IMPACTS OF HUMAN ACTIVITIES ON THE CONSERVATION OF IGANDO-IGAWA WILDLIFE CORRIDOR IN NJOMBE AND MBARALI DISTRICTS, TANZANIA

BY

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ABSTRACT

Wildlife corridors are features connecting two or more otherwise isolated patches of habitat and are among the areas of land affected by human activities. Corridors are much affected because in most cases they are not legally protected. This study assessed the impacts of human activities on the conservation of Igando-Igawa wildlife corridor in Mbarali and Njombe Districts. Specifically, the study determined socio-economic and cultural activities, the level of human disturbances to habitat as well as identifying wildlife using the corridor. A cross-sectional sampling design was employed where five villages were purposively selected for questionnaire based interviews (QBI) and focus group discussions. A total of 120 respondents were randomly selected for QBI. Disturbances were assessed by field survey in which five transects with 43 plots were located systematically in the entire corridor. SPSS package was employed for analysing socio-economic and cultural data. The excel computer programme was used to analyse resource utilisation pressure gradient. Results revealed various human activities in the corridor, namely; cultivation, pastoralism, firewood collection, poles/withies harvesting, charcoal making, hunting and logging/lumbering. Wildfires, rituals and collection of medicinal plants were other activities affecting the corridor. The use of vegetation resources before conservation begun in 2005/06 was significantly high ($p = 0.001$, $t = 3.07$). Tree resources were intensively extracted whereby 61.9 % were harvested. However there was a significant reduction in harvesting tree resources ($p = 0.0001$, $t = 7.11$) after conservation activities begun in 2005/2006. During the study, the corridor was harbouring at least 27 species of mammals, 20 of birds and eight families of herps. The corridor's ecological status had shown significant improvement in terms of wildlife and vegetations. Nevertheless, the study recommends special programmes to alleviate local community poverty around the corridor. Further studies on socio-economic and ecological issues are also suggested.

DECLARATION

I, GODFREY MAGETTA MASSAWE, do hereby declare to the Senate of Sokoine University of Agriculture, that this dissertation is my original work and that it has neither been submitted nor being concurrently submitted for degree award in any other institution.

_____ _____

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The above declaration is confirmed

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LIST OF ACRONYMS

BSP	-	Biodiversity Support Program
CAWM	-	College of African Wildlife Management
CBO	-	Community Based Organisation
DANIDA	-	Danish International Development Agency
dbh	-	diameter at breast height
DGO	-	District Game Officer
DKI	-	Discussion with Key Informants
DPMS	-	Donaldson Planning and Management Services
FAO	-	Food and Agriculture Organisation
FGD	-	Focus Group Discussions
GDP	-	Gross Domestic Product
GR(s)	-	Game Reserve(s)
IUCN	-	International Union for the Conservation of Nature and Natural Resources (The World Conservation Union)
LDCs	-	Least Developed Countries
MNRT	-	Ministry of Natural Resources and Tourism
NC	-	New Cuts
NP(s)	-	National Park(s)
NR(s)	-	Natural Resource(s)
NTFR(s)	-	Non-Timber Forest Resource(s)
OC	-	Old Cuts
PA(s)	-	Protected Area(s)
PhD	-	Doctor of Philosophy
PO	-	Personal Observations

QBI	-	Questionnaire Based Interviews
SPSS	-	Statistical Product and Services Solution
SCBD	-	Secretariat of the Convention on Biological Diversity
TANAPA	-	Tanzania National Parks
UMEMARUWA	-	Uhifadhi na Matumizi Endelevu ya Maliasili Tarafa za Rujewa na Wanging'ombe
URT	-	United Republic of Tanzania
VEO	-	Village Executive Officer
WMA(s)	-	Wildlife Management Area(s)

CHAPTER ONE

1.0 INTRODUCTION

1.1 Wildlife and People

Human beings are integral part of nature and their lives entirely depend on natural resources base. Recently, increased human actions are posing great threats towards the sustenance of nature and natural resources (Nangendo, 2000; Castellanos *et al.*, 2008). These actions are now adversely impacting humans' future. The great risks to which humans' actions have caused will potentially grow unless nature and natural resources are conserved through sustainable utilisation. According to IUCN (1980) the word conservation is defined as a management of human use of the biosphere that may yield greatest sustainable benefit to present generation while maintaining its potential to meet the needs and aspirations of the future generation. Therefore the definition implies that conservation is a wise use of the biosphere and encompassing three levels namely, design of production and sustainable land use systems, the preservation of species with actual or potential benefits to humanity, and conservation for non-economical reasons. To achieve those objectives, the world has come up with the *World Conservation Strategy* (IUCN, 1980; 1991) aimed at maintaining essential ecological processes and life supporting systems that human survival and development depend on. Also the strategy ensures preservation of genetic diversity which depends on the breeding programmes and technical innovation ensuring sustainable utilisation of species and ecosystems.

Human beings have co-existed with wildlife in a compatible manner since time immemorial. This co-existence has been because man has attached significant values to wildlife which can be justified by Stone Age painting depicting scenes of hunting and species important for human. It is clear that wildlife has long been an important integral

part of the culture of many people in Tanzania as well as in the world (Swanson, 1997). However, this balance and interdependence between people and wildlife is now facing great threat from anthropogenic activities. Poor land use practices and unwise natural resources use have subjected many ecological systems to great threat (BSP, 1993; Karpati, 2003). The environment has been degraded faster in recent decades with some change and shift in land use patterns leading to reduction in the biodiversity in respective areas. These induced human impacts have resulted into natural habitat destructions and over-exploitation of natural resources. Due to these factors, some protected areas (PAs) are now becoming ecological islands because of blockage of migratory corridors and dispersal areas, resulting to loss of wildlife critical areas and extinction. Karpati (2003) and Mpanduji (2004) described these wildlife critical areas to include wildlife corridors, dispersal areas, breeding sites and salt licking areas. These activities on the delicate ecosystem (habitat) exert stress and pressure to the state of equilibrium causing risk of extinctions to certain species. Depending on the stability and interspecies dependency, the extinction of the single or couple of wild animal/plant species could lead to eventual degradation of the habitat (Catling, 2001; Jonsell, 2007; Whitty, 2007; Blake *et al.*, 2009). For that reason, especially in developing world particularly sub-Saharan Africa, human activities have a great toll on the wildlife emanating from lack of environment standards.

Wildlife migratory corridors are the key to the survival of wild animals and ecosystem health but are heavily affected by anthropogenic activities. Their importance lies in the sense that they form a feature that connects two or more otherwise isolated patches of habitats. Animals occasionally move long distances for the purpose of reaching unoccupied and suitable habitat requirement whether breeding, salt licking or just for space. They usually try to use and prefer corridors that are similar to their natural habitat when they are not migrating and if possible avoiding areas that have high concentration of humans

(Tran, 1997). The importance of wildlife corridors in the human context may vary due to spatial and temporal bases. These variations may be due to socio-economical and cultural reasons, but also due to political ecology of a particular nation (Shombe, 2000; Robbins, 2004). Generally corridors have very significant role on biodiversity conservation (Shombe, 2000) because basically they function as a conduit, filter and sink (Cook, 2002; Mpanduji, 2004). However, for a corridor to meet its objective (function and role), various variables are needed, which include size (length and width), healthy ecosystem with ample diversity (i.e. fauna and flora), shape and strata of native vegetation (Johns, 1997; Cook, 2002; Mpanduji, 2004; Jiménez-Osornio *et al.*, 2008).

Igando-Igawa wildlife corridor is an old and still existing corridor. The corridor is an important connection between Mpanga/Kipengere Game Reserve (GR) and Ruaha National Park (NP) (for part formerly known as Usangu GR) (Frontier Tanzania, 2003; Kajembe *et al.*, 2005). Wild animals always migrate from Ruaha NP to Mpanga/Kipengere GR, which acts as a critical dry season refuge for wild animals and Frontier Tanzania (2003) pointed it as an important area for the survival of migratory wild animals from those core PAs. During dry seasons, wild animals move up from the semi-arid lowland Ruaha NP to the highland areas of the Mpanga/Kipengere GR with streams and permanent rivers. Thus the corridor is very useful as it acts as a link between these two core PAs. Despite of its importance to wildlife living on these core PAs, very little is known about threats and conservation status of Igando-Igawa wildlife corridor.

1.2 Problem Statement and Justification

In Africa, corridors do not have any legal protection status; they are just open lands or merely village lands. This has resulted in most of the corridors being blocked and/or lost (du Saussay, 1984). Most of Tanzanian wildlife corridors have been blocked and/or lost as

a result of human activities. For instance agricultural activities and human settlements have resulted to the blockage of Larja, Kilima tembo and Mswakini corridors in the Tarangire-Manyara ecosystem (Kihwele, E. personal communication, 2009). Corridors that connect/link Arusha NP and Longido Game Controlled Area have been lost as a consequence of agriculture, human settlements and extensive livestock grazing (Personal observation). Furthermore, many of the remaining ones (e.g. Kwakuchinja-Mbugwe, Jangwani, Upper Kitete-Selela and Kitendeni wildlife corridors) are under intense pressure (Shauri and Hitchcock, 1999; Kideghesho, 2002). Due to these increased pressure and lack of legal protection, corridors are increasingly threatened unnoticed and eventually unnoticed lost. Although corridors are not legally protected, the PAs connected/linked are legally protected hence their threats have been evaluated and action plan to address them established and in some cases implemented.

The core PAs connected by the Igando-Igawa corridor (viz. Mpanga/Kipengere GR and Ruaha NP) have been surveyed and evaluated and information established (Chamuya, 2002; Frontier Tanzania, 2003). On top of that, wildlife corridors in the 'northern circuit' have been evaluated and their literature available but for this corridor (Igando-Igawa wildlife corridor) very little has been done in terms of survey and evaluation. Despite the ecological role played by the corridor, currently it is under great threats from human activities (Frontier Tanzania, 2003). However, the extent of the threats to the corridor is not well known and compatible activities with the corridor management objectives have not been established as well. Therefore the extents to which these activities impact the corridor need to be determined. Also there is no any information from which long-term monitoring and conservation planning could be undertaken to the benefit of the corridor. Therefore there was a need to conduct a survey to identify and evaluate the threats to the corridor and its current conservation status.

Information established from the study is thus important for effective long-term monitoring and management of human-related activities threatening the existence of the Igando-Igawa wildlife corridor. The information is also useful for conservation and management strategies for the whole ecosystem (Ruaha-Mpanga/Kipengere ecosystem) along with other wildlife corridors in the country. The information will also promote and enhance sustainable land use practice in the area.

1.3 Research Objectives

1.3.1 General objective

To assess the impacts of human activities on the conservation of the Igando-Igawa wildlife corridor.

1.3.2 Specific objectives

- To determine the socio-economic and cultural activities within the corridor.
- To determine the level of disturbances to habitat caused by human activities within the corridor.
- To identify the species of wild animals within and those using the corridor.

1.4 Research Questions

The aim of the current study was to answer the following research questions:

- What are the human activities conducted in the corridor?
- How do these activities affect conservation strategies and possible measures for remedy?
- What is the extent of land-use practices within the corridor?
- What is the diversity and abundance of livestock grazing within the corridor?
- What is the current ecological status of the corridor?
- What are the common wild animals within and those which use the corridor?

- What conservation activities are currently undertaken or under plan?

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Human Activities and Natural Resources Conservation

Human activities vary depending on local condition and type of society. Different societies behave and act differently basing on prevailing traditions, beliefs, educational level and economic status (Kilahama, 2006). Furthermore, all communities and societies rely on natural resources for animal protein, pasture, agricultural products, timber, firewood and charcoal energy and recreational activities (Madaka, 2007). Wildlife as a natural resource on the other hand play a significant role on wildlife related employment creations and community's development. Also wildlife support and regulate services such as nutrient cycling, and sustaining vital ecosystem functions that deliver many benefits to people (Kihwele, 2008). The two forms of wildlife utilization, consumptive and non-consumptive contribute 2% to the country's Gross Domestic Product (GDP) and it is projected to reach 5% by the year 2025 (URT, 1998). In spite of these benefits, well educated and wealthier societies act and perceive things/issues (including natural resources) differently compared to less educated and poor societies (Kassas, 1997; Kilahama, 2006). These differences in perceptions and natural resources utilization are creating much pressure that impacts the ecosystem integrity (Kassas, 1997; Kilahama, 2006). In rural areas, the majority of its people are poor and illiterate or semi-illiterate hence production and consumption patterns are mainly based on land resources with devastative impacts. Even on that, there is a difference in consumption pattern of the local communities in relation to local environment and its natural endowment. The goods and services produced by their daily activities are dedicated upon by prevailing environmental conditions (Bhalla, 1992; Kassas, 1997; Kilahama, 2006). According to Bhalla (1992), Kassas (1997) and Kideghesho *et al.* (2006) the major causes of environmental destruction are poverty, population pressure,

consumption pattern, energy and technology. All in all, poverty has been singled out to be the major cause of global environmental problems as other factors mentioned are dependent on it in a causal-effect relationship (Bhalla, 1992).

2.2 General Threats to Biodiversity

Biodiversity can be defined as the natural variety and variability (variability includes diversity within species, between species and of ecosystems) among living organisms, the ecological complexes in which they naturally occur and the ways in which they interact with each other and with the physical environment (Agrawal and Redford, 2006; Regents, 2006). Threats to diversity are driven by an increasing array of homogenizing forces including the spread of introduced species, the rising impact of human landuse, agricultural business and economic development and also the dominance of humans as principle structures of ecosystems. In general biodiversity is threatened by the sum of all human activities. It is useful to group threats into the categories of over-hunting, over harvesting of natural forest, habitat destruction, and invasion of non-native species. Also these groups are categorised into pollution, and domino effects (Regents, 2006; Whitty, 2007).

It's now a widely held fact that most species are threatened by habitat destruction as it reduces its potential utilities. Habitat destruction could be grouped in three forms viz. degradation and fragmentation due to human activities and outright loss due to human development. While habitat degradation is the process by which habitat quality for a given species is diminished, fragmentation is the process by which a natural landscape is broken up into small parcels of natural ecosystems, isolated from one another in a matrix of lands dominated by human activities. The third form of habitat destruction is outright loss of

habitats which occurs when habitat quality is so low such that the environment is no longer suitable to support the survival of a given species (Hunter, 2002).

Habitat destruction is a single most important cause of known extinctions. This fact has aroused interests from scholars to try predicting the impact to biodiversity from different human activities in both protected and unprotected areas (Barnes *et al*., 1998; Regents, 2006). Habitat alteration by human being activities may explain the recent decline of plant and animal species (Stuart and Stuart, 1996; Barnes *et al.*, 1998; Regents, 2006; Whitty, 2007). There are a number of factors which may cause tree decline in an area, and among others, might include land clearing and habitat fragmentation, intensive grazing, dieback of trees and poor/failed recruitment. Dieback is a condition where trees have a rapid decline in health and may eventually die while poor/failed recruitment occurs as a result of the removal of new growth due to grazing pressures as well as the breakdown of natural regeneration processes (DPMS, 2001; Jurskis, 2009). There are two levels of land clearing which are broad-acre and erosive clearing. Broad-acre clearance is clearance of an area for future agricultural use while erosive one is small but gradual clearance of vegetation for pasture development, grazing and/or other human development (DPMS, 2001; Shaw *et al.*, 2002). Because trees increase faunal diversity by providing forage, shade, and protective cover for animals hence depletion of them has profound impact to the welfare of these wild animals.

Landscapes have constantly changed through degradation and/or loss of original habitat via proliferation of human dominated habitats (Bennett, 2003; Castellanos *et al.*, 2008) and also following the fragmentation of remaining habitats. There are three effects associated with habitat fragmentation which are patch-size effects, edge effects and isolation effects (Johnson, 2001). Patch-size effects are those resulting from differential use or reproductive success associated with habitat patches of different sizes. Patch-size effects may be

induced by edge effects whereby the phenomena such as avoidance, pairing success, predation, interspecific competition, prey availability, or brood parasitism would develop. These effects might be of different consequences with respect to location in a patch (near the edge of a habitat and in the interior of a patch). Finally, isolation from similar habitat could influence use of a particular habitat patch because of reduced dispersal opportunities (Johnson, 2001). The two phenomena (habitat fragmentation and degradation) are known to have negative impact on biodiversity. Such impacts often cause decline in some populations and in some cases extirpation or complete extinction. But also those phenomena may cause some species to overpopulate, especially for those species that are able to adapt habitats fragmentation effects, e.g. helmeted guinea fowls *(Numida melegris)*, Cuban solenodon (*Soledonon cubanus*) and jackals (*Canis aereus, Canis adustus* and *Canis mesomelas*). Cuban soledonon is a primitive insectivore that resembles a large stoutly-built shrew found at Karoo desert in South Africa. Also other animals that may overpopulate in response to habitat fragmentation include deer species (*Odocoileus spp.*) and coyote (*Canis latrans*) (Brewer, 1994; Karpati, 2003). Other opportunistic and adaptable animals that operate well in fragmented habitats include squirrels, crows, bluejays, feral and pet dogs and cats.

2.3 Wildlife Corridors and their Threats

The term “wildlife corridor” can be defined in a number of ways; it can be expanded or constricted depending on the needs, however, it should incorporate space and/or time. A wildlife corridor is defined as a narrow strip of land that differs, usually in terms of dominant vegetation, from surrounding areas and serves as a migrating route for two or more similar yet fragmented areas and provides an important source of food and cover for many species at any given time of their live cycles (Shombe, 2000; Mpanduji, 2004). But according to IUCN (1987), a wildlife corridor is a linear habitat whose function is to

connect or facilitate movement of wild animals between large habitats. For Tanzania, wildlife corridors are defined as an area used by wild animals in their movement from one part of the ecosystem to another, at any given time in search of basic requirements such as water, food, space and habitat (URT, 1998; 2002).

In the world, it is widely recognized that the decisions to allocate land to be a PA are based on three categories of reasons which are pragmatic, socio-economical and ecological. The pragmatic reason is based on factors as low productivity and availability. Socio-economical reason bases on social and economical reasons while ecological bases on naturalness, uniqueness, ecosystem diversity, integrity and size (Kideghesho, 2000; Mpanduji, 2004). In Africa, almost in all core PAs establishment, the basic criteria are socio-economics and pragmatism instead of ecological ones. The tendency has resulted into neglecting, if not abandoning critical areas for survival of wild animals, i.e. wildlife corridors, dispersal areas, foraging grounds, salt licking areas and breeding sites (Kideghesho, 2000; Mpanduji, 2004; Songorwa, A.N. personal communication, 2008). This phenomenon has caused massive land use conflicts between wild animals and human beings resulting into blockage or loss of the critical areas.

These conflicts are caused by most core PAs lacking basic requirement for the wild animals' species (de Vos, 1975; Kideghesho, 2000) as wild animals have different ecological behaviour patterns and basic requirements which may be seasonal or just in a part of their life cycle. These requirements include food, water, mineral salt licks, breeding and refugia which are not available in one core PA or core PAs (de Vos, 1975; Hudson, 1991; Kideghesho, 2000). A population to be in good health and be able to reproduce it needs among many factors, a sufficient area and each population has its own habitat requirements which most of the PAs do not have/meet. When a PA is not large enough for

certain population to maintain itself, there are certain consequences that may ensue. These may include decrease in population size, formation of inbreeding depression, sink population and decreased genetic diversity and eventually extirpation or extinction (Smith, 1990; Hudson, 1991; Tran, 1997). These conditions mark the necessity to have wildlife corridors so as to link at least two PAs which allow animals to disperse in search of their basic needs and to maintain and sustain a viable population.

Alterations and disturbances of the environment worldwide are disrupting natural processes, hence ecological integrity is significantly compromised by human-induced changes (Idso *et al.*, 2003). Wildlife corridors have not been spared from these consequences and in Tanzania, most of these corridors have been lost (Newmark, 1993; Kideghesho, 2002). For example, Lamprey (1964) recognised eight corridors that originated from Tarangire National Park (NP) by which two linked with Lake Manyara NP. The numbers of corridors were dwindling and by 1985 there were only five and currently there is only one of the two wildlife corridors, i.e. Kwakuchinja-Mbugwe corridor (Shombe, 2000). The Kitendeni wildlife corridor is the only remaining corridor linking Kilimanjaro NP and other ecosystems after the blockage of former corridors to Tsavo West NP in Kenya, Arusha NP, Meru Forest Reserve and Mkomazi NP in Tanzania (Noe, 2003).

Furthermore, disappearing trends in wildlife corridors in Tanzania have been observed (Shombe, 2000; Kideghesho, 2000; 2002; Noe, 2003). There are considerable numbers of corridors that are either under great threat, or have already been cut off due to human pressure (Patton, 1997; Barnes *et al.*, 1998; Noe, 2003). Mpanduji (2004) has documented that Selous-Niassa wildlife corridor has already been encroached by humans for various activities and their population density in 2004 was about four people per km^2. Also

according to Hassan (2007), Kwakuchinja–Mbugwe wildlife corridor is threatened from being cut off by human settlement and agriculture. In addition, the current trends in land uses change around major migratory corridors suggest that core PAs are in huge danger of becoming isolated conservation islands (de Vos, 1975; Noe, 2003; Bennett, 2003; Bennett and Mulongoy, 2006). It has also been noted that small East African PAs would most likely lose larger mammal species in the future as a result of their increasing isolation (Newmark *et al.*, 1991; Bookhout, 1996; Bennett and Mulongoy, 2006). Therefore, the loss of wildlife corridor may result into massive death and/or extirpation of migratory species (Newmark *et al.*, 1991). A good example of conservation isolation is of Nairobi NP in Kenya which is found within and completely surrounded by Nairobi city and is fenced by electric wires hence being isolated completely from other PAs and its ecosystem (Personal observation).

2.4 Effects of Habitat Isolation to Wild Animals

According to Patton (1997), wild animals can be grouped into three categories. The first category is habitat specialists (alpha species), animals with small body size and low mobility with high fecundity. Because of low mobility hence their requirements are met in identifiable vegetation. The second category is habitat generalists (gamma species), animals with large body size, high mobility and low fecundity. These characteristics make them to meet their requirements in a landscape. Large mammals may need up to 2 700 km^2 as to maintain a viable population (especially carnivores, e.g. lion). The last category is beta species, animals that are not on the above two categories. These categories are the most important single reason for migration tendency in some wild animal species and the tendency allows gene flow from one locality to another especially for higher animals.

Furthermore in higher animals, the chance of finding two individuals who are genetically identical except for identical twins is very rare (Pianka, 1978; Wong *et al.,* 2005). Also the number of polymorphic gene in at least all higher animals under normal condition is usually ranged between 10%-43% (Chapman and Reiss, 1992; Dubey *et al.,* 2009). In addition, genetic variation is not uniformly distributed throughout species range hence each subpopulation in an entire population has its own genetic variation (Smith, 1990; Hudson, 1991; Rosenzweig, 1992; Mpanduji, 2004). Isolated populations tend to reduce within-population genetic polymorphism and increase genetic differentiation among populations (Dubey *et al.,* 2009). These reasons cause isolated populations to have less genetic variation (Hudson, 1991; Rosenzweig, 1992; Mackenzie *et al.,* 2002). So small isolated populations result into intensive inbreeding, which in turn leads to a phenomenon known as genetic drift. The genetic drift consequences include loss of vigour, reduced fitness, decreased fertility and fecundity, small body size and even massive deaths (Smith, 1990; Hudson, 1991; Dubey *et al.,* 2009). This condition can lead to local species extinction if immediate and effective measures are not taken (Smith, 1990; Mackenzie *et al.,* 2002; Bennett, 2003; Dubey *et al.,* 2009).

According to Smith (1990) and Rosenzweig (1992), there are two existing natural mechanisms to overcome inbreeding. The mechanisms are spatial separation which goes together (synergies) with species abundance and kin-recognition. Spatial separation (and also differences between sexes in dispersal of young) can not be achieved in most of our PAs as they are relatively small and at the same time wildlife corridors that link to adjacent PAs are threatened or blocked and/or lost (Kideghesho *et al.,* 2006). Also kin-recognition is practised by very few animals. Some animals that practised kin-recognition include chimpanzee in Africa, beldings ground squirrel and arctic ground squirrel in North

America (Smith, 1990). Once more, small isolated population as has less genetic variation may go extinct because is more vulnerable to environmental and other stochastic events.

Although habitat destruction (habitat degradation and fragmentation) has been blamed for species extinction, there are other factors contributing significantly. These other human factors include species introduction, new diseases and pathogens introduction, habitat modification and over exploitation of wild animals through legal and illegal hunting, pollution, climate change and domino effects (Stuart and Stuart, 1996; Swanson, 1997; Bennett, 2003; Mpanduji, 2004; Regents, 2006).

2.5 Advantages of Wildlife Corridors

Wildlife corridors make an important contribution by maintaining biodiversity inside and outside core PAs. This is achieved by maintaining genetic variation in any small population where inbreeding is inevitable. Thus, protection, restoration and establishment of wildlife corridors are considered as suitable approaches to improve the ecological values of ecosystems as they enhance ecological networking (Cook, 2002; Mpanduji, 2004; Kisingo *et al.*, 2005; Jiménez-Osornio *et al.*, 2008).

Wildlife corridors have some of these benefits; allows colonisation and recolonisation and prevent inbreeding by allowing gene flows which increase genetic variation. The phenomenon increases vigour, hence increases the ability of the animal to respond to its environment. Moreover they provide refugia during adverse environmental conditions, increase foraging areas and lower incidences of diseases. Also wildlife corridors allow ecological behaviour of a particular species to occur and facilitate movement of animals between patches of suitable habitats (Caughley and Sinclair, 1994; Brewer, 1994; Patton, 1997; Mpanduji, 2004). Additionally wildlife corridors secure the integrity of physical

environmental processes that are vital to the requirements of certain species (Bennett and Mulongoy, 2006).

2.6 Disadvantages of Wildlife Corridors

Wildlife corridors may facilitate/serve as conduit of diseases, pathogens, fire and exotic species. They may act as sink habitats especially if they are much longer while are unfavourable. Also they increase exposure to poachers and predators. Furthermore these areas have cost implication of maintaining them (conservation cost) as sometimes it's much cheaper to translocate the animals than to conserve the corridor (Hudson, 1991; Brewer, 1994; Caughley and Sinclair 1994; Johns, 1997; Mpanduji 2004; Jiménez-Osornio *et al.,* 2008).

In addition, paradoxically, outbreeding also can result into reducing level of genetic variation (homogeneity) hence diminishing fitness (outbreeding depression). This also can lead to species extinction (Caughley and Sinclair, 1994; Bolen and Robinson, 1995). Spread of diseases and pathogens could be more detrimental to metapopulations than individual or grouped animals as corridors could lead to increasing homogeneity rather than variability (Caughley and Sinclair, 1994; Bolen and Robinson, 1995; Tran, 1997).

2.7 Protection of Wildlife Corridors

Practically, Tanzania has no any law that in particular protects or conserves corridors that are critical for the survival of wild animals, but just policies. Before 1998 when the wildlife policy was approved, the country protected the areas through inherited colonial policies and pieces of guidelines and regulations (Noe, 2003). All these efforts were not effective enough to protect biological resources including wildlife habitats (URT, 1998). Inadequate legal protection of these areas has led to blockages and/or loss of wildlife

corridors which is one of the important causes of species extinction (Shauri and Hitchcock, 1999; Kideghesho, 2002).

However, the approved wildlife policy of 1998 has suggested a number of strategies for protecting, conserving, and managing biodiversity (URT, 1998). Integrating wildlife conservation and rural development is a key option. One of the strategies (for integrating conservation and development) is the establishment of the new category of conservation area called Wildlife Management Areas (WMAs) for the purpose of effecting the community based conservation (CBC). WMAs are in the strict sense not PAs but rather quasi-protected areas for which rural/local communities can obtain use rights in order to manage and utilise the wildlife (Baldus, 2004; Kajembe *et al.*, 2005). The practice will provide opportunity for human communities to access natural resources and have sustainable utilisation for enhancement of rural/local development. These areas have prospect for safeguarding the wildlife corridors and other critical areas for the survival of wild animals (URT, 1998; 2002).

CHAPTER THREE

3.0 METHODOLOGY

3.1 Description of a Study Area

3.1.1 Location

The Igando-Igawa wildlife corridor lies in the southern highlands of Tanzania. The corridor extends between Mbarali and Njombe districts in Mbeya and Iringa regions respectively. The corridor lies on the southeast side and about 195 km from Iringa town (Frontier Tanzania, 2003) and 30 km southwest of Makambako Township. The corridor links Mpanga/Kipengere GR and Ruaha NP and can be accessed easily by road. The whole corridor can be easily accessed all year round by Rujewa–Madibila gravel road from Rujewa (Mbarali district headquarters).

The size of the corridor is estimated to be about 50 km long and 13 km wide. The corridor is surrounded by 20 villages, five and fifteen in Njombe and Mbarali districts, respectively. The villages in Njombe district are Igando, Iyayi, Mayale, Lyadebwe and Lyamluki. Villages in Mbarali district are Kangaga, Itipingi, Manienga, Luwango, Igava, Isunura and Ikanutwa. Other villages are Vikae, Iwalanje, Igunda, Igomero, Mkandami, Matemela, Uhamila and Ihanga.

3.1.2 Topography and climate

The altitude of the corridor ranges between 1030 metres above sea level on the north which borders Ruaha NP and 1382 metres on the south part of the corridor which borders Mpanga/Kipengere GR. The landscape consists of valleys and undulating topography on the southern part and plain area on northern part of the corridor. The most important rivers include Balali (Mbarali), Halali and Ruaha.

The rainfall pattern around the corridor is unimodal starting from late November to May with an average annual rainfall ranging from 800 mm to 1500 mm. The southern part with undulating topography has higher annual rainfall than the northern part which is more plain. The area is generally hot with temperature ranging from 18 to 32 ^{o}C and during dry seasons the area is windy and dusty.

3.1.3 Wildlife

The wildlife reported to be found in the corridor varies with respect to seasons; generally the corridor harbours a variety of wildlife species. The wild animals among many include buffalo (*Syncerus caffer caffer*), yellow baboons (*Papio cynocephalus*), greater kudu (*Tragelaphus strepsiceros*), bush pigs (*Potamochoerus porcus*), African wild dogs (*Lycaon pictus*), and jackals (unclear whether black backed and/or side striped jackal *Canis mesomelas* and/or *C. adustus*) and leopards (*Panthera pardus)*. Other animals reported to be found in the area include various snakes, lizards, toads, frogs and avifauna (Frontier Tanzania, 2003).

3.1.4 Vegetation

The area is mostly covered by miombo woodland but open *Acacia* woodland, *Acacia-Commiphora* bushlands and grassland have significant contribution to the vegetation profile of the corridor. Also there are areas of seasonal and permanent wetlands, flood plains and riverine forests along numerous streams and rivers. Miombo woodland/forests are mainly dominated by trees of the genera *Brachystegia, Julbernadia* and *Isoberlinia,* the three closely related genera from the legume family Leguminaceae and subfamily Caesalpinioideae with well developed layers of grasses and shrubs. Most of the southeast parts of the corridor are dominated mainly by open miombo woodland and shrubs. The central part of the corridor between Itipingi and Mkandami villages is dominated by

Acacia-Commiphora bushlands (*Acacia seyal* and *Commiphora africana*) associated with different varieties of cactus plants. These types of vegetation make a large proportion of vegetation on the western part of the corridor up to Ruaha NP, although when it approaches Ruaha NP (in area between Igava and Vikae villages) there is also open *Acacia* woodland (dominated by *Acacia tortilis*). The eastern parts of the corridor are dominated by open *Acacia-Commiphora* bushlands. These two types of vegetation (*Acacia seyal* and *Commiphora africana*) are mainly influenced by the nature and type of soil (clay poorly drained soils popularly known as African black cotton soil) indicating occurrences of frequent floods especially during rain seasons and very high water table.

3.2 Research Design and Sampling Procedures

A cross-sectional sampling design was employed in this study as suggested by Saunders *et al.* (2007). The design allows collection of information at one point in time and is done only once to justify its use. Based on the list of villages from district offices and reconnaissance survey, a purposive sampling of five villages for interviews was performed. Four villages namely Igando and Iyayi in Njombe district and Kangaga and Igava villages in Mbarali district were selected for both household questionnaire based interview (QBI) and focus group discussion (FGD). The fifth village namely Lyamuluki was selected for FGD only so as to try to obtain missing data after failing to conduct QBI. The villages were selected based on two factors, namely location with respect to easy accessibility to the corridor and availability of accommodation to the researcher. Igando and Kangaga villages border with Mpanga/Kipengere GR on the south and Igava and Lyamuluki villages bordering Ruaha NP on the northern part of the corridor. Iyayi village lies on the central part of the corridor. A simple random sampling technique was used to select the sampling unit (household) in order to avoid biases. A sampling intensity of 30 households per village was used as this is regarded to be a reasonable sample size usually used in social science

studies and statistically large enough to make scientific conclusion (Saunders *et al.*, 2007). According to URT (2006), a household is a single person or a group of persons who live together and share living expenses and usually constitutes a husband, wife and children. The household criterion was used in this study because in most rural areas of the developing world, the household is the basic unit of production and reproduction. Moreover in most of African traditions and customs, the household is the basic unit of social structure (Lubida, 2004; de Sherbinin, 2006).

The head of households were the main respondents although in most cases (in married families) both husbands and wives participated in the interview. In addition, other members of the family were encouraged to attend so as to supplement information. The heads of households were focused since in most African traditions and customs they are spokespersons of the household and often major decision makers on important matters concerning the welfare of other members of the household (Lubida, 2004; URT, 2006).

3.3 Data Collection

3.3.1 Primary data collection

3.3.1.1 Socio-economic and cultural data

- **Household questionnaire based interviews**

The survey was conducted using structured questionnaires containing both open and closed ended questions (Appendix I). The method was used to obtain information on land use practices, socio-economic, and cultural activities undertaken in the corridor. Also the technique was used to obtain information pertaining to wildlife using the corridor, their possible migratory habits, and seasonality of presence and traditional migratory routes of migratory mammals as adopted from Mpanduji (2004).

- **Discussions with key informants**

Key informants selected included people knowledgeable with their environment and also able and free to talk to a researcher (foreigner/stranger). Also the criteria include people who were willing to talk about the issue under study and the most influential people in the village. The category included Village Chairperson, Village Executive Officer (VEO), Village Game Scouts and District Game Officer (DGO). The discussion was guided by a checklist (Appendix II) aimed at collecting information concerning movements of large mammals, animals within the corridor along with land uses practices and local human-wildlife interactions within the corridor.

- **Focus group discussion**

Typically FGD involves four to twelve participants depending on interviewer skills and subject matter (Saunders *et al.,* 2007). The category included elders, people who care and understand the ecological aspects, traditional hunters and those who are gender sensitive. The discussion was guided by a checklist (Appendix III). The discussion aimed at collecting information concerning movements of large mammals in the corridors, animals within the corridor, land-uses practices and local human-wildlife interactions within the corridor.

3.3.1.2 Direct field survey data

The survey conducted in the corridor so as to identify wild mammals using the corridor and assess the level of habitat disturbance caused by humans. In addition, the survey aimed at identifying types of human activities performed in the corridor. The exercise was done with assistance from key informants.

After a reconnaissance survey, the corridor was stratified into two parts based on the vegetation types. The first stratum which is significantly large (about two thirds) was the area predominantly of miombo woodland while the second one was of *Acacia-Commiphora* woodland. Five line transects (four in miombo woodland and one in *Acacia-Commiphora* woodland) were systematically conducted in the corridor in order to determine habitat disturbance and presence of conspicuous mammals. Transects were laid across the corridor at an interval of about 10 km apart across the corridor. Each transect has plots of 50 m long and 10 m wide located systematically. A distance from one sampling plot to another was about a kilometre. The pellets/ dung, animal foot prints and other signs were used to identify the species using the corridor. The first transect with eight plots was laid between Igando village and Mji mwema which was one of the hamlets of Kaganga village (about eight km long), second transect between Mayale and Kaganga (about nine km long) also with eight plots and the third one was along Lyamluki–Mkandami and Mkandami-Itipingi villages (about seven km long) with five plots. Other transects were between Igava–Luwango villages (about 13 km long) with eleven plots and between Vikae and Iwalanje villages (about 12 km long) also with eleven plots. A total of 43 plots were conducted on the entire corridor.

The level of disturbance was assessed as the number of standing, cut trees and poles in the stipulated quadrats. Tree was defined as all standing woody plants with straight stems of at least 3 m and diameter at breast height (dbh) over 15 cm; poles as all standing woody plants with straight stem at least 2 m in height with dbh of 5-15 cm and regenerants with dbh below 5 cm (Madoffe and Munishi, 2005). At each sampling point, information was recorded in a field form (Appendix 4), i.e. number of live and number of newly cut and old cut woody plants. Stumps were differentiated into new and old through assessing the level of blackness at the cut point, whereby for newly cut it was assumed that they were cut

within one year period and were pale in colour while the old cut tree stumps were blackish (Madoffe and Munishi, 2005). Encroachments found along transects was recorded according to respective area. Also any other types of disturbance to the environment, e.g. fire incidents, firewood collection, honey hunting was recorded (Madoffe and Munishi, 2005).

3.3.2 Secondary data collection

Literature review was carried out. Source of information was Sokoine National Agricultural Library (SNAL), internet, faculty and department mini-libraries. Other sources are library of College of African Wildlife Management (CAWM)–Mweka, and various documents within district game offices and Mpanga/Kipengere GR offices.

3.4 Data Analysis

3.4.1 Socio-economic and cultural data

Socio-economic and cultural variables were analysed using SPSS package (Statistical Product and Services Solution, version 12). Descriptive statistics was applied to determine frequencies, percentages, mean and multiple responses. Content analysis was used to handle the qualitative data. The components of verbal discussion which were held with key informants and focus groups were broken down into smallest meaningful units of information and tendency. This enabled the researcher to ascertain values and attitude of respondents.

3.4.2 Resource utilisation pressure gradient

In order to obtain the current status and intensity of tree exploitation, the utilisation pressure gradient formula was employed. The formula was (Madoffe and Munishi, 2005):

$$U = (C/D) \times 100\%$$

Where; U = Use intensity,

C = Cut trees / poles,

D = Trees density.

Density was determined by using the following formula (Phillip, 1983):

$$N = n / Plot\ Area\ (ha)$$

Where: N = Number of stems/ha

n = number of stems.

Computer program EXCEL was used to calculate density and use intensity.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Sampled Village Profiles

A total of five villages namely Kangaga, Igava, Iyayi, Igando and Lyamuluki were purposively selected. The QBI and FGD were conducted in the first four villages while in the last village only FGD was conducted. Also a total of 120 respondents were involved in the study. The Table 1 shows village profiles for villages where QBI and/or FGD were conducted.

Table 1: Sampled village profiles

Village Name	Number of Households	Population Size	Sex		Major Ethnic Group
			Male	Female	
Igando	178	678	320	358	Wabena
Iyayi	405	2122	1003	1119	Wabena
Kangaga	803	2830	1177	1653	Wabena
Igava	534	2169	1011	1158	Wasangu
Lyamuluki	298	1381	657	724	Wabena
Total	**2218**	**9180**	**4168**	**5012**	

4.2 Demographic Characteristics

Out of 120 respondents, 61.7% and 38.3% (Table 2) were men and women respectively with their age ranging from 21 to above 60 year. It is more illustrated in Table 2 that people aged between 41 – 50 years constitute 30.0%, 31 – 40 years amounted to 24.2%, 51 – 60 years made up 20.8%, while people aged above 60 years were 15.8% and between 21 – 30 years accounted for 9.2%.

Table 2: Demographic characteristics of respondents

Category		Village				Total
		Igando	Iyayi	Kangaga	Igava	
1: Sex of respondents						
Sex						
Male	Frequency	18	21	20	15	74
	Percent	60.0	70.0	66.7	50.0	61.7
Female	Frequency	12	9	10	15	46
	Percent	40.0	30.0	33.3	50.0	39.3
2: Age grouping						
Age groups						
< 30 yrs	Frequency	4	3	3	1	11
	Percent	13.3	10.0	10.0	3.3	9.2
31 – 40 yrs	Frequency	8	8	7	6	29
	Percent	26.7	26.7	23.3	20.0	24.2
41 – 50 yrs	Frequency	6	7	12	11	36
	Percent	20.0	23.3	40.0	36.7	30.0
51 – 60 yrs	Frequency	6	6	6	7	25
	Percent	20.0	20.0	20.0	23.3	20.8
> 60 yrs	Frequency	6	6	2	5	19
	Percent	20.0	20.0	6.7	16.7	15.8
3: Marital status						
Status						
Single	Frequency	3	2	1	2	8
	Percent	10.0	6.7	3.3	6.7	6.7
Married	Frequency	24	24	28	25	101
	Percent	80.0	80.0	93.3	83.3	84.2
Separated	Frequency	2	3	1	3	9
	Percent	6.7	10.0	3.3	10.0	7.5
Widowed	Frequency	1	1	0	0	2
	Percent	3.3	3.3	0.0	0.0	1.7
4: Family size						
Size						
< 4	Frequency	4	4	4	6	18
	Percent	13.3	13.3	13.3	20.0	15.0
4 – 6	Frequency	13	15	12	11	51
	Percent	43.3	50.0	40.0	36.7	42.5
7 – 9	Frequency	12	9	11	10	42
	Percent	40.0	30.0	36.7	33.3	35.0
> 9	Frequency	1	2	3	3	9
	Percent	3.3	6.7	10.0	10.0	7.5

For the case of marital status, 84.2% of the respondents were married, 7.5% separated, 6.7% single while 1.7% were widowed. As married couple account 84.2% of respondents hence have significant impact on family size. Households with 4 – 6 members, account

42.5% while 35.0% are households with seven to nine members. These two groups (family size 4-9 members) constitute 75.5% of all respondents. Households with members below four are making 15.0% while those with more than nine members are just 7.5% of all respondents. According to URT (2006), the average household size for Iringa and Mbeya regions were 4.8 and 4.9, respectively while for the whole nation was 5.3. Again the average household for Mbarali district was 4.9. Moreover this finding is in agreement with URT (2006) which indicated that households with four to nine members make 54.8% of entire population although for rural areas was 67.5% of rural population.

Generally Tanzania has a young age structure; broad at the base with 44.2% of its total population below 15 years of age and 51.8% between 15-64 years of age generally regarded as working-age group. The old age population (above 64 years of age) constitutes only 3.9% of the total population (URT, 2006). These figures show that over 48.1% of the total population is dependent group. This age structure has an implication of burden of dependency of working-age group. The dependency ratio in Tanzania was high since 100 persons in working-age were supporting 93 people and this is almost the case in all least developed countries (LDCs) (URT, 2006). For the case of regions; the total dependency ratios for Iringa and Mbeya Regions were 94.2% and 90.8% while for youth dependency ratio were 86.5% and 82.2% respectively.

Furthermore, the population statistics indicated that the annual increase/growth rate of the total population in Iringa Region was 1.6% (Njombe district has 2.1% which was the highest in the region) while for Mbeya Region was 2.4% (Mbarali district has 3.0% and was second to Mbozi with 3.1%), while for Tanzania mainland was only 2.8% (URT, 2006). Nevertheless, the burden of old age population per head is normally much

greater than that of children per head as in LDCs, children have a significant contribution to economic and domestic activities (URT, 2006).

The major ethnic groups found in the area are Wabena who make 60.0% of respondents, Wasangu 18.3%, Wahehe 13.3%, Wakinga 4.2% and other tribes make the last 4.2% of respondents (those tribes were Waha, Wapangwa, Wasukuma and Wanyakyusa). Although the majority of those ethnic groups are 'natives' in the area, only 67.5% of respondents were indigenous while 32.5% were immigrants from other areas around the corridor. Despite of being immigrants, 71.8% of them have lived in the area for more than 20 years (38.5% for 20-30 years and 33.3% for more than 30 years). The immigrants started to immigrate to the area since 1970s mainly for agriculture and livestock keeping. Key informants commented that always people tend to cluster around areas rich in resources (particularly biological resources) for their livelihood.

In respect to education (Table 3), results show that 85.0% of the respondents had completed primary school, 9.2% had no any education (illiterate) while 5.8% had completed secondary education. There was no any respondent who had completed a tertiary education. The results revealed that the communities around the corridor are semi-illiterate as the majority of them have just basic education.

Table 3: Education level attained by respondents

Education Level		Villages				Total
		Igando	Iyayi	Kangaga	Igava	
Illiterate	Frequency	5	4	1	1	11
	Percent	16.7	13.3	3.3	3.3	9.2
Primary	Frequency	24	25	26	27	102
	Percent	80.0	83.3	86.7	90.0	85.0
Secondary	Frequency	1	1	3	2	7
	Percent	3.3	3.3	10.0	6.7	5.8

Results also revealed that 73.3% of the respondents depended on agriculture as their major occupation and hence main livelihood activity while 18.3% were government employees or engaged on small businesses. However 4.2% of respondents were livestock keepers and this was their main livelihood activity whereby the other 4.2% were depending on charcoal making. The results also showed that about 47.5% of respondents were involved in two main economic activities to support their living. Most of those respondents (54.4%), ranked agriculture second among other livelihood activities such as business, employment or livestock keeping. Additionally 5% of respondents had at least three major livelihood activities.

The finding tallies with what various authors documented about the relationship between poverty and family size. People who are heavily dependent on subsistence farming (also other manual labours) are likely to have more children to provide much-needed labour, income, to replace those that died young and represent their only superannuation (Mallick and Ghani, 2005). Although agriculture was a major activity for the whole community around the corridor, it was mainly subsistence in nature with most farm works being done manually and hardly any mechanisation. Also it is evident that the communities living around the corridor are poor and semi-illiterate and according to Kilahama (2006), communities like these tend to regard natural resources outskirting them as resources base for their wellbeing. However Agrawal and Redford (2006) and BirdLife International

(2007) have pointed out that poverty is a state of deprivation; and thus causing environmental destruction.

The trend also had shown that local communities on the area had little access to health care and education, which might mean that the next generation is likely to repeat the cycle (that might be termed as a vicious cycle). Despite of the scenario, the relationship between population growth and poverty is neither obvious nor well established as some sociologists and ecologists put forward the argument that rapid population growth aggravates poverty while others argued that could lead the community out of absolute poverty (Mallick and Ghani, 2005). Furthermore, Kelley (1998) pointed out that most studies and ecological setting reveal a strong correlation between deforestation and population growth and which also exacerbates the ecological damages. Despite the arguments on poverty, in the area cultivation has been isolated to be the main livelihood as it was practised by 73.3% of people in the area. Cultivation as a major economic activity in the area accounted for the most destruction in the corridor, thus the activity has a great devastation on the ecology. Cultivation by some studies has been singled out to be the principal route of interactions between humans and the environment which involves transforming land between uses and thus modifying the intensity of land uses (Kassas, 1997; Idso *et al.*, 2003; Dearing, 2006; Finegan *et al.*, 2008).

Poverty could be identified primarily as the inability to meet minimum needs of consumption, notably of food, housing, medical care and education and have five key dimensions viz. economic (income, livelihoods, decent work), human capabilities (health, education, nutrition), political (empowerment, rights, voice), socio-cultural (status, dignity) and protective (insecurity, risk, vulnerability) (Agrawal and Redford, 2006; BirdLife International, 2007). The above criteria for measuring poverty are not always realistic since

for some people/communities, biodiversity is inextricably linked with identity, culture and spirituality hence misleading. To these communities biodiversity is an integral part of their very existence hence categorised as poor (Roe and Elliott, 2005). Maasai people present a good example of the failure of those criteria as in most cases these people are considered as poor. Despite the fact that all humans are dependent on biodiversity for the goods and services it provides, poor people appear to be in particular more dependent (Kassas, 1997). The phenomenon might be true due to lack of financial and technical capacities that results to direct use of biological resources for food, fuel, medicine and shelter as the only way to their basic needs.

4.3 Background Information of Igando-Igawa Wildlife Corridor

Discussions with key informants have revealed that PAs adjoining the corridor were established so as to curb the electricity problems which were hampering the country in the early and mid 1990s. In late 1993 and early 1994, for the first time in living memory Great Ruaha River completely run dry for more than a month. The consequences of river drying up was seen downstream where the river drives two hydro-electric power stations (Kidatu and Mtera) that supply over half of Tanzania's electricity (Mtahiko *et al.*, 2006). Thus, the principal reason for establishment of Usangu GR, Mpanga/Kipengere GR and Kitulo NP was conservation of water catchments areas found within those now core PAs. In 1998 the former Usangu GR was established for the purpose of protecting and conserving Ihefu wetland which by then, was thought to be a source of Greater Ruaha River. In late 1990s it was proved that, Ihefu was not a real true source of Ruaha River but the real source was in Mpanga/Kipengere upper catchments areas found in Makete, Njombe and Mbarali districts. The actual source of Great Ruaha River is in Luhanga area inside Mpanga/Kipengere GR. The observed situation forced Tanzania government to establish

Kitulo NP and Mpanga/Kipengere GR in 2002. Rivers from these areas which fill Ihefu wetland include Balali (Mbarali), Kimani and Kimbi rivers.

The three named areas (i.e. Usangu GR, Mpanga/Kipengere GR and Kitulo NP) were heavily degraded from human dominated activities. In Usangu GR especially in Ihefu wetland, a great population of the basin was sustained by irrigation and the water-related livelihood such as fishing and livestock keeping. Irrigation in the basin was the major activity and the largest water user (Mtahiko *et al.*, 2006). Also the basin was degraded by livestock keepers who came to the area in late 1960s and/or early 1970s with a huge number of livestock. In Mpanga/Kipengere GR activities were mainly charcoal making and cultivation near and around water catchment areas. In Makete district, one village named Ikovo which was very close to the source of Kimani River in Mpanga/Kipengere GR which consequently affect the water flow. Human activities near that river which were mainly cultivation (irrigation and horticulture) were causing decrease of water flow thus subsequently hampering ecological status of Ihefu wetland. A part of Kitulo NP was a dairy farm owned by DAFCO (Kitulo Dairy Farm Company) since 1965. From mid 1970s encroachment started in the area, partly because of poor management of DAFCO to the extent that in 1979 a village namely Kikondo in Kitulo ward was registered. Main activities conducted were cultivation of pyrethrum, Irish potatoes and extensive grazing. Other human activities conducted in Kitulo NP included logging, free range grazing and reckless wildfires which had a significant effect to the biodiversity of entire ecosystem (Mwakilema and Davenport, 2005). All of those activities have great impacts to the environment.

In 2005/2006, Danish International Development Agency (DANIDA) opted to support materially water catchment areas in Usangu and Mpanga/Kipengere. Since 1998, the

government of Tanzania emphasises the need to conserve and protect wildlife critical areas (URT, 1998), then Usangu GR leadership asked DANIDA to allow using some fund for restoration of the Igando–Igawa wildlife corridor. The fund from DANIDA was used for conservation awareness campaign, demarcating corridor boundaries and establishment of community based organisation (CBO) as well as the WMA. Currently the CBO and WMA known as UMEMARUWA (*Uhifadhi na Matumizi Endelevu ya Maliasili Tarafa za Rujewa and Wanging'ombe*) which literary means Conservation and Sustainable Utilisation of Natural Resources in Rujewa and Wanging'ombe Divisions and is in stage three of its establishment.

The above explanations is in agreement with the reports by Kideghesho (2000) and Mpanduji (2004) who indicated that the establishment of PAs in Africa are based in two major categories which are pragmatic and socio-economic rather than ecological ones. The establishment of Ruaha NP in 1964 never consider ecological aspect thus what was then Usangu GR was neglected despite its importance to the welfare of wildlife and other biological resources found in that particular ecosystem (Ruaha-Mpanga/Kipengere ecosystem). Also Igando-Igawa wildlife corridor and Mpanga/Kipengere GR were established soon after the wildlife policy of Tanzania was approved in 1998 (Noe, 2003). Also this concur with du Saussay (1984), who documented that there was a lack of legal status to protect, preserve and conserve wildlife critical areas in Africa.

4.4 Ecological Status of the Corridor

4.4.1 Level of habitat disturbance in the corridor

Results from field survey indicated that the corridor was highly utilised before conservation activities/campaign begun. The Student's t-test revealed a significant difference on the use of vegetation resources in the corridor especially before conservation

campaign begun. The mean of extracted tree resources (mean ± standard error: 22.40 ± 2.10, n = 43) was significantly larger than the mean of live trees (14.30 ± 1.59, n = 43). In addition, the results had shown that resource utilisation pressure gradient in the same time in the corridor was significantly higher (p = 0.0001, t = 3.07, n = 43). The results tally with that of the forest vegetation use intensity which indicated 61.9% to be a use intensity of vegetation resources in the corridor (Table 4). Results in Table 4 show the density of dead and standing (live) trees was 705 individual trees per hectare but the density of live standing trees was only 269 hence extracted tree resources density was 436 individual trees per hectare. According to Isango (2007), trees density in miombo woodlands of Tanzania ranges between 74–1 041 individual trees per hectare which might implies that tree density of the corridor is still good. Despite the argument, amount of trees extracted (about two thirds of trees in the corridor) have a significant impact to the ecological status of the corridor which consequently hampers the proper functioning of the entire ecosystem. Impacts associated with the scenario include interrupting and affecting interspecies dependencies which could eventually lead to extirpation and/or extinction depending on the stability of the ecosystem (Catling, 2001; Jonsell, 2007; Whitty, 2007; Blake *et al.,* 2009).

Table 4: Forest vegetation use intensity in Igando-Igawa wildlife corridor

Transect Number	Total Plots	Plots size(Ha)	LT*	DT*	LT density	DT density	Overall density	Use intensity
1	8	0.40	136	258	340.0	645.0	985.0	65.5
2	8	0.40	117	226	292.5	565.0	857.5	65.9
3	5	0.25	24	46	96.0	184.0	280.0	65.7
4	11	0.55	202	258	367.3	469.1	836.4	56.1
5	11	0.55	136	175	247.3	318.2	565.5	56.3
Total	**43**	**2.15**	**615**	**963**	**1343.1**	**2181.3**	**3524.4**	**309.5**
Average	**8.6**	**0.43**	**123**	**192.6**	**268.6**	**436.3**	**704.9**	**61.9**

* LT = Live trees and DT = Dead trees.

Furthermore, there is a significant difference on use intensity between the two vegetation types viz. predominantly miombo woodland and *Acacia-Commiphora* woodland although

the difference was very minor. The mean of miombo woodland (24.63 ± 2.52) was significantly larger than of *Acacia-Commiphora* woodland (15.18 ± 3.15) ($t = 2.16$, $p = 0.02$, $n_1 = 32$, $n_2 = 11$). The difference might be caused by different human activities in the corridor with respect to location. Charcoal making, cultivation (of maize, simsim and sunflowers) and firewood collection (for bricks baking and tobacco processing) were major human activities on the southern part of the corridor which is predominantly miombo woodland. These activities have a great undesirable impact to the vegetation resources in the corridor. On the northern part which is predominantly *Acacia-Commiphora* woodland, human activities include intensive free range grazing of livestock, firewood collection (for bricks baking), cultivation (paddy and peanuts). These activities are relatively "friendlier" to vegetation resources than the former activities especially charcoal making.

Moreover there was no significant difference ($t = 1.53$, $p = 0.065$, $n = 43$) on the extraction of tree resources based on the maturity (mature trees and poles). The mean of cut mature trees was 12.58 ± 1.49 and 9.76 ± 1.10 of cut poles. The results indicate that the communities around the corridor were using poles and mature trees equally. These tree resources were mainly used for charcoal making, firewood for various purposes, building and construction of houses and livestock sheds.

On average, all transects were disturbed but only at a varying degree although there were statistically no significant difference ($t = 1.58$, $p = 0.075$, $n = 5$) among them. The deviation was essentially caused by different human activities on each transect. On transect number one the most important livelihood activity was charcoal making, transect two were firewood collection while on transect three the main activity was cultivation. The fourth and fifth transects, main livelihood activities were livestock keeping and cultivation (basically paddy and peanuts). There was no difference ($t = 1.58$, $p = 0.075$,

n = 5) among transects on harvesting of poles and withies in the corridor because of dependency of local communities on these resources and for bush clearance for cultivation. Human settlement was also among important factors which degraded the corridor. These various human activities and settlement in and around the corridor are compromising variables needed for proper functioning of the corridor. The variables include size (length and width), healthy ecosystem, ample diversity, shape and stratum of native vegetations (Johns, 1997; Cook, 2002).

In addition, wildfires were another agent of vegetation resources depletion. In the corridor there was evidence of wildfires especially on the southern part of the corridor bordering Mpanga/Kipengere GR than central and northern part. Causative agents of wildfire were bush clearing for cultivation, poaching, un-extinguished charcoal kilns and arsonistic reasons.

Most of tree resources which were in high demand include poles and withies which were basically used in construction of houses (mainly roofing) and livestock sheds. Other factors which cause vegetation resources depletion in the corridor include wildfires, extensive free range grazing and logging for timber although in a small scale. The removal of these vegetation accounts for a significant proportion of disturbance in the named wildlife corridor. A Table 5 shows that trees were in high demand as compared to poles in both cuts (new and old) in all transects. Regardless of the argument, statistically (Student's t-test) the study revealed that there was no significant difference (t = 1.53, p = 0.065, n = 43) between trees and poles extraction.

Table 5: Use intensity of new and old cuts of trees and poles in the corridor

Transect	**Trees**	**Poles**	**Trees**	**Poles**

number	NC* density[@]	OC* density	NC density	OC density	NC use intensity	OC use intensity	NC use intensity	OC use intensity
1	92.5	347.5	57.5	147.5	9.4	35.3	5.8	15.0
2	12.5	300.0	47.5	205.0	1.5	35.0	5.5	23.9
3	0.0	20.0	28.0	136.0	0.0	7.1	10.0	48.6
4	101.8	158.2	63.6	145.5	12.2	18.9	7.6	17.4
5	11.0	156.4	20.0	131.0	2.0	27.7	3.5	23.2
Total	**217.8**	**982.1**	**216.6**	**765.0**	**25.1**	**124.0**	**32.4**	**128.1**
Average	**43.6**	**196.4**	**43.3**	**153.0**	**5.0**	**24.8**	**6.5**	**25.6**

* NC = New cuts and OC = Old cuts, [@]Density = Plants/ ha.

The survey showed that people in vicinity to the corridor were clearing the forest to acquire land for cultivation, charcoal making and firewood collection. Furthermore intensive free range grazing, logging and wildfires have contributed significantly on affecting the ecological status of the corridor. Also those factors have resulted in the fragmentation of the corridor. The corridor has been almost fragmented because of anthropogenic disturbance, the area along Lyamluki, Mkandami and Itipingi/Kangaga villages, humans' settlement and cultivation have a immensely devastated the corridor. The situation could undermine the integrity of whole ecosystem with disastrous implications for wildlife and other biological resources. There are three which result from habitat fragmentation; patch-size effects, edge effects and isolation effects. Each of these effects (patch-size, edge, and isolation effects) can affect the occurrence, density, or reproductive success of animals in a habitat patch (Johnson, 2001).

The removal of woody vegetation is among practices within the livestock keeping practice especially in free-range grazing. Plants were killed and/or removed by clear-cutting or wildfires purposely for acquiring area for cultivation or to stimulate early growth of pasture for grazing. Impacts associated with the practise include alterations in soil health, hydrology and salinity. Other impacts include changes in vegetation structure, plant species composition and density. Livestock keeping especially that bordering Ruaha NP

has resulted in tree species to experience dieback condition. This was due to soil fertility change, failed recruitment which leads to soil erosion and compaction caused by intensive grazing.

4.4.2 Impacts of conservation activities on ecological status of the corridor

Conservation activities in the corridor which begun in the 2005/06 have significant positive impacts on the ecological status of the corridor. Student's t-test revealed that the mean of old cuts (18.21 ± 1.80) was significantly larger than that of new cuts (4.19 ± 0.80) ($t = 7.11$, $p = 0.0001$, $n = 43$). The figures suggest that the extraction of tree resources in the corridor was reduced significantly. Also Table 5 showed the dramatic decrease in extraction of new poles and trees in the entire corridor. The extracted densities of trees per hectare were 196.4 and 43.6 for old and new cuts respectively. The densities of poles extracted in the corridor were 153 and 43.3 poles per hectare for old and new cuts respectively. The data indicates there were significant improvement of the corridor conservation status that begun in the fiscal year 2005/06. This finding is in agreement with other results from social survey which suggests significant improvement on ecological status of the corridor. The results (Fig. 1) show that about 75.0% of respondents indicated that current ecological status of the corridor was fair and about 11.7% suggested that the corridor was in good condition (almost reached optimal ecological status) while 13.3% suggest that the ecological situation was still poor.

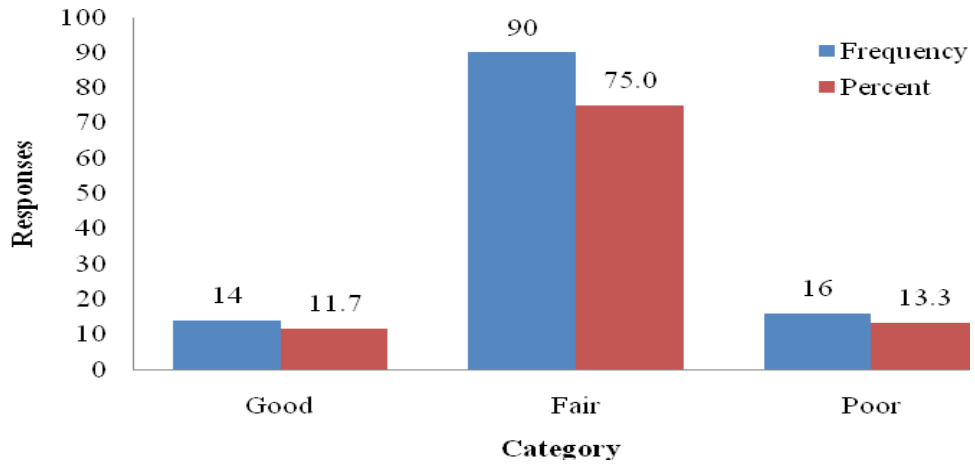


Figure 1: Perception of people toward the status of the corridor

The improvement of ecological status of the corridor was the result of conservation education awareness raising campaigns carried out by leaders of the former Usangu GR with the aim of restoring the corridor. The campaign resulted in the reduction of human's population and their activities as well as identification of compatible activities inside the corridor. Discussions with local communities around the corridor and other influential individuals justify this scenario. Data from QBI had shown dramatic decrease of local population dependency to the corridor. About 67.5% of 120 respondents indicated that after the conservation awareness campaign was introduced, the dependency was just fair while 9.2% suggested it was low. Nearly a quarter (23.3%) of people interviewed claimed the dependency in the corridor is still high. There are two reasons to justify the notion. Firstly, about quarter of the population around the corridor still depend on it for their livelihoods. Secondly, poor people did not consider conservation as means to enhance and improve their present well being and also indifferent to measures which just aim at the well being of the future generations. The phenomenon might be due to the influence of poverty of local communities, hence, are forced and driven by subsistence requirements for their dire survival.

In addition respondents claimed that the intensity of activities that still carried out inside the corridor is considerably high. QBI shows that 55.0% of respondents claim that the intensity of those activities is still high, 41.7% claim to be fair, while 3.3% indicated that it is very low.

The results and field survey had indicated that the corridor's ecological status had improved drastically for a short period of time since conservation activities begin. Environmental condition (hence habitat) was improving thanks to nature of miombo woodland, resilience. Miombo woodlands are naturally resilience to disturbances so able to regenerate easily when pressures subjected to it are removed or minimised. Wild animals had steadily returning inside the corridor as dispersal area or as a dispersal area and a migratory route. Some of the animals returning in the corridor were not seen for a long period of time and were seen either migrating through or roaming in. These wild animals include wild dogs, zebras and greater kudu. Generally, the results indicated that, with little conservation efforts that include human component (local communities) in planning and implementation, reasonable achievements become eminent.

4.4.3 Reasons for local community continue using the wildlife corridor

Although conservation activities are of high agenda, small proportions of people still continue to utilise the area for their day-to-day lively activities. About 23.3% out of 120 interviewees still rely on the wildlife corridor for their living (Table 6). This scenario showed that the extent of these activities has been reduced since conservation campaign started. Those communities have different reasons of supporting their actions.

Even though the corridor was heavily encroached by people for their livelihoods needs, still there is more vegetation and other natural resources (biological resources) hence

possesses a different weather condition (microclimate) compares to adjacent villages. The area has relatively higher and stable rainfall compared to nearby villages. This was a key reason to local communities around the corridor to use it. There are also two other factors which attracted local communities to continue using the corridor. The factors included the lack of any legal protection that can support conservation and the land scarcity problem along the corridor. More over some local people were narrating that there was shortage of land and at the same time some villages are overpopulated. In order to curb the problem of land scarcity and overpopulation, some villages have created effective the land use plan.

Table 6: Reasons for people using the wildlife corridor

Reasons	Responses	Percent
Good soil for cultivation and easy availability of NRs	59	38.3
No legal protection of the corridor	29	18.8
Overpopulated villages	26	16.9
Easy availability of natural resources (NRs)	22	14.3
Good soil for cultivation	18	11.7
Total	**154**	**100.0**

4.5 Socio-economic and Cultural Activities within the Corridor

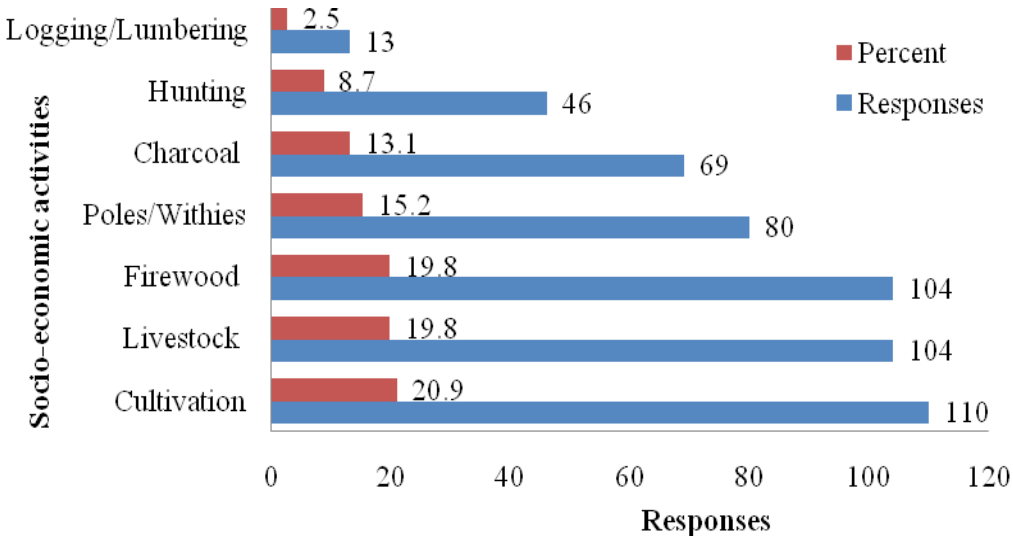
4.5.1 Socio-economic activities

There are various activities both socio-economic and cultural that were carried inside the corridor. There were seven leading activities (Fig. 2); cultivation was the most prominent activity whilst lumbering was the least one.

According to FDG and personal observation, crops that were mostly cultivated include maize (*Zea mays*), sunflowers (*Helianthus annuus*), and groundnuts/peanuts (*Arachis hypogaea*), paddy (*Oryza sativa*) and saseme/simsim (*Sesamum indicum*). Tobacco was the main cash crop in Mayale village from 1967 but the cultivation was abandoned in early 2000s. The cultivation was abandoned partly due to shortage of firewood for tobacco processing and high cost of cultivating tobacco. Groundnuts inside the corridor were

mainly cultivated in areas adjoining Ruaha NP because the soil inside the corridor was very suitable for groundnuts/peanuts than outside the corridor. Other crops were equally distributed between farms inside and outside the corridor. Again since the northern part of the corridor experiences periodic flooding, paddy was widely cultivated at small scale manner for both commercial and food purposes.

Figure 2: Responses on socio-economic activities inside the corridor



Livestock and firewood collection were second mostly practiced activities in the corridor (Fig. 2). Although livestock keeping was among the top two activities, indigenous communities seldom practiced this form of livelihood. This form of livelihood was mainly practiced by immigrant communities especially Sukuma, Mang'ati and Maasai people. Discussion with Mr. Iman Kaili (Mbarali DGO) revealed that, Sukuma people started immigrating to the corridor as early as 1972 with huge stocks of livestock including cattle, goats, sheep and donkeys.

These Sukuma people are agropastoralists, thus, they also own large areas of land for cultivation, where they mostly grow maize and paddy. Other two tribes came in the area in

the early 1990s searching for pastures for their huge stocks of livestock. There were two forms of livestock keeping in the area. The first form was that practiced mainly by indigenous people whereby the corridor was just a grazing area. The second form was practiced mainly by immigrants whereby livestock were living permanently inside the corridor.

Firewood collection was mainly for domestic use and commercial purposes. Firewood for commercial purposes was sold to local urban centres and within villages where it was used for bricks baking as most of houses in the area was built by using baked bricks. Because of high demand of firewood for bricks baking, people instead of collecting only dead woods, they also cut or debark trees so as to meet the demand.

Illegal harvesting of poles and withies was the fourth activity done inside the corridor. The products were mainly used for building/constructing houses and livestock sheds. Poles and withies were mainly used for livestock sheds building by both indigenous and immigrant communities. Immigrant communities have double tragedies to the corridor. These communities live inside the corridor with their huge livestock consequently cut down a substantial amount of trees to build livestock sheds. Furthermore, the immigrant communities as were residing inside the corridor, they were clearing a considerable area of land to give room for livestock sheds.

The fifth activity was charcoal making. The product was mainly for commercial purposes. According to FGD conducted in all four villages, charcoal business was the root cause of informal establishment of the Igando village in 1974 by immigrants mainly from Njombe highlands. Even today, the charcoal making and business is concentrated on the southern part of the corridor especially along Iringa–Mbeya highway (mainly in Igando and

Igomero villages in Njombe and Mbarali districts respectively). On the northern part of corridor, the activity was less prominent but firewood collection was more visible.

Hunting for subsistence was the sixth activity carried out in the corridor. According to FGD and DKI, the bushmeat was consumed within the local communities and very little was transported to local urban centres like Wanging'ombe, Ilembula and Rujewa. The most consumed animals were bushbuck (*Tragelaphus scriptus*), greater kudu (*Tragelaphus strepsiceros*), dikdik (*Madoqua kirkii*) and bushpigs (*Potamochoerus porcus*). Also birds like doves, pigeons, guinea fowls (*Numida meleagris* and *Guttera pucherani*) and francolins (*Francolinus spp.*) were among wild animals that were hunted. There were various means used in hunting wildlife including snares, dogs, traditional weapons (e.g. spears, arrows and bows) and firearms (i.e. muzzle-loader guns popularly known as *gobore*). Also fires were used as a tool in hunting activities as it scares and drive animals to direction hunters' want. In most cases the hunting was done at night by using flashlights.

The least activity noticed to be carried out was logging for lumbering. The entire corridor has limited number of mature trees which might be a contributing factor for logging/lumbering to be a minor activity. Personal observation during field survey show that even in areas where miombo woodland is dominant, there were very few trees with more than 30 cm dbh.

4.5.2 Cultural activities

There were only two cultural activities in an area during the study. These activities (Fig. 3) were collection of traditional medicine and ritual ceremonies. Collection of traditional medicine was the single most practiced activity inside the corridor (60.7%, n=120). The basic reason of this scenario is that local communities around the corridor depend

heavily on informal health services (traditional medicine) as formal ones are not easily accessed. There were two reasons, distance from villages to those facilities and transportation (i.e. roads and means of transport). There were two nearby hospitals namely Ilembula Lutheran and Mbarali District Hospitals which were very far from the villages around the corridor. Mayale was the only nearby village to a hospital (Ilembula hospital) which was more than five kilometres away.

Ritual activities were practiced by few people (30.4%). According to FGD and informal discussion with local people, the only practice they perform was visiting their ancestor shrines for various purposes and reasons. Also very few respondents (8.9%) said that they do not know and not aware of the practice within the community.

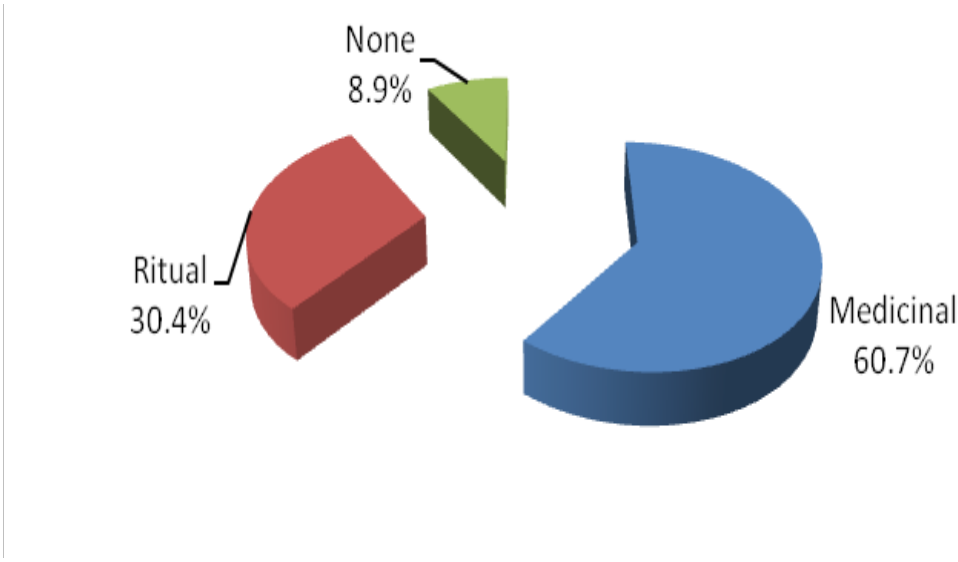


Figure 3: Responses on cultural activities in the corridor

4.5.3 Wildfires

According to Nangendo (2000) fire is one of the tools that have been used by indigenous communities in vicinity to any forest through history for several domestic activities. These activities include clearing and fertilising the land, recharging pastures, purging fields of pests and disease, protecting lands against late wildfire and for hunting. This argument coincides with the finding of the study. The survey indicated that the wildfires in the corridor could be categorised as a socio-economic activity because in most cases they were used as a tool to achieve certain socio-economic goals.

Those fires were often used by poachers to drive wild animals from cover, by pastoralists to reduce woody vegetation and stimulate early growth of pasture and by farmers for clearance of bushes ready for cultivation activities. Thus most of the fires were ignited deliberately as sometimes with “good reasons”, accidental (e.g. when a fire on extracted charcoal kiln is left un-extinguished) or just for a fun (arsonistic reasons).

Direct field survey and social surveys indicates the frequent incidences of wildfires on the corridor. Both surveys demonstrated that on the southern parts of the corridor was more prone to fire incidents as compared to the central and northern parts. QBI showed that 69.2% of respondents agree that wildfire was the problem as it occurs more often at least at every dry season, and only 30.8% stated that there were no wildfire incidents in the corridor. Although 30.8% suggested that wildfire was not an issue of concern, they further commented that it was only on the past three to four years ago, when the conservation awareness campaign was not yet. On the other hand, 64.9% of interviewees who reported that there was no wildfire incidents in the corridor came from villages in Mbeya region and only 36.1% from Iringa region.

It was not easy to establish in a precise manner why that huge difference in perception concerning wildfires in areas just separated atmost by 13 km apart. The only reason put forward were poaching was so intense in area near the highway and accidental fires from charcoal kilns.

Miombo trees are well adapted to fires intensities having thick barks, vegetative insulation, above ground resprouting, below ground and underground stems (Kikula, 1986; Cauldwell and Zieger, 2000). Although miombo woodlands and fire have coexisted together for years to the extent that miombo would not flourish in absence of fire, fires that occur too often can lead to loss of native plant and animal species (Mapaure and Campbell, 2002). Late-season burning inhibits the regeneration of trees, leading to a loss of the tall canopy-forming trees of the genera *Brachystegia*, *Julbernardia* and *Isoberlinia* because at that particular time fire is very intense. Frequent wildfires gradually remove the kinds of trees or understorey plants that are not able to withstand repeated fires and replace them with hard, thick barked, often inedible plants or might convert miombo woodlands to open woodlands of fire-tolerant trees that are dominated by tall grasses. These repeated fires mostly have a severe and negative effect on wildlife. Also fire has a tremendous impact on ground nesting birds, reptiles, insects, creeping animals, sick animals or even young ones of larger animals (Mapaure and Campbell, 2002).

Local communities were aware of all of the consequences of the fires on the biodiversity and the environment in general. The results indicate that 52.5% of QBI respondents claimed that fires kill insects, small and creeping animals while 25.0% of respondents suggest loss of cover and fodder to animals. Also 22.5% of respondents' claimed that fires in general leads to depletion of animals as it increases predation (of both animals and humans) as well as killing a plentiful of small and creeping animals.

Also those respondents (22.5%) further claimed that fire reduces quality and quantity of fodder. Besides that argument, Moe *et al.* (1990) documented that sprouting plants are of high quality compared to unburnt plants. The sprouting plants have high amount of protein, calcium, potash, phosphorus as well as other potential elements. Also it have been found that in some cases, sprouting plants have 75-100% more protein than unburnt plants (Moe *et al.*, 1990). For the case of impacts caused by wildfires on habitat, 49.3% of QBI respondents (Fig. 4) indicated that fires kill regenerants and seedlings and also burn seeds. About 33.3% of respondents claimed fire to cause and/or exacerbate vegetation destruction while 10.0% claimed fire was causing deforestation. Also some of respondents (8.4%) indicated that these wildfires destroy and deplete pastures and kill some trees which can not tolerate fire.

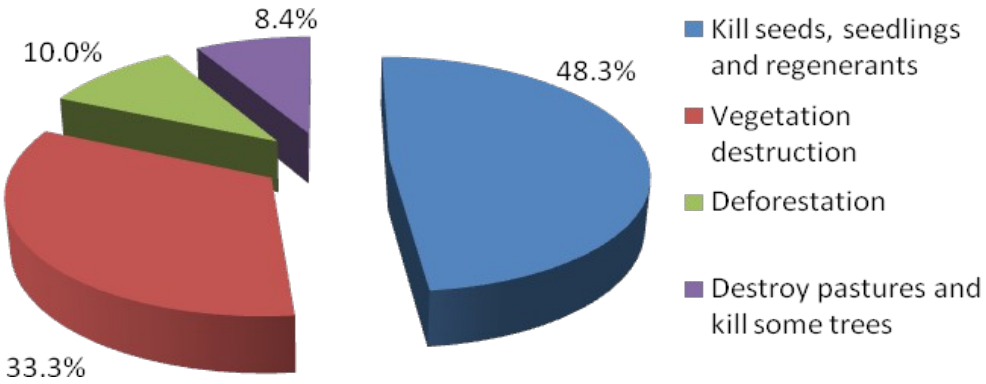


Figure 4: Responses on the impacts of wildfire to habitat

4.5.4 Extraction of non-timber forest resources (NTFRs) from the corridor

A non-timber forest resource refers to natural resources collected from the forest apart of sawn timber. According to SCBD (2001) and Chamberlain *et al.* (2004), NTFR is “all the biological material (other than industrial round wood and derived sawn timber, wood chips, wood-based panel and pulp) that may be extracted from natural ecosystems, managed plantations, etc. and be utilized within the household, be marketed, or have social, cultural or religious significance”. Other authors like Chamberlain *et al.* (2004) and Chamberlain (2006) have put forward that wildlife or other fauna are not generally included in the definition.

NTFRs could be categorised into four groups; culinary products which might include fungi, ferns, roots and tubers and specialty wood based products which include produces from trees and tree parts with exclusion of produces from sawn timbers. Other groups are floral and decorative products as well as therapeutic (medicinal) products and dietary supplements (Chamberlain, 2006). Based on those categories, people around the corridor have been relying heavily on the NTFRs for their supplementary nutritional needs (Fig. 5) whereby 29.2% of responses were for medicinal products and dietary supplements (e.g. fruits, vegetables and mushrooms). As stated earlier local communities depend on those products, especially medicinal ones because formal health services were not easily accessed. Dietary supplements were primarily used as supplementary to diets predominated by starchy staples as valuable sources of nutrients that are deficient in starchy staple diets. Also these dietary supplements were used as an alternative source of income to households. The second mostly utilised NTFRs was specialty wood based products (25.3%) which were thatch grasses, withies as well as poles and were mainly used for house and livestock sheds constructions.

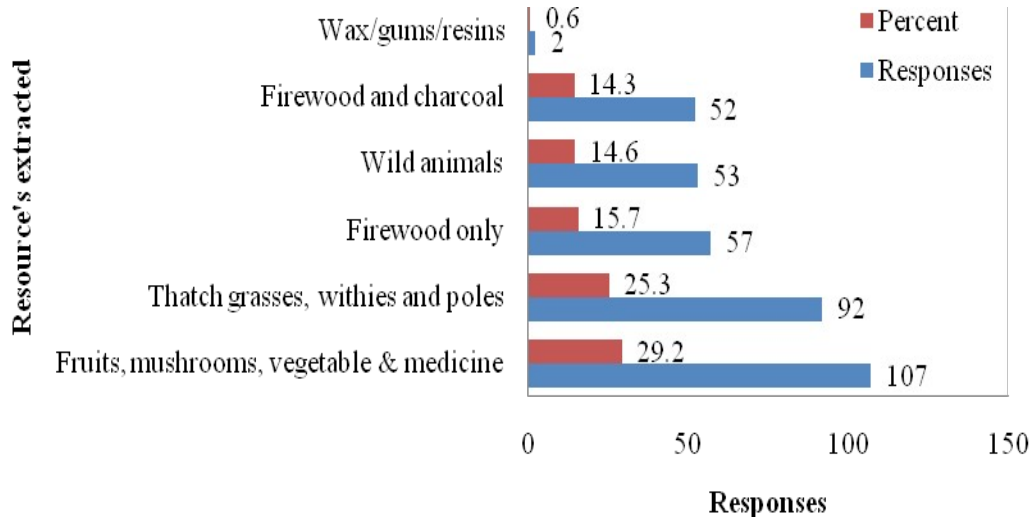


Figure 5: Types of NTFRs extracted from the corridor

The least resources extracted in the corridor were wax/gums/resins (with 0.6% of responses) as there was no particular appropriate use of them to population in vicinity to the corridor.

There was a controversial result concerning extraction of wild animals in the corridor. The result of socio-economic activities revealed that hunting/poaching were less practised activities in the corridor while data from NTFRs indicates that extraction of wild animals was among the moderate activities. The deviation was mainly caused by the perception of local communities on the word hunting/poaching. The local communities were considering hunting to be only extraction of big games but when answering for NTFRs, the word mean extraction of all fauna including small sized animals and birds. Also the local communities do not like to talk about hunting, because in most cases, it is illegal activities and hence are worry for penalties.

4.6 Wild Animals in the Corridor

4.6.1 Trend of wildlife in the corridor

About 92.5% of QBI respondents regardless of their interests on conservation issues had the same opinion that for atmost five years now, wildlife in the corridor were significantly increasing while only 7.5% said that wild animals were decreasing. Also all people concerned with wildlife conservation (e.g. Districts Game Officers, staff of Mpanga/Kipengere GR, leaders of UMEMARUWA) and FGDs agree that animals were increasing. The results indicate that conservation activities in the area around the corridor have a significant impact to local communities on raising their awareness toward wildlife, wildlife habitat and environment in general. According to local communities there were at least five reasons (Table 7) to justify why animals were increasing in those years.

Even though the communities have put the reasons in five categories (Table 7), in real sense is just one reason which is the increase of conservation activities in Mpanga/Kipengere-Ruaha ecosystem. Wild animals began to increase inside the corridor soon after the establishment of Usangu GR in 1998 and Mpanga/Kipengere GR in 2002. In addition, eviction of humans from Usangu wetland (specifically in and around Ihefu swamp) in mid 2006 resulted in substantial increase of wild animals in the corridor.

Table 7: Factors contributing to increase of wildlife in the corridor

Factors	Responses	Percent
Increase of conservation activities inside the corridor	57	29.7
Eviction of humans and conservation of Ihefu wetland	46	24.0
Participatory NR conservation and management	42	21.8
Decrease of humans and their activities in the corridor	34	17.7
Increase of conservation awareness	13	6.8
Total	**192**	**100.0**

Human population in Usangu plain had grown up from 31 000 in 1948 to around 210 000 in 2002 and their major occupation was agriculture in the form of farming and livestock

keeping (Landford and Franks, 2000; Mtahiko *et al.,* 2006). Usangu plains cover an area of about 5800 km^2 while the wetland covers about 2000 km^2 and the core of the wetland (locally called Ihefu) was a permanent wetland (Mtahiko *et al.,* 2006). Exact populations of livestock in the plains was not known but was predicted to be around two million which is a huge number in a small area especially during dry seasons. Presence of humans and their activities including livestock in Usangu plains force wild animals to move deeper inside Ruaha NP and blocking the movement of the animals within the same ecosystem. But soon after the eviction of agropastoralists in mid 2006, wildlife moved in and thus restore the connectivity between Ruaha NP and Mpanga/Kipengere GR through the corridor as a result the number of wildlife increased dramatically.

4.6.2 Variety and occurrence of wild animals in the corridor

Results from FGD, DKI, QBI and personal observation (PO) revealed that, currently the corridor accommodates all categories of wild mammals which are herbivores, primates, insectivores and carnivores (Table 8)**.** Also there are birds, herps and various insects. About 67.5% of QBI respondents claimed that there are five categories of animals (namely herbivores, primates, predators, insectivores and birds) while 21.7% said they just sighted herbivores and primates. Also 8.3% and 1.7% had seen only herbivores and predators respectively while 0.8% had sighted both predators and primates. Results from DKI had revealed that there were nine species of herbivores, four species of insectivores, five species of predators and three species of primates. Also there were more than 20 species of birds and more than eight families of herps. During QBI and FGD there were other animals identified, which were two predators (lion - *Panthera leo* and wild dog - *Lycaon pictus*), one bird (ostrich - *Struthio camelus*) and two herbivores (waterbuck - *Kobus ellipsiprymus* and lesser kudu - *Tragelaphus imberbis*).

The interviewees who reported presence of those animals in the corridor (principally ostriches, wild dogs and waterbuck) in most cases where elders and frequent visitors of the corridor for various reasons. Ostriches, wild dogs and lesser kudus were animals pointed out in all four villages where QBI were done. Lions also were mentioned in all villages and by almost all respondents while waterbucks were cited by few but prominent interviewees of Iyayi and Igando villages. Probably the animal (waterbuck) was mentioned only in central and southern parts of the corridor because of presence of many water bodies like rivers and ponds as compared to the northern part.

Table 8: Animals present in Igando-Igawa wildlife corridor

Common name	Scientific name	Swahili name	Category	Identified through
Red duiker	*Cephalophus natalensis*	Paa	Herbivore	DKI, FGD, QBI, PO
Greater kudu	*Tragelaphus strepsiceros*	Tandala mkubwa	Herbivore	DKI, FGD, QBI, PO
Dikdik	*Madoqua kirkii*	Digidigi	Herbivore	DKI, FGD, QBI, PO
Bushbuck	*Tragelaphus scriptus*	Pongo/Mbawala	Herbivore	DKI, FGD, QBI, PO
Hare	*Lepus capensis*	Sungura	Herbivore	DKI, FGD, QBI, PO
Buffalo	*Syncerus caffer caffer*	Mbogo/Nyati	Herbivore	DKI, FGD, QBI, PO
Bushpig	*Potamochoerus porcus*	Nguruwe pori	Herbivore	DKI, FGD, QBI, PO
Banded Mongoose	*Mungos mungo*	Nguchiro	Carnivore	DKI, FGD, QBI, PO
Jackal*	*Canis mesomelas/adutus*	Mbweha	Carnivore	DKI, FGD, QBI, PO
Bushbaby	*Galago crassicaudatus*	Komba	Primate	DKI, FGD, QBI, PO
Vervet monkey	*Cercopithecus aethiops*	Tumbili	Primate	DKI, FGD, QBI, PO
Hedgehog	*Erinaceus eurapaeus*	Karunguyeye	Insectivore	DKI, FGD, QBI, PO
Porcupine	*Hystix cristata*	Nungununugu	Insectivore	DKI, FGD, QBI, PO
Yellow baboon	*Papio cynocephalus*	Nyani	Primate	DKI, FGD, QBI, PO
Aardvark	*Orycteroptus afer*	Muhanga	Insectivore	DKI, FGD, QBI
Pangolin	*Manis gigantea*	Kakakuona	Insectivore	DKI, FGD, QBI
Hyena*	*Crucuta crucuta*	Fisi	Carnivore	DKI, FGD, QBI
Hyena*	*Hyaena hyaena*	Fisi	Carnivore	DKI, FGD, QBI
Ratel	*Mellivora capensis*	Nyegere	Carnivore	DKI, FGD, QBI
Eland	*Taurotragus oryx*	Pofu	Herbivore	DKI, FGD, QBI
Giraffe	*Giraffa camelopardalis*	Twiga	Herbivore	DKI, FGD, QBI
Leopard	*Panthera pardus*	Chui	Carnivore	DKI, FGD, QBI
Lion	*Panthera leo*	Simba	Carnivore	FGD, QBI
Wild dog	*Lycaon pictus*	Mbwa mwitu	Carnivore	FGD, QBI
Zebra	*Equuis burchelii*	Pundamilia	Herbivore	FGD, QBI
Waterbuck	*Kobus ellipsiprymus*	Kuro	Herbivore	FGD, QBI
Ostrich	*Struthio camelus*	Mbuni	Bird	FGD, QBI
Lesser kudu	*Tragelaphus imberbis*	Tandala mdogo	Herbivore	QBI

* = Unclear whether all species are present in the corridor or just one species among the two.

Other animals reported and found to be in the corridor include; monitor lizards, tortoises, chameleons, snakes and several species of amphibians. There were various snakes, but poisonous and dangerous snakes were more known to local communities due to potential danger they pose to them. The snakes include, black mamba (*Dendroaspis polylepis*), green mamba (*Dendroaspis angusticeps*), cobras (*Naja spp.*), vipers (*Bitis spp.*), brown striped snake and pythons (*Python sebae natalensis*). The area also harbours variety of birdlife which include helmeted and crested guinea fowls (*Numida meleagris* and *Guttera pucherani* respectively), francolins (*Francolinus spp.*), cattle egret (*Bubulcus ibis*), storks (*Ciconia spp.*), and blue-billed firefinches (*Lagonosticta rubricata*). Other birds are African marsh owl (*Asio capensis*), red-billed hornbills (*Tockus erythrorhynchus*), pygmy falcons (*Polihierax semitorquatus*), cuckoos, sand grouses, African sun birds, and doves.

Also these birds were reported to be within the corridor, wagtails (*Motacilla spp.*), lilac-breasted rollers (*Coracias caudata*), orange-billed parrots (*Neophema chrysogaster*), lovebirds, pigeons, night jars and plovers.

The variety and occurrence of these wild animals varied substantially with respect to location and season. During the study, areas that adjoin Ruaha NP had with relatively high abundance of wildlife compared to those adjoining Mpanga/Kipengere GR. The reason for the scenario is that Ruaha NP was then the only a PA in that ecosystem with abundant wildlife than other areas. The situation cause wild animals in some occasions to disperse in the corridor. Results from QBI show that 64.2% of respondents reported more frequent sightings of wild animals during wet season than during dry season. At the same time 15.0% reported no difference in the frequency of wild animal sightings between seasons while the remaining 20.8% reported more sightings during dry season.

The increase of wild animals in the corridor during the wet seasons could be caused by flooding situations inside the Ruaha NP. Some parts of Ruaha NP (Usangu plain) have periodic flooding during rain seasons which might be a driving force for animals to come out of the NP. The phenomenon forces wild animals to seek refuge on areas with no flood or on highlands. The act of moving from core PAs to the corridor marks one of the importances of corridors; to provide refugia during adverse environment conditions.

On the other hand, ratel (honey badger), aardvarks, zebras, wild dogs and ostriches were reported being sighted only in the areas adjoining Ruaha NP whereas waterbucks only in areas adjoining Mpanga/Kipengere GR. Though QBI indicated the probability of lions being inside the corridor, key informants reported that there were no lions in the corridor. The pride of lions which local communities keep on referring was seen in 2004 and was

just migratory animals from Ruaha GR to Mpanga/Kipengere GR. Since then no pride or just single lion has been sighted in the corridor.

4.6.3 Migratory animals

Local communities around the corridor narrated that there are two classes of wild animals in the corridor. First class include animals which are residents and/ or use the corridor as a dispersal area while the second class use the corridor as a dispersal area and migratory route. For the case of migratory animals, 76.6% of respondents reported that they have a specific routes during their movement, 14.2% reported no specific route while the remainder (9.2%) were not aware about either existence of migratory animals and/or their routes. FGD and DKI reported that animals have specific routes during their movement from one PA to another.

Results from QBI show (Fig. 6) that there are at least five species of mammals which tend to migrate from one core PA to another. Those animals were buffalo, greater kudu, hyena (not known if were either spotted or striped hyena; or both species), lion and eland. Other species reported to be ‘migratory’ comprise of vervet monkey, yellow baboon, bushpig and jackals which were reported to be increasing in population in the corridor. Although QBI indicated the animals are migrating, in actual sense they are just dispersing in their large home range.

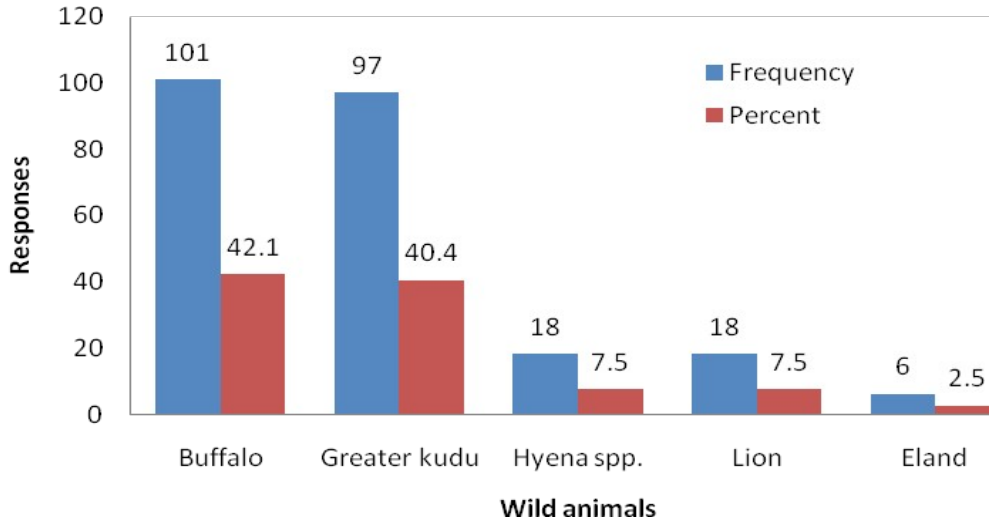


Figure 6: Responses on the species of migratory animals using the corridor

Key informants pointed out that buffalo and greater kudu were the only wild animals that were using the corridor as a migratory route from either Mpanga/Kipengere GR or Ruaha NP. Key informants also reported that even giraffes have started to migrate from Ruaha NP to Mpanga/Kipengere GR. At least three herds of them were sighted heading to highlands from lowlands in the area between Igando and Igomero villages (the area bordering Mpanga/Kipengere GR). Eland herd was also sighted slowly moving from Ruaha NP heading south of the corridor however according to Mpanga/Kipengere GR staff, the herd was still in the corridor. As elaborated above, lions were sighted once in 2004 heading to Mpanga/Kipengere GR and were considered to have established a territory in that PA.

In addition, Mpanga/Kipengere GR staff informed that pride of lions had started raiding local communities' livestock as it happened in October, 2008 in a village called Wangama in Imalinyi ward, Njombe district. The village is in vicinity to Mpanga/Kipengere GR and adjacent to the corridor. Moreover at the time of the study there was no precise information pertaining hyena movements in the corridor.

The findings indicate that only animals with relatively large body size do migrate from one PA to another. The results correspond with what Patton (1997) commented about relationship between migration habit and body size, mobility and low fecundity. Patton (1997) named those animals' as gamma species or habitat generalists and stipulated the following as their basic characteristics; relatively large in body size, high mobility and low fecundity.

4.7 Effect of Human Activities on the Corridor

4.7.1 Cultivation

Presently, a large proportion of villages appear to have no clear guidelines on how people may acquire land for substance farming. The land is typically acquired by bush clearing or inheritance. In most cases, the majority of peasants in those villages were practising slash and burn system and they use a hand hoe for tilling the soil. Also other activities associated with farming were done manually after burning the trashes. The farming system was extensive cultivation (shifting cultivation) as most of them are too poor to afford land improvement practices particularly fertilisers application. The practice has adverse consequences on the biodiversity of the area as a lot of vegetation had is cleared.

The Sukuma people were the major ethnic group which practices intensive and extensive agriculture whereby they were using farming implements like oxen operated plough and manure. The paddy crop was mainly produced for business. Results from FGD indicated that a single Sukuma farmer could harvest to at least 400 bags of paddy while indigenous farmers could harvest hardly 200 bags (roughly a bag weighs 65 kg). The paddy farms are associated with massive clearance of vegetations (Plate 1) as mixed cropping is not possible.

Those types of farms were found mainly on the northern part of the corridor which borders Ruaha NP, for example Plate 1 is a paddy farm inside the corridor and its area was estimated to be over 20 acres (trees seen on the background are inside Ruaha NP).

Plate 1: Paddy field inside the wildlife corridor in the vicinity to Ruaha NP

The central part of the corridor was heavily affected by cultivation. The corridor between Iyayi and Kangaga villages was very narrow. The width of the corridor was estimated to be just about two kilometres as compared to other areas where the width of the corridor were up to 13 km. The Iyayi village has one hamlet named Kihoa which stand as a 'thorn in the throat' in the corridor. The major livelihood activity in that village was agriculture and was done exclusively inside the corridor. The main crops cultivated were simsim along with sunflowers and sometimes maize.

Another central part of the corridor much affected by cultivation was in between Lyamluki and Itipingi villages. In the area there is a village namely Mkandami which is totally surrounded by the corridor to the extent that it is not easy to someone to have a clear demarcation of borders between villages and the corridor.

The expected boundaries of the corridor were inside farms in all three villages and still there were animals using the same area. It was in this area of the corridor where more cases of human-wildlife conflicts were reported. On the north eastern part of the corridor near Luwango village, bush clearance was continuing.

Extensive form of cultivation on the corridor which was poorly done have resulted in degradation the biodiversity in the area. The abundance and distribution of wildlife in the corridor were hampered whereby some wild animals were completely forced out from the corridor. According to DKI done in villages, since 1969 elephants were not seen migrating through the corridor while 1972 was the year which last elephants were sighted roaming around areas adjoining Itipingi, Manienga, Luwango and Igava villages. The blockages of the corridor in those central parts of the corridor have caused the southern part of the corridor (which borders Mpanga/Kipengere GR) to have very few wild animals in terms of variety and variability. The wild animals frequently sighted on that part were vervet monkeys, yellow baboons, greater kudu, dikdik, bushbucks, giraffe, jackals, buffalo and red duikers. Waterbucks could be regarded as residents of the southern part of the corridor.

4.7.2 Livestock keeping

Results from DKI show that pastoralists accompanied by large number of stocks started to invade the area in the early 1970s from the northern part of the country searching for pastures. At the time of the study, the area was harbouring few but huge herds of livestock primarily of Maasai and Mang'ati people. The smallest herd encountered had at least 250 heads of livestock (most of herds encountered include cattle and several goats, sheep, few donkeys and dogs). People kept those huge numbers of livestock because they value them as 'walking banks', petty cash and insurance.

Pastoralists in the corridor practice free range grazing without keeping in mind about land carrying capacity. Pastoralists in the corridor were practising extensive livestock keeping whereby herds were left to graze freely, grow spontaneously with no or very limited food supplements and veterinary inputs. Also there were excessive numbers of male animals, cows without enough milk especially during dry seasons. Furthermore, animals have irregular growth and commonly lose weight during dry seasons. According to Kilahama (2006) an average of 3 ha/head is needed for sustainable cattle grazing throughout the year which is not the case in this corridor. The number of livestock kept which exceeds the carrying capacity has resulted into deforestation, land conversion and loss of natural habitat (as pastures continue to encroach on native ecosystems due to increased demand and degradation of existing pastures). The loss of natural habitat could also be due to frequent wildfires which were deliberately ignited so as to allow/encourage off-season pastures regrowth during the new rain seasons.

Exceeding the carrying capacity was evident through trampling and overgrazing observed in the corridor. Again high stocking rate of pastures lead to loss of top soil and organic matter, reduction in water infiltration, increased soil compaction and reduced fertility on some areas. Other impacts associated with the livestock keeping include alterations in soil health, hydrology, and salinity. The northern part of the corridor was mostly affected by those forms of degradation as compared to the southern part.

Naturally wild herbivores wander from area to area searching for pastures to graze but livestock tend to concentrate in a place for long periods of time grazing on grasses and trampling most of vegetation. Sheep always cut the grass down so close to the ground which may hinder its resprouting, goats often browse on young trees and shrubs which may result in failed recruitment hence destroy the forest. Livestock induces risks for soil

compaction by trampling and thereby reduced infiltratibility. The situation worsens if the grazing area is a riparian or near water source and livestock are in huge number. The tendency greatly reduces the suitability of land for wild animals and loss of natural vegetation eliminates important cover for prey animals from potential predators and poachers/hunters. Loss in vegetation and erosion of stream/river banks reduce vegetative cover. This resulted in decrease of the amount of water flowing due to increased evaporation consequently hampers the ecosystem of aquatic animals including amphibians and some reptilians. In general removal or loss of vegetation which is often associated with grazing leads to changes in vegetation structure, plant species composition and density and consequently wildlife abundance and distribution (Malmer and Nyberg, 2008).

4.7.3 Fuel wood (firewood and charcoal)

Miombo woodlands were the chief source of firewood and charcoal in the study area and the most important use of wood was for fuel mostly for cooking and heating. It is known that woodlands trees produce a heavier and more concentrated fuel than most fast growing softwood species and tropical rain forests hence more preferred (Monela *et al.*, 1999). In general, miombo woodlands comprise of the three closely, related genera (*Brachystegia, Julbernadia* and *Isoberlinia*) from the legume family Leguminaceae.

For the case of firewood there were two basic uses observed during the study; firewood for home use and for bricks baking (Plate 2). The demand for house construction for various reasons (e.g. residential houses, schools) using baked bricks regardless of the material used in roofing has increased tremendously in few years back. For years now, the production of baked bricks has increased in area around the corridor hence making it one of the major human economic activities. The activity was done in a manner that was not conducive for sound environmental conditions.

Plate 2: One of the firewood piles ready for bricks baking at Lyamuluki village

All firewood for that purpose were collected/cut within the corridor and then transported to villages where the activity was usually done (Plate 2). As the demand for firewood was high, there were no possibilities of people to deal only with naturally dead woods, but they were also cutting green woods. The situation resulted in bush clearing which cause patches of bare land hence negatively impacting the biodiversity in the area.

Charcoal produced in that corridor was principally for commercial purposes although in very limited extent for home consumption, thus the activity was concentrated to areas near Iringa–Mbeya highway on the southern border of the corridor. The major problem associated with this activity is cutting down many trees just to produce one bag of charcoal. The problem was caused by low rate of conversion of wood to charcoal (average kiln efficiency) in trees found in miombo woodlands. Wood to charcoal conversion efficiency is generally low in miombo woodlands varying between 14 to 24 % depending upon several factors that include tree species, log arrangement, type of kiln and experience of kiln/charcoal makers (Monela *et al.*, 1999; School of GeoSciences, 2008).

The average kiln efficiency at Kitungalo Forest Reserve in Morogoro was about 23.5% which requires nine trees of about 10 cm dbh to produce roughly about 29 bags of charcoal (each bag approximately weigh about 50 kgs) (Monela *et al.*, 1999). Generally commercial fuelwood extraction such as charcoal production requires large volume of wood, which in turn depletes tree stocks resulting to various forms of environmental degradation such as soil erosion, lowering and affecting abundance and diversity of trees in an area of concern. The narrated scenario was observed in the corridor especially on the southern border.

4.7.4 Illegal hunting (poaching)

Poaching could be defined as illegal hunting, killing or capturing of wild animals and can occur in a variety of ways. On the other hand, poaching can refer to the failure to comply with regulations for legal harvest, resulting in the illegal taking of wildlife that would otherwise be harvested legally (Wyler and Sheikh, 2009). The definition and explanations conforms to what was happening in the corridor. Poaching in the corridor include taking without a license or permit, use of a prohibited means of hunting (i.e. weapons and traps), taking outside of the designated time of day or year (animals were hunted throughout the year and done mostly at night) and taking of a prohibited sex or life stage. Also animals hunted in most cases were those allowed by law e.g. bushbuck and dikdik. The methods of poaching in the area include snares, bows and arrows, spears and dogs. Also it includes the use of firearms mainly muzzle-loader gun (locally made gun and popularly known as *gobore*). Fires were widely used during poaching especially when using spears and/or dogs. All of these have negative impacts to wildlife populations because wild animals are taken without any regulations and/or management. In general poaching has severe impacts on wildlife as it may directly reduce wildlife populations hence negatively impacting biodiversity and probably transmitting zoonotic diseases. Wyler and Sheikh (2009) reported that the illegal hunting (poaching) of wildlife may directly contribute to the

decline of some species of wildlife and plants and the situation worsens if poaching is combined with habitat loss or alteration.

4.7.5 Harvesting tree resources

Nearly all techniques of removing trees from the land for any reason have detrimental effects to the environment and logging is one of the techniques. Logging is mainly done either for forest management and/or timber productions (Simmons, 1979). Timber is used to build houses, furniture, firewood, charcoal etc. Naturally, logging is done for many economical reasons including lumbering and charcoal. Basically there are two categories of harvesting of tree resources namely selective and clear-cutting/clear-felling. Clear-cutting/clear felling was the main category used in the corridor as it comprises cutting down all types of trees for various reasons including logging, harvesting of poles and withies. Logging for lumbering was rarely practiced in the corridor either because trees suitable for lumbering were very few or was not economically viable. Field survey showed that, there were very few trees which were above 30 cm dbh especially on the parts bordering Mpanga/Kipengere GR.

Extraction for poles and/or withies was mainly done by pastoralists who use them in building sheds for their livestock. Pastoralists who live inside the corridor with their huge number of stocks were largely blamed for much of destruction based on that form of activity as compared to those who kept their stocks in villages. The sheds built by former pastoralists were so huge in size and as they are in the corridor, a substantial area of a bush was cleared. Poles for house constructions were also extracted from the corridor although its impact to the area was minimal as it was for primarily for domestic use only. Poles extracted for these purposes were mainly for roofing because most houses were built using baked bricks.

Regardless of being lawful or unlawful, logging and tree resources extraction are controversial due to its potential environmental and aesthetic impacts. Logging and harvesting of tree resources actually alters species composition, forest/bush structure and nutrient depletion. The phenomenon might cause some species of plants and animals to flourish while others are hindered. The phenomenon also alters the balance of plant and animal species and accordingly changes ecological systems of the forests/bushes.

4.8 Views of Local Communities toward Conservation of the Corridor

Local communities around the corridor were aware of conservation activities going on inside the corridor but the majority of them were suspicious about the motives. The suspicions were raised because in the 2007 before annexing Usangu GR to Ruaha NP, people in the whole ward namely Msangaji were evicted to allow expansion of Ruaha NP based on ecological reasons. Despite the fact that people evicted from Msangaji ward were compensated, local communities in the corridor vicinity were not happy with the move of the central government. Some people though minority were narrating that the government was more and too sympathetic to wild animals than humans, whereby Almighty God has created animals for the welfare of humans and not other way round. Also other people were complaining about land scarcity thus restoration of the corridor magnified the problem.

Based on those divergences, local communities were asked to comment if they think establishment and restoration of the wildlife corridor was a desirable idea. A considerable number (39.2%) of interviewees thought that it was not a desirable idea and in general were against conservation issues and activities. Despite of their answers, local people were requested to recommend on measures/actions required to be taken so that conservation activities could achieve the vision, mission and goals. Respondents had multiple answers.

The results showed that the participatory NR conservation and management was ranked high (Fig. 7). Other recommendations (in descending order) were conservation awareness educations, economic empowerment and sustainable utilisation of (biological) resources, proper land use plan and compensation (Fig. 7).

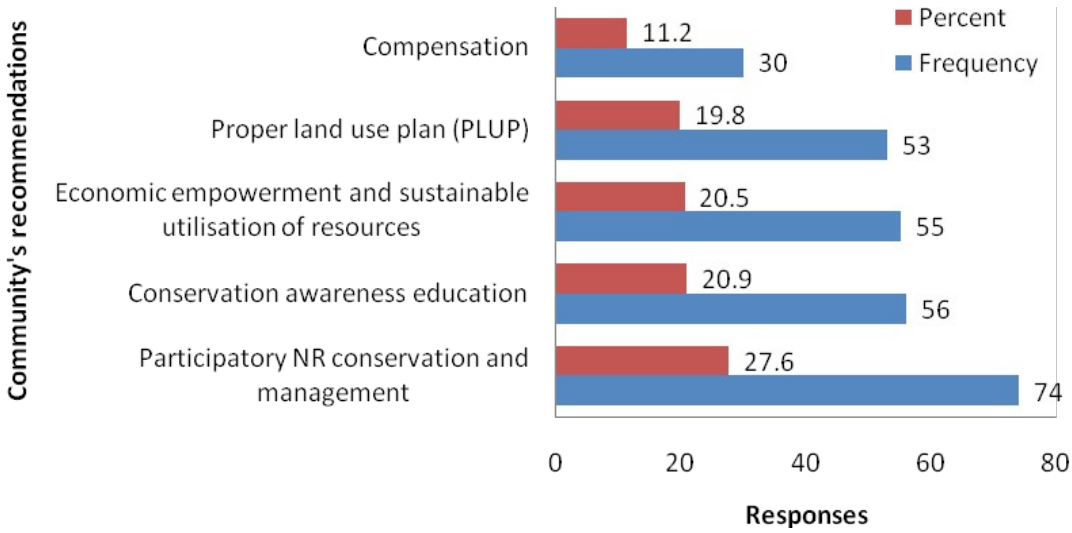


Figure 7: Responses on recommendations for corridor's conservation sustainability

Generally, the finding indicated that the local communities around the corridor who were key stakeholders were not aware of their organisation (CBO) establishment processes. As local communities were unaware about their CBO which would have the mandate to manage a proposed WMA, thus were very suspicious to the restoration of the wildlife corridor. Local communities were thinking that the WMA will be solely under the central government as that was the case for Ruaha NP and the former Usangu GR. The discrepancies, suspicions of local communities toward corridor restoration and lack of common understanding between local communities and CBO leaders have resulted in all of those recommendations.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Generally the corridor has shown significant improvement in restoring its ecological status since 2005 when active conservation activities started. The campaign has resulted in habitat improvement, decreasing in presence of humans and their resulting activities which in turn encourages wild animals to steadily return to the area.

There were at least seven human types of activities in the corridor, but agriculture was singled out to be the major activity for the whole community in vicinity to the corridor even though was mainly subsistence in nature with most work being done manually and hardly any mechanisation. Livestock keeping was the second activity but was mainly practiced by immigrant communities and exclusively inside the corridor. Indigenous community's livestock were using the corridor only as a grazing zone. Other activities include firewood collection, harvesting of poles/withies, charcoal making, poaching and logging which have profound negative impacts to the welfare of the corridor. During the study it was clear that there was a significant reduction of the above mentioned activities in the corridor even though about a quarter of population still depend on it for their living.

The reduced human activities have profound impact to the ecological status of the corridor as there is significant decrease of tree cutting/felling, number of people cultivating in the corridor and fire incidents. Tree cutting was basically for charcoal making, firewood, opening grazing areas and cultivation plots. The density of newly cut tree resources extracted from the corridor was statistically low as compared to old cuts. Also as miombo woodlands are resilient to disturbances, they begun to regenerate.

Currently the corridor harbours a variety of wildlife species. Some of wild animals reported to be in the corridor were not seen for a long period of time, e.g. wild dogs, zebras and greater kudus. Also the corridor has begun its role, to act as a conduit for species of wild animals. Greater kudus and buffalo are using the corridor for their movement from either two core PAs viz. Mpanga/Kipengere GR and Ruaha NP.

5.2 Recommendations

Although there are encouraging results from conservation activities, wildlife management and conservation stakeholders should equally bare measures to make sure that the corridor reach and maintain its optimal ecological functioning as it is one of the key links within the named ecosystem. The vision will only be achieved if local communities around the corridor are fully participating in the conservation activities.

Rural and poor communities can engage in conservation activities if and only if co-operation and support are granted to them. Because of this prerequisite condition; co-operation and support have emerged as a major option of in-situ biodiversity conservation. In order for these people to fully participate in in-situ conservation deliberate measures are needed to address about poverty of local communities around the corridor. The area has various economic potentials which could be used in poverty alleviation programmes hence reducing dependency to natural resources in the corridor. Among these potentials include ecological and cultural tourisms and also beekeeping. The honey is as good as the one produced in Manyoni miombo woodlands.

Additionally, wildlife management and conservation stakeholders should make sure they win hearts and minds of local communities by intensifying conservation awareness education campaign. There were about 39.2% of local people who were against

establishment and restoration of the wildlife corridor and conservation activities in general. Also deliberate measures are needed to accelerate processes for establishing WMA. The establishment of WMA would influence local communities to perceive natural resources in the corridor as theirs and not of the government hence encourage sustainable utilization of resources. Either it would facilitate minimization of the notion that conservation activities are solely governmental. They would be able to know that both core PAs (NPs and GRs) and WMA were pertaining to conservation issues but are of different scenario and levels of utilization. The core PAs especially NPs are more-or-less preservation rather than conservation per se.

Moreover the name of the corridor should be changed as it is too long and does not depict the real situation of the area. Igando is a village while Igawa is a hamlet of Igowero village, both bordering Mpanga/Kipengere GR and found along Iringa–Mbeya highway. The best name for the corridor should be Mawindi wildlife corridor as most of it borders Mawindi ward. Besides of that, the word Mawindi literary means “area with many streams/rivers” which depict real physical situation of the area as it has many streams/rivers that may need intensive conservation.

Also, in Mbarali district there were at least two parallel wildlife corridors, namely Igando–Igawa and Machimbo. Both of these corridors are connected to Ruaha NP and Mpanga/Kipengere GR. Machimbo wildlife corridor lies on the west side of Igando–Igawa. The corridor connects Ruaha NP at the area formerly known as Msangaji ward and Mpanga/Kipengere GR at the area known as Mabadaga. Both Mabadaga and Igawa were hamlets of same village; Igomero village. DKIs indicated that the corridor was harbouring various wild animal species and greater kudu was the only wild animal species which was using the corridor as a migratory route. It was reported that in Machimbo corridor, gold

mining was the main human activity which threaten its existence. The corridor got its name from this activity. The Machimbo corridor needs to be under scrutiny in order to identify its potentials and how to it could be conserved.

Lastly, Igando–Igawa wildlife corridor is still virgin in terms of research as very limited study had been done. Resource inventory was the only study which had been done in the corridor. Because of this weakness, conservation stakeholders are required to support morally and/or materially numerous intensive and extensive studies. I recommend further intensive studies to be able to understand the complex ecological, social-economical and social-cultural issues and at least one study should be done by a doctor of philosophy (PhD) student.

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APPENDICES

Appendix 1: Questionnaire for Household Based Interview

Questionnaire's number…….

Date: ……./……./ 2008

Interviewer's name……

Location: a). Village…… b). Ward……..

c). Division…… d). District……...

e). Region…….

A: Demographic Data

1. Respondent's age: a) Below 30 yrs…… b). 31 – 40 yrs……

c). 41 -50 yrs…… d). 51 -60 yrs…….

e). Above 60 yrs

2. Respondent's sex: a). Male……. b). Female……..…

3. Marital status: a). Single…….. b). Married…….

c). Widowed…… d). Separated ……

e). Divorced……..

4. Household size: a). Below 4…… b). 4 – 6……..

c). 7 – 9…….. d). Above 9……

5. Major economic activity:

a). Farming…….. b). Livestock keeping……..

c). Charcoal making…… d). Hunting……..

e). Logging…….. f). Lumbering…….

g). Employed…… h). Business…….

6. Other economic activities (List them according to preferences):

a). Farming - - - - - - - - -(……...) b). Livestock keeping (……...)

c). Charcoal making - - - (……...) d). Hunting - - - - - - - (……...)

e). Logging - - - - - - - - - (……...) f). Lumbering - - - - - (……...)

g). Employed - - - - - - - -(……...) h). Business - - - - - - (……...)

7. Education status:

a). None…… b). Primary education……

c). Secondary education…… d). Tertiary education……

8. Residential status: a). Native…… b). Immigrant……

9. If you an immigrant, how long has you been in this area (years)……

10. What is your tribe……

From which region? ……..……

B. Conservation Awareness

11. Do you know what wildlife corridor is:

a). Yes…….. b). No……

12. What is the current integrity status of the corridor?

a). Excellent…… b). Good…….

c). Fair……. d). Bad……

e). Worse……

13. What are activities which hamper/ threatened the integrity of the corridor? List them according t their importance in conservation activities:

a)……

b)……

c)……

14. There are frequent presences of wildfires inside the corridor?

a). Yes……. b). No…….....

15. What are the consequences of these wildfires to:

a). Wild animals ……

……...

b). Habitat ……

……...

16. What is the current conservation status of the corridor……...

17. What are the current or the future plans conservation activities carried out inside the corridor……

18. Are you aware about the consequences of human activities on the corridor?

a). Yes…… b). No……..

Can you elaborate your answer above?

……

……

C. Human, Wildlife and their Interactions

19. Do you see wild animals in that area?

a) Yes……. b). No……..

20. If yes, name them in major categories of wild animals that seen in recent times, seen their signs, or heard of being exists here:

a).Herbivores……...

……

b).Predators…….

……

c).Primates……..

……

21. What animals are not currently seen but was used to be seen and why so?

……

……

22. In what season of the year normally has high population of wild animals in the area?

a). Dry season…… b). Wet season……c). Both seasons……

23. What is there direction during their movements?

a). From Usangu to Mpanga/Kipengere …….

b). From Mpanga/Kipengere to Usangu…….

c). From both direction ……..

24. Specify the months and abundance of species mentioned above:

…….

…….

25. Based on the list above, which are resident of the corridor and which are migratory?

a). Resident animals ……..……

……

b). Migratory animals ……...……..

……

26. For migratory animals, do they have a specified route during their migration?

a). Yes…… b). No …… c). I don't know …….

27. Give your comments on whether in the last five years wild animals are:

a). Increasing……. b). Decreasing ……

Give reason(s) for your answer

……

……

D. Humans Activities

28. What are the economic activities carried out inside the corridor?

a). Cultivation…… b). Livestock grazing……

c). Logging…… d). Charcoal making……..

e). Lumbering…… f). Hunting……

g). Firewood ……. h). Others (specify)……

29. Do these activities carried out legally?

a). Yes…….. b). No…… c). I don't know……

30. If they are legally carried, how do you or they acquire permit(s):

……

……

31. Why people prefers to take economic activities in the corridor rather than other area:

a)…….

b)…….

c)…….

32. What is the intensity of these activities in equation 26 above?

a). Very high……. b). High…… c). Fair……

d). Low…… e). Very low…… f). No……..

33. What is the extent of people dependency to the corridor?

a). Very high……. b). High…… c). Fair……

d). Low…… e). Very low…… f). No……..

34. What are the cultural activities carried out in the corridor:

a). Ritual…….. b). Medicinal activities……

c). Others (specify)……

35. Do these activities affect the integrity of the corridor?

a) Yes…… b). No…… c). I don't know……

36. Support / explain your answer above:

……

……

37. There is any traditional method of conservation:

a). Yes……. b). No……

38. If yes, what is (are) the method(s):

a)……

b)……..

39. What is the effectiveness of these methods to the conservation activities?

……

…….

E. Non Timber Forest Resources (NTFRs)

40. What type of non-timber forest resources that are harvested inside the corridor? (List them according to preferences):

a). Fruits, mushrooms, vegetables and medicines - - - - - - - - - - - - - (…….)

b). Thatch grasses, withies and poles -(……)

c). Fuelwood (firewood and charcoal) - (…….)

d). Wild animals - (…….)

f). Wax/ gum/ resins - (…….)

g). Firewood only - (…….)

41. Do harvest of these products harmful to the conservation/ integrity of the corridor?

a). Yes…….. b). No…….

42. Support your answer above (i.e. if YES, how; NO, why):

……

……

F. Suggestions about Conservation

43. Do you thing is important to let the area (wildlife corridor) to wildlife rather than human being:

a). Yes …….. b). No ……..

Support your answer(s) above:

…….

……

44. What do you think should be done in order that conservation of natural resources in corridor to become successful?

……

Appendix 2: Checklist for Key Informants

1. What is the conservation status of the corridor?
2. There is any policy or law or regulation that protects the corridor?
3. What are human activities carried out inside the corridor?
4. How these activities do affects conservation strategies?
5. What is the extent of land use practices within the corridor?
6. What are the consequences of those activities to the integrity of the corridor?
7. What are possible measures for remedy?
8. What are wild animals that are inside the corridor?
9. What were the common wild animals that were inside the corridor?
10. What are wild animals that are using the corridor as a migratory route?
11. What were the common wild animals that were using the corridor as a migratory route?
12. What conservation activities are currently undertaken or under plan?
13. What do you think should be done in order that conservation of natural resources in corridor to become successful?

Appendix 3: Checklist for Focus Group Discussion

1. Do you know what is and aware about the existence of the wildlife corridor?
2. What is the conservation status of the corridor?
3. What are the human activities carried out inside the corridor?
4. What is the historical pattern of human activities inside the corridor?
5. Why and when did people start to utilise the corridor for various socio-economic and cultural activities?
6. What are the benefits that are accrued from the corridor?
7. What are wild animals that are inside the corridor?
8. What were the common wild animals that were inside the corridor?
9. What are wild animals that are using the corridor as a migratory route?
10. What were the common wild animals that were using the corridor as a migratory route?
11. Those migratory wildlife do they have specific routes inside the corridor?
12. What is the extent of land use practice inside the corridor?
13. What are the consequences of those activities to the integrity of the corridor?
14. What conservation activities currently undertaken or under plan?
15. There is any indigenous/cultural system(s) of conservation?

Appendix 4: Field Form for Habitat Disturbances

Transect number …….. Plot number …… Total no. of stems …… Bearings ……...

S/n	Items												
1.	**Tree cuts**	**Species**			**Trees**		**Poles**		**Regenerants**		**Uses**		
					New	Old	New	Old	New	Old			
2.	Fire	Signs			Possible causes			Area disturbed		Remarks (Change of vegetation)			
3.	Fuelwood	Species			Disturbance			Mode of collection			Standing trees		
					Area	Trampling		Machete	Axe	Dragging		Green	Dry
4.	Encroachment	Mining (area)		No of traps/types	Grazing (area)			Fodder (area)		Honey hunting		Cultivation (ha)	
5.	Medicine	Species			Type of plant				Part of plant collected				
					Tree	Shrub	Herbs	Grasses	Whole	Roots	Leaves	Bark	Others
6.	Alt. use of the corridor	Research			Tourism			Ritual sites			Bee keeping		
		Litter	Path	Tramp.	Litter	Path	Tramp.	Litter	Path	Tramp.	Litter	Path	Tramp.