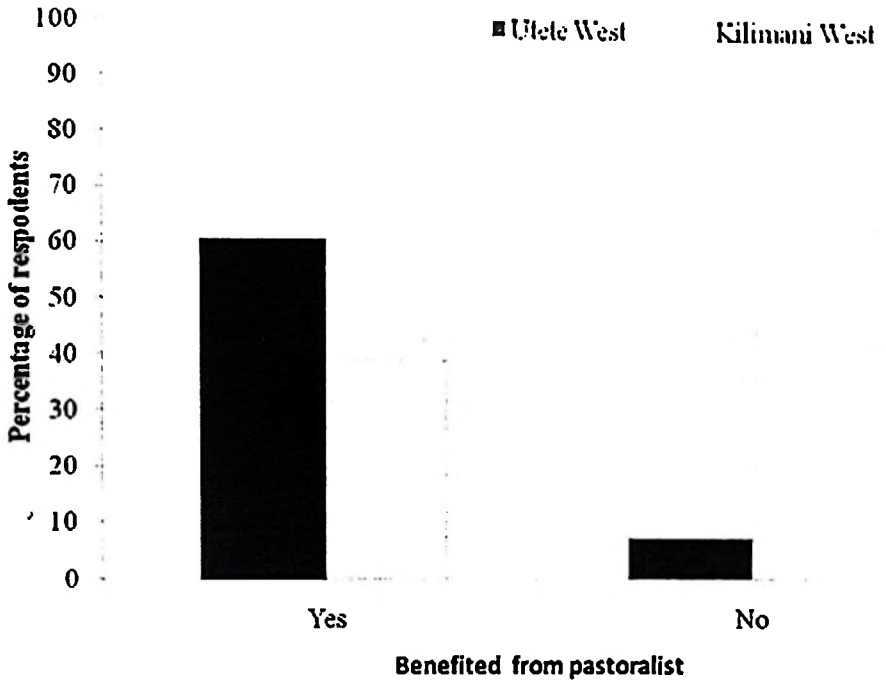


Figure 7: Effect of Pastoralism on Local Community's Livelihood

Some people even claimed pastoralism to have brought new livelihood options to farmers such as livestock keeping, new ways of farming (growing certain crops such as sweet potatoes and vegetable) as well as application of manure that increase soil fertility and improve production (Fig. 8 and 9).

In addition, it was found that there were differences in opinion on the benefits of pastoralism to the livelihoods between Utete West (61%) and Kilimani West (39%) because Kilimani is a small village where there isminimal interaction between pastoralists and local communities due to a small movement of people than in Utete West. In Utete there is a lot of business which is either established or improved due to the introduction of pastoralists. For instance, due to the availability of livestock, more burchers were established from one in 2006 to six in 2012; hence more meat was available and more people were involved in the business. Likewise, people got involved in milk and cattle

business as they were purchasing milk and cattle from pastoralists and sell, and this was also a source of employment and protein to people residing in Utete while such business were lower in Kilimani.

Furthermore, some bussiness related to livestock including livestock auctions were established in Utete because it is a district centre and closer to the highway compared to Kilimani. This has attracted a lot of people from different parts which creates a market where local people sell different commodities including food, clothes, agriculture products and even alcohol, and also the District Council collects levies and gets revenue. Thus, all these has caused the differences in perception of benefits of pastoralism between the two villages.

As this is not enough, Letara (2006) estimated around (6.6%) of the population in Arusha to have been receiving livelihood support through the meat supply chain for *nyama choma* from pastoralists; the business, as said ealier, was estimated to employ 5600 people with an estimated 25 000 dependents. Also, Mbwile *et al.* (2012), as reported ealier, found increased food security due to increased production of food crops, increase availability of meat and milk, growth of social interactions between pastoralists and farmers including marriages between them as among important positive changes in the study area as a result of the incoming of the pastoralists in the southern highlands of Tanzania.

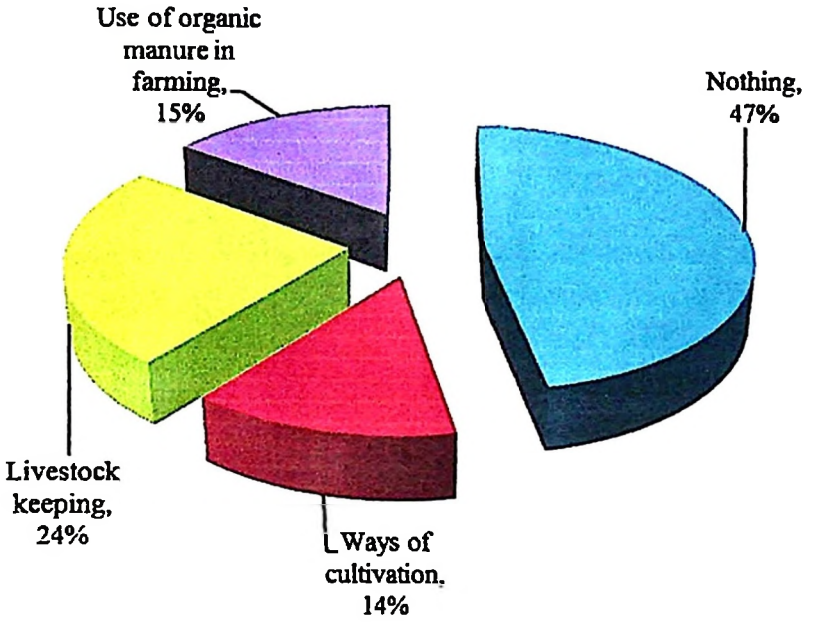


Figure 8: Lessons brought by pastoralists to farmers in Utete West village, Rufiji District

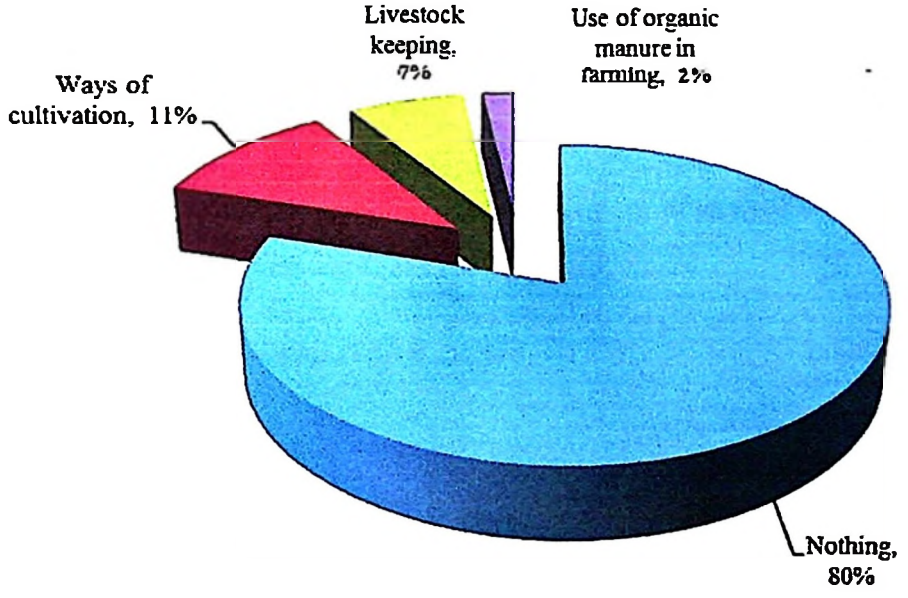


Figure 9: Lessons brought by pastoralists to farmers in Kilimani West village, Rufiji District

4.4.2 Negative effects of pastoralism on local communities' livelihood

With this, the study has found that, most of the respondents (92.6%) in Kilimani West village have not benefited from the introduction of pastoralism (Fig.7). About (87.5%) of the respondents had negative attitude to pastoralism stating that, following the introduction of pastoralists in the village, life has been more expensive (Table 8). Through the discussion, it was noted that some local communities were against the introduction of pastoralism for reasons that livestock damage their crops resulting to conflicts between the groups. It was noted further that due to crop damage, farmers have been getting low harvest resulting in food insecurity to farmers.

A good example is that, in Kilimani West village, farmers and pastoralists since 2007 have fought three times, and two farmers and one pastoralist were badly injured. Likewise, in Ikwiriri a farmer was killed by pastoralists in May 2011. This caused serious tribal fights that culminated in death of two pastoralists and many casualties including property loss for both groups such as destruction of houses and killing of livestock.

Table 7: Positive and negative effect of pastoralism on local economy and livelihood of local communities (n=114)

Positive and negative effects	% of respondents on effect of Pastoralism to local communities livelihoods Village	
	Utete West	Kilimani West
Increase income of household through trade	80	6.25
Increase local government (village) revenues through paying tax	10	6.25
Life has been more expensive	0	87.5
Availability of livestock products (milk, meat and manure)	10	0.0
Total	100	100

A study by Benjaminsen *et al.* (2009) reported that when land areas allocated to pastoralists are not large enough or their livestock number is higher, it leads to herder search for pasture and water outside pastoral village areas; resulting in crop raiding by livestock, and as a result most of farmers' time is spent in fights and fear; hence affecting negatively their harvest due to raiding, loss of time for production, and hence their income reduction and effecton their livelihood.

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The study has revealed that, introduction of pastoralism has led to resource use conflicts between different user groups of Kilimani West and Utete West villages, in Rufiji District. There are conflicts between pastoralists and farmers (81%), pastoralists and conservationists (49%), among pastoralists of different ethnic groups (41%), and the existing conflict between farmers and conservationists (22%). Crop damage by livestock in Kilimani (96%) and in Utete (71%) was the highest cause of land use conflict between the farmers and pastoralists which has even resulted to confrontations, deaths, injuries and loss of properties. Other causes include livestock predation, human injury and loss of life, livestock theft, and destruction of water points. It was found further that conflicts between farmers and pastoralists have been caused by inefective land use plan which was done before the arrival of pastoralists and therefore did not consider their needs and requirement.

Pastoralism has also been reported to have negative effects on wildlife habitats and population. This was proved by high abundance of less desirable and undesirable species including *Panicum* spp, *Sporoborus spp*, *Cyperus spp* and *Bothriochloa spp* livestock grazed areas compared to high abundance of highly desirable species such as *Pasparum spp*, *Cynodon spp*, *Bracharia spp* and *Velvet spp* in livestock ungrazed areas. Therefore, there was a significant difference ($p= 0.02$) in the level of desirability between grazed and ungrazed areas. Also, the percentage of perennial in livestock grazed area were relatively lower (56.61%) compared to livestock ungrazed areas (79.39%). Moreover, it has been stressed that higher proportions of annual and undesirable grasses in the livestock grazed

areas indicate habitat degradation and retrogression from a climax due to grazing pressure. Therefore, this might be one cause of the observed differences in visibility of wildlife in Kilimani West and Utete West as it has led to wildlife species shifting from original areas (local extinction) or change movement patterns. Depredation was another r threat to wildlife population as some of predators were killed by pastoralist,from 2006 to 2011 for reported 18 lions, 4 leopards, 20 hyenas and 9 crocodiles killed due to different cases including livestock depredation.

On the livelihood aspect, the study has found that, pastoralism has some positive and negative effects on the economy and livelihoods of the residents. Most respondents (61%) in Utete West indicate benefiting from pastoralism due to involvement in activities such as selling cattle, goat, and sheep or their related products such as meat andmilk in hotels, restaurant or in bars and night clubs as *nyama choma* and selling other products in auction days. Furthermore, people adapted from Sukuma pastoralists farming methods (14%), learned livestock keeping (24%) and using livestock organic manures (15%) to improve soil fertility; hence high production especially in gardens. This has created employment to many people, and hence improved household income to most families.

However, pastoralism has negatively affected the economy and livelihood of local communities as indicated by 93% of the farmers in Kilimani West due to crop damage by livestock. This has sometimes led to several confrontations between them and resulted to injuries and death which has then caused farmers to fail to produce due to despair and fear; hence low production of crops and food insecurity.

5.2 Recommendations

Basing on the objectives, results and discussion of this study, it is recommended that:

i. The District in collaboration with villagers . should develop a livestock management strategy that will provide wise and sustainable use of the available grazing area.

ii. There should be a deliberate awareness creation and education on livestock husbandry and rangeland management to the pastoralists

iii. The District Council should do land use plans and review in some villages where it was done before arrival of pastoralists and should involve all stakeholders not to compromise the existence of other resource users.

iv. Range conditions in areas that were set aside for pastoralism should be assesssed to come up with a recommended carrying capacity so that the number of livestock apportioned to these areas should comply with the areas carrying capacity to avoid overgrazing which seem to be one of the many reasons for resource use conflicts in Kilimani West and Utete West.

REFERENCES

Bengis, R. G., Kock, R. A. and Fischer, J. (2002). Infectious animal diseases: The wildlife/livestock interface. Scientific and technical. *Journal of Internationaldes Epizootes* 21(1):53 – 65.

Bernard, H. R. (1995). *Research Methods in Anthropology: Qualitative and Quantitative Approaches.* (2nd Ed.), Alta Mira Press, Oxford. 585pp.

Benjaminsen, T., Faustin, A., Maganga, P. and Jumanne, M. (2009). The Kilosa killings: Political ecology of a farmer-herder conflict in Tanzania. *Development and Change* 40(3): 423 – 455.

Blench, R. (2001). You can't go home again: Pastoralism in the new millennium. [http://www.odi.org.uk/pdn/eps.pdf] site visited on 18/12/2012.

Boyd, H. K., Westfall, R. and Staach, S. F. (1981). *Marketing Research Texts and Cases.* Richard D Publisher, Illinois. 813pp.

Burnsilver, S. B., Boone, R. B. and Galvin, K. A. (2003). Linking pastoralists to a heterogeneous landscape: The case of four Maasai group ranches in Kajiado District, Kenya. In:*Linking Household and Remotely Sensed Data: Methodological and Practical Problems.* (*Edited by Fox, J. et al.*), Kluwer Academic Publisher, New York. pp. 173 – 199.

Butler, J.R. (2000). The economic cost of wildlife predation on livestock in Gokwe communal land, Zimbabwe. *African Journal of Ecology* 38(1): 23 – 30.

Campbell, K. and Borner, M. (1995). Population trends and distribution of Serengeti herbivores: Implications for management. In:*Serengeti Dynamics, Management, and Conservation of Ecosystem. (Edited by Sinclair, A and Arcese, P.),* The University of Chicago Press, Chicago. pp. 117 – 145.

Chaichi, M., Saravi, M. and Arash, M. (2005).Effects of livestock trampling on soil physical properties and vegetation cover: A case study of Lar rangeland, Iran. *International Journal of Agriculture Biology* 7:1 – 5.

Chambers, R. and Conway, G. (1992). *Sustainable Rural Livelihoods, Practical Concepts for The 21st Century.* Discussion Paper No. 296. University of Sussex, Institute of Development Studies, Brighton, UK. 6pp.

Chrisholm, A. and Dumsday, R. (1987). *Land Degradation*: *Problems and Policies.* Cambridge University Press, London. 404pp.

Christopher, K. B. andScott, G. (2010). *Communal Violence and Property Rights.Centre for the Study of Civil War.* Poverty and Peace Programme, Norway. 129pp.

Cline, R., Sexton, N. and Stewart, S. C. (2007).*A Human-Dimensions Review of Human-Wildlife Disturbance: A Literature Review of Impacts, Frameworksand Management Solutions.* File Report No.1111. Geological Survey, USA. 88pp.

Coughenour, M. B. (2009). Causes and consequences of herbivore movement in landscape ecosystems. In: *Fragmentation in Semiarid and Arid Landscapes. (Edited by* Galvin, K., Reid, R., Behnke, R. H. and Hobbs, N.), The Netherlands, Springer. pp. 45 – 91.

Davies, S. (1996). *Adaptable Livelihoods:Coping With Food Insecurity in the Malian Sahel.* Macmillan Press, London. 335pp.

Devereaux, S. (1993). Goats before ploughs: Dilemmas of household response sequencing during food shortages. *Institute of Development Studies Bulletin* 24(4): 52 – 59.

Dyksterhuis, E. J. (1949). Condition and management of rangeland based on quantitative ecology. *Journal of Range Management* 2: 104 – 115.

Ellis, F. (2000). Rural livelihoods and diversity in developing countries. *Journal of Development Economics* 70(1): 248 – 252.

Ellis, J. E. and Swift, D. M. (1988). Stability of African pastoral ecosystems: Alternate paradigms and implications for development. *Journal of Range Management* 41: 450 – 459.

FAO (2001). *Pastoralism in the New Millennium:* Animal production and health. Paper No. 150. Food and Agriculture Organization, Rome, Italy.150pp.

FAO (2005). *Strategies to Mitigate Human-Wildlife Conflict in Mozambique:* National Directorate of Forest and Wildlife, Rome, Italy. 68pp.

FAO (2009). Human-wildlife conflict in Africa Causes, consequences and management strategies. [http://www.fao.org/docrep/012/i1048e/i1048e00.pdf] site visited on 6/10/2013.

Gemolo-Dalle, G., Maass, B. and Isselstein, J. (2006). Range condition and trend in semi-arid Borana lowlands Southern Oromia Ethiopia. *Africa Journal of Range and Forage Science* 23: 49 – 59.

Government of Namibia Ministry of Environment and Tourism (2007). *National Policy on Human –Wildlife Conflict Management.*Government Printer, Windhoek, Namibia, 34pp.

Havnevik, K. J. (1993). *Tanzania: The Limits to Development from Above.* Uppsala, Nordic Africa Institute, Dar es Salaam, Tanzania. 343pp.

Heitschmidt, R. K., Dowhower, S. L. and Walker, J. W. (1987). Some effects of a rotational grazing treatment on the quantity and quality of available forage an amount of ground litter. *Journal of Range Management* 40: 318 – 321.

Hesse, C. and MacGregory, J. (2006). *Pastoralism Dry Lands Invisible Assets? Developing a Framework for Assessing the value of Pastoralism in East Africa.* Issue Paper No.142. International Institute for Environment and Development, London. 45pp.

Hesse, C. (2009). Generating wealth from environmental Variability. The economics of pastoralism in East Africa in pastoralism indigenous knowledge affairs. *International Workgroup for Indigenous Affairs* 14: 3 – 4.

Holmern, T., Nyahongo, J. and Roskaft, E. (2007). Livestock loss caused by predators outside the Serengeti National Park, Tanzania. *Biological Conservation* 135: 518 – 526.

Homewood, K. M. (2004). Policy, environment and development in African rangelands. *Environmental Science and Policy* 7(3): 125 – 143.

Hugo-Jones, M. E. and de Vos, V. (2002). Anthrax and wildlife: Scientific and technical. *Internationaldes Epizootes* 21(2): 359 – 382.

IUCN (2003). World parks congress press release. [www.iucn.org] site visited on 01/09/2010.

Irunga, P. (2001). *Formalisation of Village Peace Committees in the Karamoja Cluster Pastoral Community Harmonisation Initiative: The Organization of African Unity. Community-based Animal Health and Participatory Epidemiology Unit.* Inter-African Bureau for Animal Resources, Nairobi, Kenya. 54pp.

Kajembe, G. C. (1994). *Indigenous Management Systems as a Basis for Community Forestry in Tanzania.A Case Study of Dodoma Urban and Lushoto Districts.* Tropical Resource Management Paper No. 6. Wageningen Agricultural University, Netherlands, 194pp.

Katani, J. Z. (1999). Coping strategies against deforestation: impact of social economic factors with special attention to gender based indigenous knowledge. Dissertation for Award of MSc Degree at Sokoine University of Agriculture, Morogoro, Tanzania, 110pp.

Kent, M. and Coker, P. (1992).*Vegetation Description and Analysis, A practical Approach.* Belhaven Press, London. 363pp.

Kideghesho, J. R., Nyahongo, J. W., Shombe N. H., TorinoT. C. and Nsajigwa, E. M. (2006). Factors and ecological impacts of wildlife habitat destruction in theSerengeti ecosystem in Northern Tanzania. *African Journal of Environmental Assessment and Management* 11: 917 – 932.

Kisoza, L. J. (2007). The role of local institutions in the management of agropastoral and pastoral systems: A case study of Mkata Plains, Kilosa District and Ngorongoro Conservation Area. Ngorongoro District, Tanzania. Thesis for the Award of PhD Degree at Sokoine University of Agriculture, Morogoro, Tanzania, 374pp.

Lambin, E. F., Turner. B. L., Geist, H. J., Agbola, S. B. and Angelsen, A. (2001). The causes of land-use and land cover change: Moving beyond the myths. *Global Environmental Change-Human and Policy Dimensions* 11(4): 261 – 269.

Lane, C. (1996). *Pastures Lost: Barabaig Economy, Resource Tenure and the Alienation of their Land in Tanzania.* Initiatives Publishers, Nairobi, Kenya. 15pp.

Letara, J. (2006). *The Economics of the Nyama Choma Business in the City of Arusha, Tanzania.*International Institute for Environment and Development, London. 22pp.

Lynn, S. (2010a). Cultivating the savannah: Implication of land use change for wildlife conservation and Maasai livelihood in East Africa Thesis for Award of PhD Degree at Colorado State University, Fort Collins, Colorado, 331pp.

Lynn, S. (2010b). *The Pastoral to Agro-Pastoral Transition in Tanzania*: Human Adaptation in an Ecosystem Context, Chicago. 26pp.

Madulu, N. F. and Liwenga, E. (2004). *Economics of Pastoralism in East Africa: Tanzania Component.*International Institute for Environment and Development, London. 39pp.

Mattee, A. Z. and Shem, M. (2006). *Ambivalence and Contradictions. A Review of the Policy Environment in Tanzania in Relation to Pastoralism.* Dry Lands Issue Paper No. 140. International Institute for Environment and Development, Morogoro, Tanzania. 48pp.

Mbonile, M. and Mwamfupe, D. (1997). Immigrants and their impacts on land management: A case of Usangu Plains. *Tanzania Journal of Population Studiesand Development* 4(1): 37 – 53.

Mbwile, P. R., Mwambene, L. P., Kimbi, C. E., Hoeggel, U., Materu, J., Mwaiganju, A. and Madoffe, S. (2012). Understanding the dynamics of forced livestock movements and pastoral livelihoods and future development options in Ruvuma and Lindi Regions of Tanzania. [http://www.cde.unibe.ch/CDE/pdf/Q 076_rese arch_report_final.pdf] site visited on 4/11/2013.

McCabe, J., Perkin, S. and Schofield S. (1992). Can conservation and development be coupled among pastoral people? An examination of the Maasai of the Ngorongoro Conservation Area, Tanzania. *Human Organanisation* 51(4): 353 – 366.

McNaughton, S. J. (1979). *Grassland-herbivore Dynamics in Serengeti: Dynamics of an Ecosystem.* (Editors by Sinclair, A. R. E. and Norton, G.), University of Chicago Press, Chicago, USA. pp. 46 – 81.

Mishra, C. (1997). Livestock depredation by large carnivores in India trans-Himalaya: Conflicts perceptions and conservation prospect. *Environmental Conservation* 24: 338 – 348.

Mizutani, F., Muthiani, E., Kristjanson, P. and Recke, H. (2005*)*. Impact and value ofwildlife in pastoral livestock production systems in Kenya. In: (Edited by Osofsky, S. A.), *Possibilities for Healthy Ecosystem Conservation and Livestock Development For The Poor,* Nairobi, Kenya. pp. 121 – 132.

Morell, V. (1997). Counting creatures of the Serengeti: Great and small. *Science* 278: 2058 – 2060.

Mphinyane, W. N. And Rethman, N. F. (2006). Livestock utilization of grass species at different distances from water both traditional cattle post and ranch management systems in Botswana. *Africa Journal of Range and Forage Science* 23: 147 – 151.

Muhereza, F. E. (2004). *The Economic Contribution of Pastoralism in Uganda:* International Institute for Environment and Development, Uganda. 45pp.

Mung'ong'o, C. and Mwamfupe, D. (2003). *Poverty and Changing Livelihoods of Migrant Maasai Pastoralists in Morogoroand Kilosa Districts, Tanzania.* Research Paper No. 3. Research on Poverty Alleviation, Morogoro, Tanzania. 5pp.

Muruthi, P. (2005). *Human- Wildlife Conflicts: Lessons Learned from African Heartland.* African Wildlife Fund, Nairobi, Kenya. 12pp.

Mwalyosi, R. B. B. (1992a). Land-use changes and resource degradation in South-West Maasailand, Tanzania. *Environmental Conservation* 19(2): 145 – 152.

Mwalyosi, R. B. B. (1992b). Influence of livestock grazing on range condition in South-West Masailand, Tanzania. *Environmental Conservation* 29: 181 – 188.

Mwilawa, J. A. (2003). Assessment of potential rangeland resources in selected areas towards developing livestock development strategy in Rufiji District. [http://coastalorests.tfcg.org/pubs/REMP%2041%20Technical%20Report%2040%2 0Rangeland%20Resources.pdf] site visited on 6/10/2013.

Nelson, F. (2009). *Natural Conservationists? Evaluating The Impact of Pastoralist Land Use Practices OnTanzania's Wildlife Economy.* International Institute for Environment and Development, London. 8pp.

Niboye, P. E. (2010). Impacts of changing pastoral strategies on environmental, resources and livelihoods in Tanzania's Lake Victoria Basin. [http://books. google.co.tz/books?id=NC1v5bjsWJYC&pg=PR6&lpg=PR6&dq=why+pastora list+was+evicted+from+ihefu+wetlands&source=bl&ots=kDppKoBTOo&sig=9ir yetC5YD2Wv_xZIMapD_qtg0s&hl=en&sa=X&ei=y9tgUu-FHsWd0QWcwIG ID g&ved=0CEIQ6AEwAw#v=onepage&q=why%20pastoralist%20was %20evicted %20from%20ihefu%20wetlands&f=false] site visited on 18/10/2013

Odhiambo, M. O. (2008). *Conflicts in Ngorongoro District: Causes, Consequences and Possible Solutions:*Consultancy report by Ngorongoro pastoralists project. Ngorongoro District Council, Arusha. 33pp.

Ogada, O. and Ogada, D. L. (2004). *Factors Influencing Levels of Carnivores Livestock Conflicts In Samburu Heartland and Proposed Mitigation Measures.*Africa Wildlife Foundation, Nairobi, Kenya. 96pp.

Ogada, M., Woodroffe, R., Oguge, N. and Frank, G. R. (2003). Limiting depredation by African carnivores: The role of livestock husbandry.*Conservation Biology* 17(6): 1521 – 1530.

Ojalammi, S. (2006). Contested lands: Land disputes in semi arid parts of northern Tanzania. Case studies of the Loliondo and Sale division's in Ngorongoro District. Thesis for Award of PhD at University of Helsinki, Finland, 386pp.

Osofsky, S. A., Cleaveland, S., Karesh, W. B., Kock, M. D., Nyhus, P. J., Starr, L. and Yang, A. (2005). *Conservation and Development Interventions at the Wildlife/Livestock Interface: Implications for Wildlife, Livestock and Human Health.* International Union for Conservation of Nature, Switzerland, 253pp.

Packer, C., Ikanda, D., Kissui, B. and Kushnir, H. (2006). The ecology of man- eating lions in Tanzania.*Nature and Fauna* 21(2): 10 – 15.

Parker, G. (2013). Human-wildlife conflict. [http://www.Paceproject.net/Userfiles/File/ Living%20With%20Wildlife /Human%20wild life%20conflict.pdf] site visited on 6/10/2013.

Petterson, B. D., Kasiki, S. M., Selompo, E. and Kays, R. W. (2004). Livestock predation by Lion (*Pantheraleo*) and other carnivores on ranches neighbouring Tsavo National Park, Kenya. *Biological Conservation* 119(4): 507 – 516.

Rodriguez, L. (2008). *A Global Perspective on the Total Economic Value of Pastoralism: Global Synthesis Report Based On Six Country Valuations*. World Initiative for Sustainable Pastoralism, Nairobi, Kenya. 28pp.

SCBD (2010). *Pastoralism, Nature Conservation and Development.* A Good Practice Guide. Montreal. 43pp.

Sendalo, D. S. C. (2009). *Reviewing Land Tenure Policy Implications on Pastoralism in Tanzania.* Ministry of Livestock Development and Fisheries, Dar es Salaam, Tanzania. 29pp.

Shem, M. N., Mtengeti, E. and Mutayoba, K. S. (2005). *Development of Livestock Management and Policy Strategies for Pastoralists in Kiliosa.* African Institute for Capacity Development, Morogoro, Tanzania. 38pp

Sillero-Zubiri, C. and Laurenson, M. K. (2001). *Interactions Between Carnivores and Local Communities: Conflicts Or Co-Existence? Carnivores.* (Edited by Gittle man, J. L,), Cambridge University Press, UK. pp. 282 – 321.

Treves, A. (2007). Balancing the needs of people and wildlife: When Wildlife Damage Crops and Prey on Livestock. [http://www.nelson.wisc.edu/ltc/docs/!ltcbrief7-human_wildly fe_conflict.pdf] site visited on 6/10/2013.

Turpie, J. K. (2000). *The Use and Value of Natural Resources of the Rufiji Delta.*Technical Report No. 17. Rufiji District Council, Coastal, Tanzania. 92pp.

URT (2007). *The Wildlife Policy of Tanzania.* Government Printers, Dar es Salaam, Tanzania. 50pp.

URT (2010). *Tanzania Tourism Sector Survey. The 2008 International Visitors Exit Survey Report.* Government Printers, Dar es Salaam, Tanzania. 50pp.

URT (2013). *Population and Housing Census, General Report.* Central Census Office, National Bureau of Statistics, President's Office-Planning and Privatization, Dar es Salaam, Tanzania. 264pp.

Wallace, O. (2003). What is wildlife conservation? [http://www.wisegeek.com/what-is wildlife-conservation.htm] site visited 12/3/2011.

Wanjau, M. W. (2002). *Resolving Conflicts between People and Crocodiles: A Case Study of Athi River, Kibwezi-Tsavo Ecosystem.* Kenya Wildlife Services, Nairobi, Kenya. 112pp.

World Bank (1994). *Reversing the Spiral. The Population, Agriculture and Environmental Nexus in Sub-Saharan Africa.*The World Bank, Washington DC. 22pp.

World Bank (2013). *Tourism in Africa: Harnessing Tourism for Growth and Improved Livelihood.* The World Bank, Washington DC. 12pp.

WISP (2008). Forgotten Services, Diminished Goods: Understanding the Agro ecosystem of Pastoralism. [http://data.iucn.org/wisp/documents_english/WISP_PN8_en.pdf] site visited on 12/11/ 2011.

Zaal, F. (1998).Pastoralism in a golden age.Livestock marketing and pastoralcommercial activities in Kenya and Burkina Faso. Thesis for Award of PhD Degree at University Van, Amsterdam, Holland, 289pp.

URT (2013). *Population and Housing Census, General Report.* Central Census Office, National Bureau of Statistics, President's Office-Planning and Privatization, Dar es Salaam, Tanzania. 264pp.

Wallace, O. (2003). What is wildlife conservation? [http://www.wisegeek.com/what-is wildlife-conservation.htm] site visited 12/3/2011.

Wanjau, M. W. (2002). *Resolving Conflicts between People and Crocodiles: A Case Study of Athi River, Kibwezi-Tsavo Ecosystem.* Kenya Wildlife Services, Nairobi, Kenya. 112pp.

World Bank (1994). *Reversing the Spiral. The Population, Agriculture and Environmental Nexus in Sub-Saharan Africa.*The World Bank, Washington DC. 22pp.

World Bank (2013). *Tourism in Africa: Harnessing Tourism for Growth and Improved Livelihood.* The World Bank, Washington DC. 12pp.

WISP (2008). Forgotten Services, Diminished Goods: Understanding the Agro ecosystem of Pastoralism. [http://data.iucn.org/wisp/documents_english/WISP_PN8_en.pdf] site visited on 12/11/ 2011.

Zaal, F. (1998).Pastoralism in a golden age.Livestock marketing and pastoralcommercial activities in Kenya and Burkina Faso. Thesis for Award of PhD Degree at University Van, Amsterdam, Holland, 289pp.

APPENDICES

Appendix 1: Checklist for Key informant's Interview

- Natural resource use conflicts and the underlying causes
- The number of livestock available in the District or village
- The contribution of livestock to the economy
- Activities that have evolved due to Pastoralism
- Comparing the availability of wild animals in pastoralist areas now and in the past
- Incidences of predation of livestock by wildlife
- Incidences of disease transmission from wildlife or livestock

Appendix 2: Questionnaire Administered to Pastoralists

A. GENERAL INFORMATION OF THE HOUSEHOLD

1. Village name.....
2. Ward .....
3. Age of the respondent.....
4. Sex of the head of the household.....
5. Household size.....
6. Date.....
7. Duration of residence in the village (years).....
8. Level of education.....
9. Marital status.....
10. How many livestock do you have by type?

Type	No
Cattle	
Goat	
Sheep	
Donkey	

B. Resource Use Conflicts

11. Where do you graze your livestock?

    (i) Open access (ii) Harvested fields (iii) Communal grazing land

    (iv) Anywhere depending on the availability of grasses

12. At what season of the year do you experience shortage?

    (i) Dry season (ii) Wet Season (iii) Year around

13. Do you have access to use open land or farms on the village

    (i) Yes (ii) No

14. Are there restrictions on stocking rate in the village?

    (i) Yes (ii) No

15. What type of natural resources uses conflict make you face most?

    (i) Conflict on land use and water with farmers

    (ii) Conflict with WMA

    (iii) Conflict with Selous Game Reserve

    (iv) Conflicts with other pastrolists of different ethnic group

16. What are the causes of existing conflicts?

(i) Crop damage by wildlife animals (ii) Livestock depredation (iii) Human injury and loss of life (iv) Destruction of water points for domestic use by wildlife

17. Other than livestock keeping, what do you do?

.....

18. Mention type of crops you grow

.....

19. Mention types of crops damaged and types of animals responsible

Types of crop	**Animal responsible**

20. What is the attitude of farmers/villagers towards you?

(i) Positive (ii) Neutral (iii) Negative

21. What are the incentives attracted you to stay or migrate in this village

(i) Pasture (ii) Water (iii) Land for cultivation (iv) Ecological stability

22. Do you meet wild animals when grazing in the bush?

(i) Yes (ii) No

23. If yes, mention the types of animal species you encounter

.....

24. What can you say about their number since you arrived in the area?

(i) Increasing (ii) Decreasing (ii) No change

25. What do you think is the reason for the change that you have observed?

.....

26. What tree species do you use in making your Boma, Mention them?

.....

27. Can you estimate the number of trees used in a single boma

.....

28. How many times per year do you repair your Boma , or shift from place to Place? (i) Once (ii) Twice (iii) Thrice (iv) Many times

29. How do you compare the availability of the tree species you use in making Your Boma now and the time you arrived in terms of distance you travel to find them?

(i) Still are in close distances from our bomas (within 1 kilometre)

(ii) We have to travel further than we used before (between 2-3 kms)

(ii) We have to travel a long distance now than before (above 4kms)

30. Are the wild animals affecting you in your daily life activities?

(i) Yes (ii) No

31. In what aspects are they disturbing you? .....

32. Do you lose your livestock due to predation?

(i) Yes (ii) No

33. Mention types of wild animals responsible for livestock predation.....

34. How many livestock by species have you lost since you arrived per year?

Type/ years	Number of animals lost						Animal responsible
	2006	2007	2008	2009	2010	2011	
Cattle							
Goats							
Sheep							
Donkey							

35. What do you think of the following animals?

Type of animal	Like them	Dislike them	Don't know why
Lion			
Leopard			
African Wild dog			
Spotted Hyena			
Nile Crocodile			

36. What would you like to see happen to the numbers of the following animals?

Type of animal	Increase	Decrease	Stay the same	Don't know
Lion				
Leopard				
African Wild dog				
Spotted Hyena				
Nile Crocodile				

37. Which animal causes the biggest problems in the area around your village?

.....

38. Does your livestock face grazing competition with wildlife?

(i) Yes (ii) No

39. If a programme arises to opt for either to remove or retain wildlife in the area

What will be your choice?

.....

40. What do you think are the most effective ways of protecting livestock from Predators?

.....

41. How often do you use these methods? If not, why not?

.....

42. What do you do with the wild animal especially predators after attacking your livestock?

.....

43. What do you do to prevent these events of livestock attacks?.....

Appendix 3: Questionnaire Administered to Natives

A. GENERAL INFORMATION OF THE HOUSEHOLD

1. Village name.....
2. Ward .....
3. Age of the respondent.....
4 Sex of the head of the household.....
5. Household size.....
6. Date.....
7. Duration of residence in the village (years).....
8. Level of education.....
9. Marital status.....

B. Resource Use Conflicts

10. What are the types of natural resource use conflict in the area?
    (i) Conflict on land use and water between crop producer and pastoralists
    (ii) Conflict between pastoralists and WMA (iii) Conflict between pastoralists and Selous Game Reserve
11. What are the causes of existing conflicts?
    (i) Crop damage by wildlife animals (ii) Livestock predation (iii) Human injury and loss of life (iv) Destruction of water points for domestic use by wildlife
12. What type of crops do you grow?
    (i) Annuals (ii) Perennials (iii) Both
    (iii) (Others) specify.....
13. Mention types of crops damaged by livestock and animals responsible

Types of crop	Animal responsible

14. Do you allow pastoralists to feed livestock on crop residues and land you own
    (i) Yes (ii) No
15. If yes which term do you use?
    (i) Free access (ii) Sell by cash (iii) Barter

16. Do they graze their livestock on your farms without permission?

(i) Yes (ii) No

17. If yes what do you do after the incident?

(i) Report to the authority (ii) Keep quiet (iii) Resolve with the pastoralist

(iv) Others specify.....

18. What is the attitude of pastoralists towards you?

(i) Positive (ii) Neutral (iii) Negative

19. Has the immigration of other ethnic groups in your village affected the land you inherited from your ancestors?

(i) Yes (ii) No

C. Economic and Social Significance of Pastoralism

20 .Do you benefit anything due to the presence of Pastoralists in your area?

(i) Yes (ii) No

21. If yes what benefits do you get, mention them

.....

22. Do you think the availability of livestock meat from pastoralists has reduced your dependence on game meat?

(i) Yes (ii) No

23. If yes, to what extent?

(i) High (ii) Low (iii) Medium

24. Do you use manure from the livestock

(i) Yes (ii) No

25. If yes in what terms do you get manure from pastoralist?

(i) Free access (ii) Purchase (iii) Barter

26. Has pastoralism helped you improve your living?

(i) Yes (ii) No

27. If yes, how? Explain

.....

28. What type of pastoral products do you use?

(i) Milk (ii) Meat (iii) Oil (iv) Manure (v) Skin

29. What have you adapted from the pastoralists way of living

(i) Farming (ii) Livestock keeping (iii) Use of organic manure in farming

16. Do they graze their livestock on your farms without permission?
    (i) Yes (ii) No
17. If yes what do you do after the incident?
    (i) Report to the authority (ii) Keep quiet (iii) Resolve with the pastoralist
    (iv) Others specify.....
18. What is the attitude of pastoralists towards you?
    (i) Positive (ii) Neutral (iii) Negative
19. Has the immigration of other ethnic groups in your village affected the land you inherited from your ancestors?
    (i) Yes (ii) No

C. Economic and Social Significance of Pastoralism

20 .Do you benefit anything due to the presence of Pastoralists in your area?
    (i) Yes (ii) No
21. If yes what benefits do you get, mention them
    .....
22. Do you think the availability of livestock meat from pastoralists has reduced your dependence on game meat?
    (i) Yes (ii) No
23. If yes, to what extent?
    (i) High (ii) Low (iii) Medium
24. Do you use manure from the livestock
    (i) Yes (ii) No
25. If yes in what terms do you get manure from pastoralist?
    (i) Free access (ii) Purchase (iii) Barter
26. Has pastoralism helped you improve your living?
    (i) Yes (ii) No
27. If yes, how? Explain
    .....
28. What type of pastoral products do you use?
    (i) Milk (ii) Meat (iii) Oil (iv) Manure (v) Skin
29. What have you adapted from the pastoralists way of living
    (i) Farming (ii) Livestock keeping (iii) Use of organic manure in farming

(v) Others (Specify).....

30. Is there currently any member of your family engaged in any business in Pastoral products

(i) Yes (ii) No

31. Which products does he/she use? Mention them

.....

.....

32. Has pastoralism improved the economy of your village?

(i) Yes (ii) No

33. If yes, how? Explain

.....

D. Wildlife Population Data

34. What is your opinion on the availability of wildlife in the bush before and after introduction of pastoralism?

(i) Increasing (ii) Decreasing (iii) No change

35. What do you think is the reason for the change that you have observed?

.....

36. When you move from the village to the bush, how far do you go before spotting wild animals? .....

37. Before the introduction of the pastoralists in the area, did you move the same distance or you moved less or higher than that? .....

38. Is there a difference in terms of the number of animal groups and group size of wild animals seen in the bush before and after the introduction of pastoralism in your area?

(I) Yes (ii) No

39. Are there animal species that were commonly seen before pastoralism that are now hardly seen?

(i) Yes (ii) No

40. Mention these animal species.....

Appendix 4: Areas in Rufiji with Livestock

KATA	KIJIJI	MALISHO (HA)	
	Chumbi C	3023.44	
	Chumbi A *		
	Chumbi B *		
	Bungu B *	0	
	Uponda	1455.6	
	Utunge	6984.81	
	Nyamwage	7757.11	
	Mbwara	5043.08	
	Tawi	13000.23	
	Kipo	406	
	Kipugira	150	
	Nyaminywili *	0	
	Utete mash *	0	
	Utete magh	4980.18	
	Kilimani Mash	982.97	
	Kilimani Magh	201.05	
	Ngorongo Mash	331.42	
	Ngorongo Magh *	0	
	Mloka	1398.24	
	Mwaseni/Mbuyusaba	1738.95	
	Ndundunyikanza *	0	
	Mtanzamsona	1276.50	
	Muyuyu *		
	Kiwanga *		
	Mohoro *		
	Kikale *		
	Ruaruke *		
	JUMLA	**48729.58**	

NB:***Hekta 2 zinatosha kulisha ng'ombe 1 kwa mwaka*** ****Maeneo yenye mifugo lakini hayajapimwa***

Appendix 5: Range Condition Data Form

Plants Data Collection Form

No.	Local name	Scientific Name	Status		Category		
			AN	PA	HD	LD	UD

Where; HD-Highly desirerable, LD- less desirable and UD- Undesirable.

AN-Annual and PN-Pereannual

Appendix 6: Soil Data Collection Form

Data Collection Form for Soil Errosion

Rate of Soil Errosion

SOIL ERROSION RATE	SCORES
No sign of soil erosion	5
Slight sand mulch	4
Weak-side pedestals	3
Steep-sided pedestals	2
Pavement	1
Gullies	0

TRANSECT NO.....

PLOT NO.	SCORE.

Appendix 7: Species composition in grazed and ungrazed areas of Kilimani west and Utete west villages

Botanical name	Life	Type	Desirability	Grazed area	RD grazed	S D (Stems/ha)	Ungrazed area	RD Ungrazed	SD (Stems/ha)
Acacia spp	T	P	HD	1	0.14	614.72	1	0.14	614.72
Acacia xanthophlea	T	P	HD	1	0.14	614.72	1	0.14	614.72
Bothriochloa spp	G	p	LD	32	4.43	19671.12	34	4.70	20900.57
Bracharia spp	G	A	HD	48	6.64	29506.69	2	0.28	1229.45
Chloris spp	G	A	HD	20	2.77	12294.45	1	0.14	614.72
Cida spp	G	P	UD	1	0.14	614.72	1	0.14	614.72
Comelina spp	G	A	UD	9	1.24	5532.50	7	0.97	4303.06
Commerhina benghelensis	G	A	UD	1	0.14	614.72	1	0.14	614.72
Cymbopogon spp	G	A	LD	32	4.43	19671.12	81	11.20	49792.53
Cynodon spp	G	P	HD	60	8.30	36883.36	30	4.15	18441.68
Cyparum rotundus	G	P	UD	5	0.69	3073.61	5	0.69	3073.61
Cyperus spp	G	A	UD	58	8.02	35653.91	109	15.08	67004.76
Digitalia spp	G	A	HD	41	5.67	25203.63	81	11.20	49792.53
Erogratis spp	G	A	HD	16	2.21	9835.56	8	1.11	4917.78
Heteropogomy spp	G	P	LD	10	1.38	6147.23	10	1.38	6147.23
Enreropogon spp	G	P	HD	5	5.00	22222.22	10	1.38	6147.23

Botanical name	Life	Type	Desirability	Grazed area	RD grazed	S D (Stems/ha)	Ungrazed area	RD Ungrazed	SD (Stems/ha)
Micropitilian spp	G	A	HD	1	0.14	614.72	1	0.14	614.72
Panicum coloratum	G	A	LD	9	1.24	5532.50	9	1.24	5532.50
Panicum maximum	G	P	LD	44	6.09	27047.79	70	9.68	43030.58
Panicum spp	G	P	LD	104	14.38	63931.15	102	14.11	62701.71
Paspalum spp	G	A	HD	65	8.99	39956.97	26	3.60	15982.79
Pennisetum spp	G	A	LD	6	0.83	3688.34	3	0.41	1844.17
Setaria spp	G	A	HD	4	0.55	2458.89	4	0.55	2458.89
Sporoborus Africanus	G	P	UD	38	5.26	23359.46	38	5.26	23359.46
Sporoborus spp	G	A	UD	31	4.29	19056.40	23	3.18	14138.62
Stylosanthes spp	G	P	HD	21	2.90	12,909.17	2	0.28	1229.45
Uknown1	G	P	HD	0	-	-	4	0.55	2458.89
Unknown 2	G	P	HD	11	1.52	6761.95	0	-	-
Unknown 3	G	P	HD	6	0.83	3688.34	5	0.69	3073.61
Urochloa politus	G	P	HD	10	1.38	6147.23	0	-	-
Velvet spp	G	P	HD	38	5.26	23359.46	25	3.46	15368.07
Wandia tylorii	G	P	UD	0	-	-	4	0.55	2458.89
TOTAL				**728**	**100.69**	**447,518.06**	**698**	**96.54**	**29,076.38**

Note: RD+ Relative Density, SD=Species density, p= Perennial, A=annual