LAND USE CHANGES ALONG WILDLIFE CORRIDORS AND THEIR IMPLICATIONS TO CONSERVATION: A CASE OF SAADANI-WAMI-MBIKI WILDLIFE CORRIDOR, TANZANIA

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ABSTRACT

Wildlife corridors are facing conservation threats as a result of land use changes within and along them. The understanding of changes happening in the corridors over time is important for establishing the management baseline data. This study aimed at identifying land use changes along Saadani-Wami-Mbiki wildlife corridor and their implications to wildlife conservation. Specifically the study determined the rate of land cover changes in the corridor between 1975 and 2011 and assessed the associated land use practices towards corridor land cover change. Land sat imageries of 1975, 1995 and 2011 were used to assess the rate of vegetation cover changes as a result of various land use practices carried out in the corridor. Household survey and key informants interview methods were used to obtain socio-economic data which were analysed using SPSS while satellite imagery data were analysed using the ERDAS IMAGINE 9.1 and ArcGIS 9.3 programmes. In the past 36 years (1975-2011), the cultivated land increased by 25%, settlement by 13%, open forest by 10% while closed forest and grassland decreased by 18% and 3% respectively. Shifting cultivation, over grazing, charcoal making and settlements were identified as major land use practices threatening the corridor. Basing on the results, it is recommended that, deliberate measures are needed to address about poverty of local communities around the corridor. Among the potentials include ecological and cultural tourism and beekeeping.

DECLARATION

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

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LIST OF ABBREVIATIONS

CBC	Community Based Conservation
FGD	Focus Group Discussion
GDP	Gross Domestic Product
IUCN	International Union for Conservation of Nature
KI	Key Informants Interview
LUP	Land Use Practices
LUS	Land Use Systems
LRM	Logistic Regression Model
MNRT	Ministry of Natural Resources and Tourism
PA	Protected Area
QBI	Questionnaire Based Interview
SANAPA	Saadani National Park
TANAPA	Tanzania National Park
TAWIRI	Tanzania Wildlife Research Institute
URT	United Republic of Tanzania
UTM	Universal Transverse Mecartor
WMA	Wildlife Management Area

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

The anxiety about land use and land cover change globally emerged due to realization that change of nature of land surface influence climate and those changes has an impact on ecosystems, goods and services that are derived from it (Turner *et al.*, 1990; Turner *et al.*, 1994; Lambin and Lepers, 2003). One of the important land use change is that the world's forests, grasslands and woodlands have declined, the cropped land areas have expanded in the same magnitude (Skole and Tucker, 1993; Slayback, 2003). Tanzania's ecosystems have been vulnerable at the expense of human driving forces like demand of land for agriculture, pasture, logging, charcoal making and mining (Kideghesho, 2001; Ogungo and Njuguna, 2004; Ntongani *et al.*, 2009).

Land use changes along wildlife corridors have been said to cause negative impacts on corridors in northern Tanzania. Noe (2003) studied land use changes and their impacts on wildlife corridor between Mount Kilimanjaro and Amboseli National Park, Tanzania and found that settlements and agriculture expanded into wildlife grazing and dispersal areas which reduced the actual size of the corridor from approximately 21 km^2 in 1952 to approximately 5 km^2 in 2001, changed the number of migration routes, animal numbers and distribution in the corridor. Kideghesho (2002) revealed the emergence of agriculture, mining and small business enterprise in the wildlife corridor between Lake Manyara National Park and Tarangire National Park, which blocked wildlife movement from one park to another.

The current land uses are not compatible with wildlife and biodiversity conservation and they pose threats that contribute notable progressive decline in ecological value of landscapes to support wildlife in the corridor (Ntongani *et al.*, 2009). Saadani-Wami-Mbiki wildlife corridor provides an important biological link between Wami-Mbiki WMA and Saadani National Park, the only wildlife sanctuary in Tanzania bordering the sea. In spite of its importance, it has been observed in recent years that there is a persisting problem of uncontrolled encroachment in the corridor and movement of people from informal settlements.

However, the extent of land use changes over time in the corridor was not yet established either in part of the corridor or the whole area of the corridor. Thus, the study identified different land use changes and possible causes of identified changes in the corridor for about 36 years ago and explained causal effect relationship behind the effect of human disturbances on this ecosystem and finally provided a base for developing a sustainable utilization and management of the natural resources for improving social and economic benefits.

1.2 Problem Statements and Justification of the Study

Reducing land use along wildlife corridors has recently become an important issue in many countries including Tanzania. Wildlife is directly impacted by the increased land use within corridors. Though some empirical data exist regarding the impact of land use change in African wildlife corridors, little has been done in determining the land use change and their implication to conservation in wildlife corridors of Tanzania.

Saadani-Wami-Mbiki wildlife corridor has been under great utilization pressure due to land use practices carried out along and within. Wild animals such as elephants and buffaloes migrate via this corridor. Despite its importance in wildlife conservation, there is no adequate information about the implication of land use change along and within this corridor. Therefore, this study provides reliable baseline information about land use changes and their implication for wildlife conservation. The information will assist managers, planners and policy makers in determining proper land use management practices.

1.3 Research Objectives

1.3.1 Overall objective

The overall objective of this study was to determine land use change along Saadani-Wami-Mbiki wildlife corridor and their implications for wildlife conservation.

1.3.2 Specific objectives

The specific objectives of the study were:-

- To determine the rate of land cover change in the corridor between 1975 and 2011 as a result of various land use practices
- To assess the associated land use practices towards corridor land cover change

1.4 Research Questions

The major focus of this study was to answer the following research questions;

- What are the rates of various land cover changes in the corridor?
- How much is the rate of land cover change in the corridor over 36 years?

- To what extent the land cover changed?
- What are the associated land use practices in the corridor towards land cover change?
- What are the implications associated with land cover change on wildlife conservation?

1.5 Conceptual Framework

The conceptual framework acts as a basis for discussing the relationships between different variables and can always be progressively revisited as further information becomes available (Lusambo, 2009). The rapid loss of biodiversity and habitat around Saadani-Wami-Mbiki wildlife corridor occurring as a result of change in resource use patterns caused by demographic changes over time. The associated activities include settlements, cultivation, grazing, charcoal making and firewood collection as a source of energy. These land use practices in turn lead to overexploitation of natural resources causing habitat loss ultimately resulting in biodiversity loss and protected area's isolation.

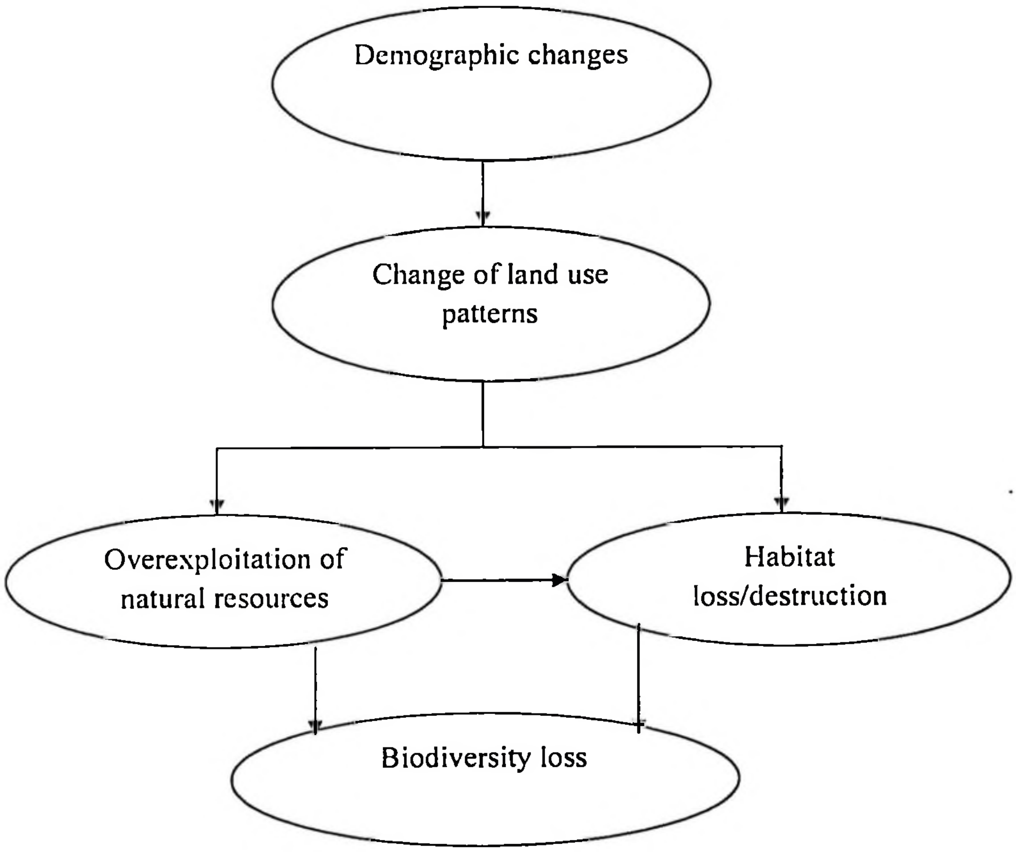

Figure 1: Conceptual framework for the Saadani-Wami-Mbiki wildlife corridor

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Importance of Wildlife Corridors

Wildlife corridor is a linear habitat whose function is to connect or facilitate movement of wild animals between different habitats (Caro *et al.*, 2009). Corridors serve as migratory routes and provide an important source of food and cover for many species at any given time of their life cycle (Shombe, 2000).

For small protected areas, migratory corridors are vital for survival of wildlife as they establish connections between different habitats and facilitate animal dispersal. This enables interbreeding with wildlife of different genetic setup, creating a genetic exchange, searching for food and water in other areas (Banko, 2001; Robert *et al.*, 2006). For example, during the dry season buffalo (*Syncerus caffer*), eland (*Taurotragus oryx*), lion (*Panthera leo*), red duiker (*Cephalophus harveyi*), zebra (*Equus quagga*) and elephant (*Loxodonta africana*) move from Ruaha National Park to Mpanga/Kipengere Game Reserve through Igando-Igawa corridor searching for water (Jones *et al.*, 2009).

Also elephants use Kitendeni corridor that links Amboseli National Park and Kilimanjaro National Park during the dry season searching for pastures and water. The corridor as well provides important calving areas for zebra (*Equus burchelli*), wildebeest (*Connochaetes taurinus*), thomsons gazelles (*Gazella thomsonii*) and grants gazelle (*Gazella grantii*) (Caro *et al.*, 2009). In the Western Serengeti Corridor, wildebeest migrate from central Serengeti, west of the park boundary near the shoreline of Lake Victoria, to the northern part crossing the Grumeti River. In this case, they look for pastures and good areas for calving (Jones *et al.*, 2009)

Conserving wildlife corridors is increasingly important for maintaining ecological and genetic connectivity in times of unprecedented habitat fragmentation. Documenting connectivity loss, assessing root causes, and exploring restoration options are therefore priority conservation goals (Jones *et al.*, 2012).

2.2 Status to Wildlife Corridors in Tanzania

The interaction and disturbances of the environment are disrupting natural processes worldwide. Ecological integrity is significantly compromised by natural and human induced changes (Idso *et al.*, 2003). Wildlife corridors are particularly threatened by human activities such as agriculture, settlements, mining, livestock grazing, infrastructure and other developments (Patton, 1997; Balmford *et al.*, 2001).

In Tanzania most of the corridors have been interfered and others reaching the stage of being lost (Newmark, 1993). For example of the eight corridors that originated from Tarangire National Park, that two linked to Lake Manyara National Park were lost (Lamprey, 1964). By 1985 only five corridors remained including Kwakuchinja-Mbugwe corridor. The study done by Noe (2003) revealed that Kitendeni wildlife corridor was the only remaining corridor linking Kilimanjaro National Park and other ecosystems after the disappearance of the former corridors to Tsavo West National Park in Kenya, Arusha, Meru Forest Reserve and Mkomazi Game Reserve in Tanzania.

A study conducted by Gamassa (1998) and Shombe (2000) in Lake Manyara National Park, exposed the threats posed by human activities over wildlife corridors that linked Lake Manyara National Park to outside systems. These threats resulted from among other factors, change of land use practices, a rapid growth of human population, infrastructure development and settlements in the previously unpopulated areas.

The current trend in land use changes caused by various land use practices around major migratory corridors suggest that core protected areas are in great danger of becoming isolated conservation islands (Bennet, 2003). The loss of wildlife corridor may result into massive death and/or extirpation of migratory species (Newmark *et al.*, 1991).

The animal species that have been affected through pressure exerted on corridors include elephant (*Loxodonta Africana*) and buffaloes (*Syncerus caffer caffer*) in Upper Kitete/Selela corridor (Jones *et al.*, 2009), elephant (*Loxodonta Africana*), coke's hartebeest (*Alcelaphus buselaphus*), oryx (*Oryx gazella*), lesser kudu (*Tragelaphus imberbis*), cheetah (*Acinonyx jubatus*), eland (*Taurotragus oryx*) in Kwakuchinja corridor (Jones *et al.*, 2009). Others include elephant (*Loxodonta Africana*), wildebeest (*Connochaetes taurinus*), gerenuk (*Litocranius walleri*), lesser kudu (*Tragelaphus imberbis*) and wild dogs (*Canis familiaris*) in Tarangire-Mkungunero corridor and elephant (*Loxodonta Africana*), buffalo (*Syncerus caffer caffer*), wildebeest (*Connochaetes taurinus*), zebra (*Equus burchelli*) and lichtenstein hartebeest (*Alcephalus lichtensteinii*) in Selous-Niassa corridor just to mention few.

The research conducted by Jones *et al.* (2009) revealed that, the opportunities for establishing, maintaining or managing corridors between protected areas are rapidly diminishing, endangering the future of the ecosystem services and biodiversity that these areas provide. In Tanzania there are thirty one (31) known wildlife corridors as shown in Appendix iv.

2.3 Disadvantages of Wildlife Corridors

Wildlife corridors may facilitate the spread of diseases and pathogens to metapopulations as they migrate from one Protected Areas (PAs) to another because of the easiest path of such animals to move to other areas (Caughley and Sinclair, 1994; Tran, 1997). Wildlife corridors may serve as a conduit to fire and exotic species. For example in the Florida wildlife corridor, New Zealand as verified by Thomas (1991) revealed to have been one of the factors to conduit fires from one part of the protected area to the other on its occurrence.

In addition, corridors play role in zoonotic disease transmission between wildlife and domestic animals. For example the case of New South Wales wildlife corridors in Netherlands, dears have been the source of Foot and Mouth Disease (FMD), Blue Tongue (BT), Bovine Virus Diarrhoea (BVD), Paratuberculosis and Babesiosis to domestic animals when come into contact during migration through the corridor (Cermy *et al.*, 2013)

Corridors as well increase exposure of wildlife to hunters, poachers and other predators. For example Gondwana link corridor exposure in Western Australia was reported to increase poaching of cockatoos during wildlife migration (Johnson, 2010). When these animals migrate from the Nullarbor Plain to West forest in far South West Australia through this corridor become more vulnerable to poachers who end up killing most of them. In Western Serengeti poaching increases and a good toll of animals are killed as they migrate from one area to the other, especially during migration of wildebeest (Jones *et al.*, 2009). Corridors being the extension outside the core PAs increase the costs of maintaining and conserving as it is much easier to protect animals within the PA than in the corridor where there are lots of interference and exposure to other threats (Hudson, 1991; Brewer, 1994; Johns, 1997; Jemenez-Osornio *et al.*, 2008).

2.4 Protection of Wildlife Corridors

In Tanzania, wildlife corridors are regarded as the critical areas for the survival of wild animals (Noe, 2003). The Wildlife Conservation Act Na. 5 of 2009 has recognized the importance of protecting wildlife corridors. Also the wildlife policy approved in 1998 recommended a number of strategies for protection, conservation and maintenance of biodiversity in the wildlife corridors (URT, 1998). The integration of wildlife conservation and rural development through Community Based Conservation (CBC) is one of the recommended strategy. To this end, the establishment of the new category of PA known as Wildlife Management Areas (WMAs) is pursued as a way of effecting the Community Based Conservation (CBC) where communities are involved in protecting the wildlife and their associated environment. In most cases, WMA among other advantages are intended to safeguard the wildlife corridors and other critical areas for the wildlife survival (URT, 1998; Massawe, 2010).

For example, establishment of Ikoma WMA has managed to protect the corridor that links between Serengeti and Maasai-Mara National Parks. Through WMAs, local communities can obtain a user right that enables them to manage and utilize wildlife resources from them (Baldus, 2004; Kajembe *et al.,* 2005). Through this strategy the local communities are able to access natural resources and have sustainable utilization for their livelihood while being the ambassadors in protecting these resources to enhance their sustainability.

CHAPTER THREE

3.0 METHODOLOGY

3.1 Study Site Description

3.1.1 Location

The Saadani-Wami-Mbiki wildlife corridor lies in the coastal area of Tanzania (Fig. 2). The corridor extends between Saadani National Park and Wami-Mbiki Wildlife Management Area (WMA), hence a link between them. The corridor lies on the northern side and about 80 km from Dar es Salaam. The area occupied by the corridor is interspersed with rocky hills of thin soil cover and valleys with deep clay or alluvial soils; altitude varies between 350 and 400m. The corridor is estimated to be 620 km^2 and comprising 29 villages.

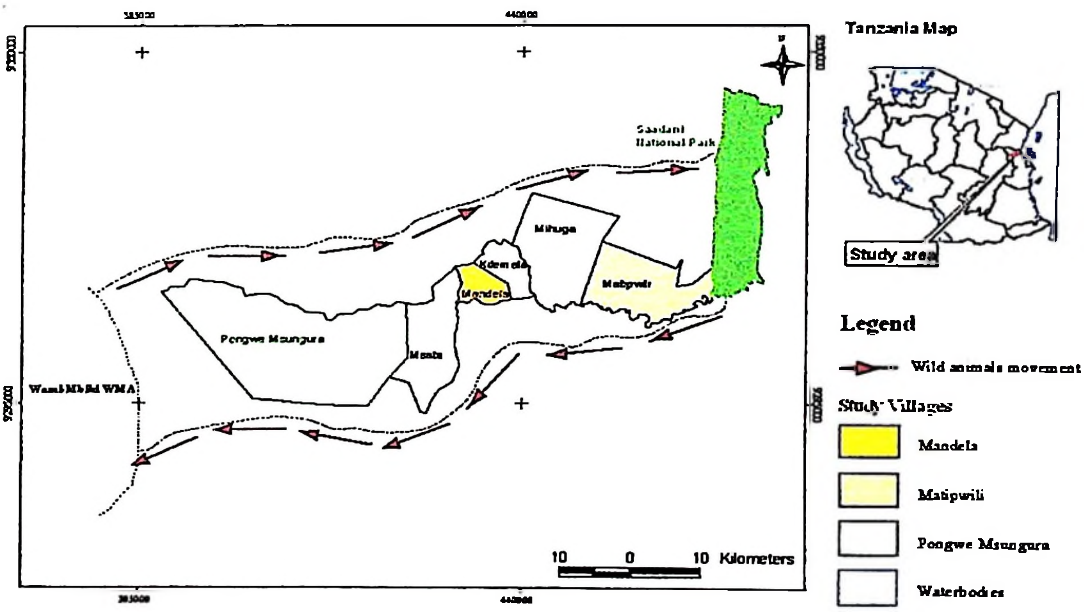

Figure 2: Location of the corridor and study villages

3.1.2 Climate

The area is characterized by bi-modal rainfall that is typical of a coastline climate with rainfall peaks between March and May and a smaller peak between October and December during which monthly averages exceed 100 mm (Baldus, 2001). The rainfall varies from 820 mm in Wami area to 1000 mm in Mkwaja Ranch. Highest rainfall is experienced at higher altitudes. January and February are usually dry (Tobler. 2001).

Temperatures are typical of the equatorial coastal region of East Africa with an annual maximum temperature of 29.7°C while minimum being 21.9°C. July and August are the coolest months while January is the hottest. Relative humidity is high, ranging from 79% in October to 91% in April. Evaporation is between 1800mm and 2000 mm per annum (Winnegge, 1999).

3.1.3 Fauna

The large mammals found in the Saadani ecosystem are mainly those associated with savannah ecosystems. It harbours a combination of species found between Miombo woodland and Vachellia savanna.

According to Baldus *et al.* (2001) the most common large mammals in the area among many include giraffe (*Giraffa camelopardalis*), coke's hartebeest (*Alcelaphus buselaphus*), waterbuck (*Kobus ellipsiprymnus*), wildebeest (*Connochaetes taurinus*), warthog (*Phacochoerus aethiopicus*), zebra (*Equus burchelli*), bushbuck (*Tragelaphus scriptus*) and reedbuck bohor (*Redunca redunca*), yellow baboon (*Papio cynocephalus*), vervet monkey (*Cercopithecus aethiops*), lion (*Panthera leo*), leopard *(Panthera pardus)*, hyena (*Crocuta crocuta*) and buffalo *(Syncerus caffer caffer)*.

Others include elephant (*Loxodonta africana*), sable antelope *(Hippotragus niger*),hippopotamus (*Hippopotamus amphibious*), common waterbuck (*Kobus ellipsiprymnus*), bushbaby (*Galago senegalensis*), bushpig (*Potamochoerus porcus*), serval cat (*Felis serval*), crocodile (*Crocodilus niloticus*), dikdik (*Rynchotragus kirkii*), red duiker (*Cephalophus natalensis*), african hare (*Lepus capensis*), colobus monkey (*Colobus polykomos*), nyegere (*Mellivora capensis*). Others include different species of reptiles. amphibians, and avifauna.

3.1.4 Flora

The dominant trees in the area are vachellia species such as *Vachellia polyacantha*, and *Vachellia robusta*. Other tree species include *Lannea stuhlmanii* and *Pteleopsis myrtifolia* that have significant contribution to the vegetation profile of the corridor (Baldus and Siege, 2001).

In the western side of the corridor, probably due to increasing rainfall, tree density increases eventually leading to savanna woodland having some miombo characteristics. However, the physiognomy is still savanna-like with a high proportion of *Vachellia* and only a limited number of *Caesalpiniaceae* (e.g. *Brachystegia sp.*).

The continuous tall grass cover is mostly composed of millet grasses (e.g. *Panicum maximum*).

A vast area between the shoreline and the savanna woodland is covered with different types of trees, shrubs and grasses (less than 2% canopy cover) having a variable woody cover (Baldus and Siege, 2001).

3.2 Research Design and Sampling Procedure

A cross-sectional design which allows data to be collected at one point in time was adopted as suggested by Kothari, (2004) and Saunders *et al.*, (2007). Based on the list of villages from the District office and reconnaissance survey, a purposive sampling method was used to select three villages namely Matipwili, Mandela and Pongwe Kiona. The villages were selected on the basis of location with respect to accessibility and proximity to the corridor. The sampling units of 30 households in each village were randomly selected from the sampling frame (village register). This sample size is recommended by Saunders *et al.*, (2007) on grounds that it is a reasonable sample size for social science studies as it is statistically large enough to make scientific conclusions.

According to URT (2006), a household includes a single person or 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 the Africans traditions and customs, the household is the basic unit of social structure (Lubida, 2004).

The heads of the household were the main respondents since 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). In all selected villages, the household questionnaire based interviews were administered (See appendix 1).

3.3 Data Collection

3.3.1 Primary data collection

3.3.1.1 Questionnaire survey

The survey was conducted using a structured questionnaire 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 and along the corridor. Also, the technique was used to obtain villagers' views on the remarkable impacts associated with these land use practices on the corridor and wildlife.

3.3.1.2 Discussion with key informants

Key informants included individuals who were conversant with their environment and willing to talk to the researcher. They also included people with their professionals in the village such as District Game Officer (DGO), Village Game Scouts (VGS), Village Agricultural Extension Officers, and Wami-Mbiki WMA and Saadani National Park Officials. The discussion was guided by a checklist (Appendix III) and aimed at collecting information concerning the types of land use practices done in and along the corridor and their associated impacts to the wildlife conservation. Furthermore, the collected information was on the trend of wild animals and human wildlife interaction within and along the corridor.

3.3.1.3 Physical observations

A participant observer is the one who seeks to go beyond outward appearance and probe the perception, motives, belief, values and attitudes of the people studied (Lusambo, 2009). For the entire period of fieldwork, the researcher was keen observing various aspects related to land use practices. These included assessing the level of habitat disturbances caused by humans, identifying wild animals using the corridor and the types of land use practices carried out in the corridor.

3.3.1.4 Remote sensing and GIS

Remote sensing and GIS techniques were employed to assess vegetation cover changes as a result of land use along the corridor. Three sets of Landsat satellite imageries for 1975, 1995 and 2011 were purchased by considering the possible minimum presence of cloud cover, spatio-temporal characteristics, image data availability and image data costs. Image pre-processing, rectification/geo-referencing, enhancement and correction of distortions for all acquired images were done. The researcher used a handheld GPS for ground truthing/geo-referencing purposes that was so done by recording coordinates which later on were used to allocate features for verifying and documenting types and magnitude of vegetation cover change in the area (Plate 1).

Plate 1: Researcher tracking the coordinates in the study area

3.3.1.5 Image data acquisition

Materials used in the study were Multispectral Scanner (MSS) of 27th July 1975, landsat 7 ETM+ imagery of 27th July 1995 and Landsat 7 ETM + of 21st February 2011. The images were obtained from the Institute of Resources Assessment (IRA) of the University of Dar es Salaam. Topographical maps with a scale of 1:50 000 were acquired from the Survey and Mapping Division of the Ministry of Lands, Housing and Human Settlements Development for geo-referencing Landsat images preparation of land use/cover interpretation key. The sub scenes covering the Saadani-Wami-Mbiki wildlife corridor were extracted from the mentioned images. Global Positioning System (GPS) was used in land use and cover map verification and updating land use and land cover map to include land use pattern up to the year 2011. Images were selected based on low cloud cover, seasonality, date and phonological effects.

3.3.2 Secondary data collection

A range of secondary data about the land use practices carried out along the corridor and their associated impacts to wildlife conservation was collected from relevant offices, villages, and wards authorities as well as in relevant government and non-governmental offices. Other documents and publications were obtained through unpublished literature, literature search using the Internet and from Wami-Mbiki WMA office. This information was important in broadening perspectives and also in providing in-depth understanding of the research topic.

3.4 Data Analysis

3.4.1 Quantitative data from household surveys

Quantitative data from household surveys were processed and analysed using Statistical Package for Social Sciences (SPSS) version 12.0 computer programme and Microsoft Excel Spreadsheet. Most of the analysis under quantitative data falls under the domain of "descriptive statistics". Descriptive statistic was applied to determine frequencies, percentages and multiple responses.

3.4.2 Content and structural–functional analysis

The qualitative data from household survey ad key informants were analyzed using content and structural-functional analysis techniques. Content analysis method was used to analyze in detail the components of verbal discussions held with key informants and from open-ended questions. The structural functional analysis was used to explain the way social factors relate to each other within a social system and to the physical surroundings. This type of analysis helped the researcher to distinguish between manifest and latent functions. Manifest functions are consequences which are intended and recognized by actors in a system while latent functions are consequences which are neither intended nor recognized (Kajembe and Luoga, 1996).

3.4.3 Pre processing of landsat data

Pre-processing of imagery, image rectification/geo-referencing and image enhancement were performed. Geo-referencing was performed in order to be able to bring the image in the real world coordinate system. The image of 1975, 1995 and 2011 were geo-referenced using ERDAS IMAGINE 9.1 software with reference to topographic map having a scale of 1:50 000, covering the study area. Easily identifiable ground control points on permanent features were used. Thus, image coordinates were transformed into map coordinates as per 37S Universal Transverse Mercator (UTM) zone projected to Transverse Mercator Spheroid Clark 1880 and Datum Arc 1960. Three rectified images were reduced to the size of the study area by using subset commands in ERDAS IMAGINE 9.1 Software (clipping process). Image enhancement was then performed to reinforce visual interpretation. False colours composite was created by combining images (bands) captured at different wavelengths to enable better visualization of vegetation, soil, streams and settlement in the landscape.

3.4.4 Interpretation of landsat images

The enhanced images in ERDAS IMAGINE 9.1 software were interpreted in ArcGIS 9.3. The image analysis extension in ArcGIS 9.3 helped to sharpen more features for better visual identification of features of greatest interest in the study area. Different land cover categories were extracted using photo texture. False colours composite was formed using

Red, Green and Blue for bands 4, 3, 2. The automated method was used in identifying land covers. Cover classes were determined based on ground truthing data which were used as reference points for each land cover collected from the field by using GPS.

3.4.5 Preliminary image classification

Within the scope of this study, image classification is defined as the extraction of differentiated land use/cover categories of remotely sensed satellite data. Supervised Maximum Likelihood Classifier (MLC) remote sensing classification methodologies were utilized to create a base map for ground truthing. The supervised classification process involved classification of training sites in the image which represent specific land classes to be mapped. Training sites of pixels that represent what is recognised as a discernable pattern or potential land cover class (ERDAS, 1999). The training sites were generated by on-screen digitizing of selected areas for each land cover class derived from colour composite. Training was an iterative process, whereby the selected training pixels were evaluated by performing an estimated classification (ALARM command). Based on the inspection of alarm results, training samples were refined until a satisfactory result was obtained.

3.4.6 Size and shape of the classified map

The boundary used for extracting subset was based on village boundaries. These village boundaries were extracted from the map of Tanzania in which all country villages were combined. The extracted study area contains Matipwili, Mandela and Pongwe Kiona villages. The map was in a vector format. Thereafter, each image was overlaid with the village boundary so as to extract the area of interest. The extraction process is known as image subset using ERDAS Imagine program.

3.4.7 Ground truthing

Ground truthing was done in order to verify and modify land covers described in the preliminary image interpretation. Before implementing field ground truthing, preliminary image classification was performed to identify vegetation types. Sets of hard copies of colour composite images, with overlays of roads and UTM co-ordinates, were produced using an image acquired on 27 July 1995. This was used as base maps during ground truthing. In addition, a handheld GPS was used to locate samples of land cover observations. This was done at the peak of the dry season to ease access to impassable areas during wet seasons. Recognizable features were recorded and circled on the map and their respective position recorded. During the ground truthing, the following major land cover classes were identified: closed forest, open forest, bushland, shrubland, cultivated land, grassland, open water bodies and settlement. Local communities were involved to give some information on land cover and particularly land cover changes in their communities.

3.4.8 Change detection analysis

Change detection is a very common and powerful application of satellite based remote sensing. Change detection analysis entails finding the type, amount and location of land use changes that are taking place (Kashaigili, 2006). The change detection was performed through an overlay method basing on generated vector themes of different years. The change detection was done between data sets of 1975 – 1995 and 1995 – 2011 years. The overlay was performed by intersecting feature themes so that the boundaries and attributes of themes were combined to form the derivative output theme. The attribute tables of the output themes were summarized in definition table and results were exported into MS-excel package to compile areas of change for each information category. Algorithms for change detection analysis can be grouped into two categories namely pixel-to-pixel comparison of multi-temporal images before image classification and post-classification comparison. In this study, a post classification comparison method was used to assess land use and cover changes.

The method has been found to be the most suitable for detecting the land cover change (Kashaigili, 2006). The approach identifies changes by comparing independently classified multi-date images on a pixel-by-pixel basis using a change detection matrix (Yuan and Elvidge, 1998). The matrix analysis produces a thematic layer that contains a separate class for every coincidence of classes in a multi - date dataset. Although the use of a change detection matrix provides detailed *from-to* information on the nature of change, mis-classification and mis-registration that may be present in each classified image may affect the accuracy of the results. Therefore, accurate classifications are imperative to ensure precise change detection results (Foody, 2001; Kashaigili, 2006).

3.4.9 Assessment of the rate of cover change

The estimation of the rate of change for the different covers was computed based on the following formulae (Kashaigili and Majaliwa, 2010):

$$\% \, Change_{year\ x} = \frac{Area_{i\ year\ x} - Area_{i\ year\ x+1}}{\sum_{i=1}^{n} Area_{i\ year\ x}} x\,100 \quad \text{.......... (1)}$$

$$Annual\ rate\ of\ change = \frac{Area_{i\ year\ x} - Area_{i\ year\ x+1}}{t_{years}} \quad \text{.......... (2)}$$

$$\% \, Annual\ rate\ of\ change = \frac{Area_{i\ year\ x} - Area_{i\ year\ x+1}}{\sum_{i=1}^{n} Area_{i\ year\ x}\ x\ t_{years}} x100 \quad \text{.......... (3)}$$

Where: Area $_{i\ year\ x}$ = area of cover i at the first date

Area $_{i\ year\ x+1}$ = area of cover i at the second date

$\sum_{i=1}^{n} Area_{i\ year\ x}$ = the total cover area at the first date and

t_{years} = period in years between the first and second scene acquisition dates

CHAPTER FOUR

4.0 RESULTS

4.1 The Spatial Extents of Different Land Cover Classes

The main land use/land cover maps for 1975, 1995 and 2011 are presented in Fig. 3, 4 and 5 respectively. The figures show the proportion of each land cover category between the three time periods of analysis. In the year 1975 (see Fig. 7) the land use/cover in the study area was dominated by closed forest and bushland occupying 30% (59 413 ha) and 25% (50 788 ha) respectively followed by cultivated land occupying 13% (26 165 ha) then grassland 12% (24 278 ha) and shrubs 11% (22 007 ha). Others were open forest and settlement, occupying 4% (8599 ha) and 4% (7618 ha) respectively and finally open water bodies comprising 1% (1095 ha).

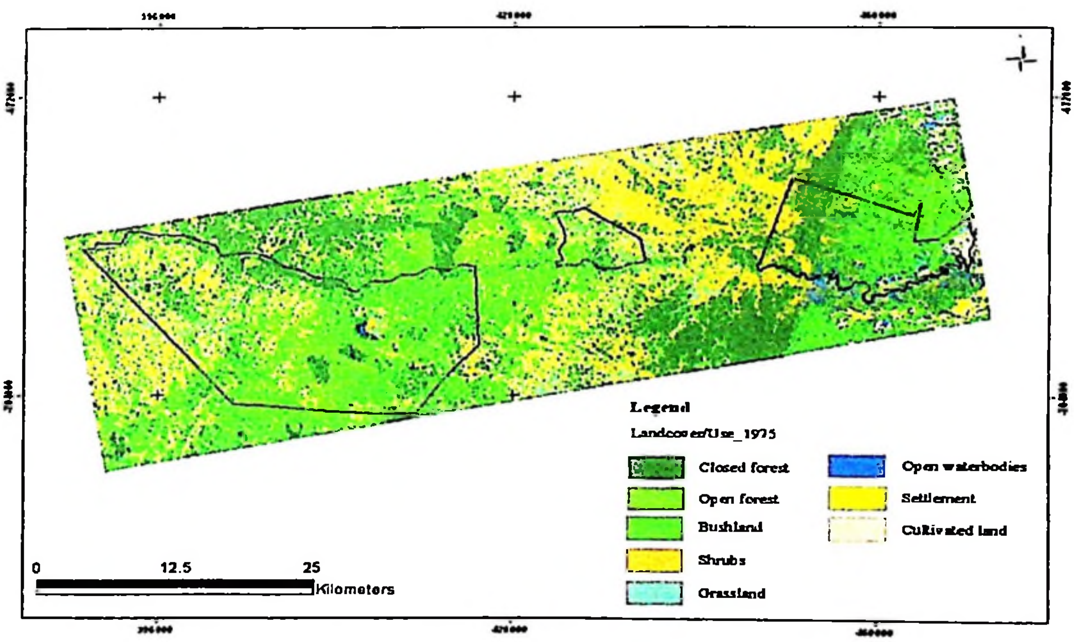

Figure 3: Land cover/use map of image scene, 1975

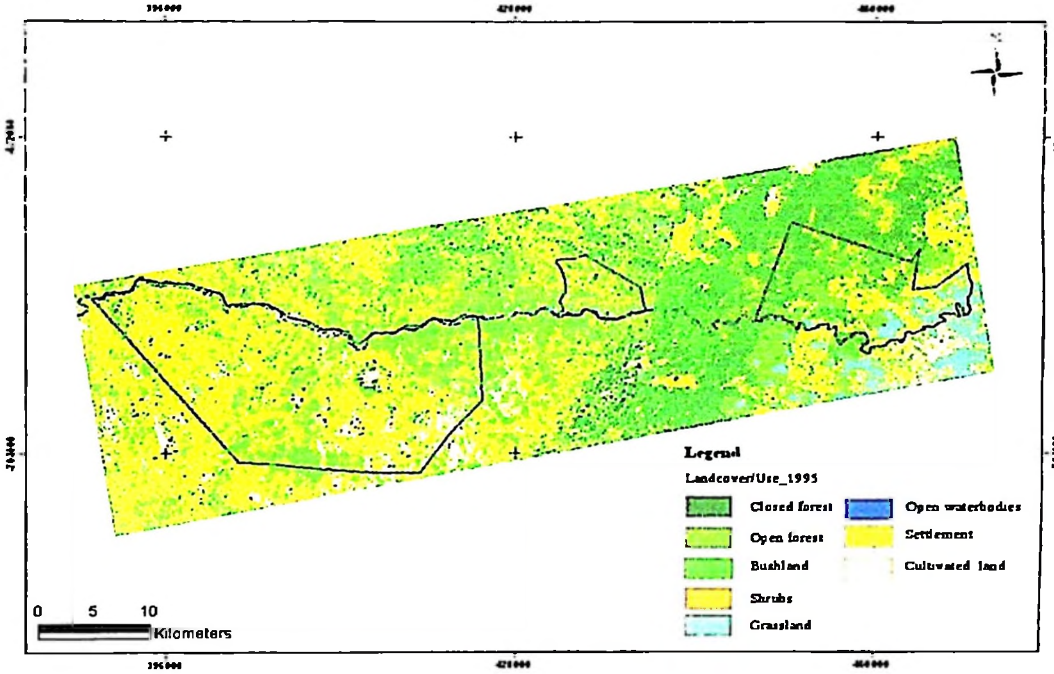

Figure 4: Land cover/use Map of Image scene, 1995

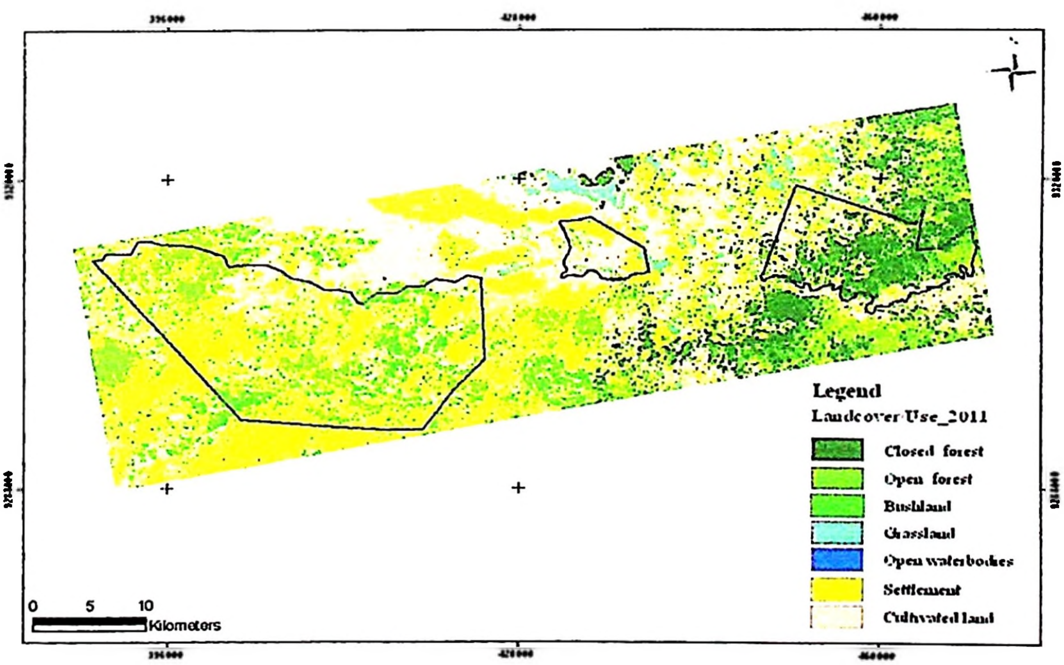

Figure 5: Land cover/use map of image scene, 2011

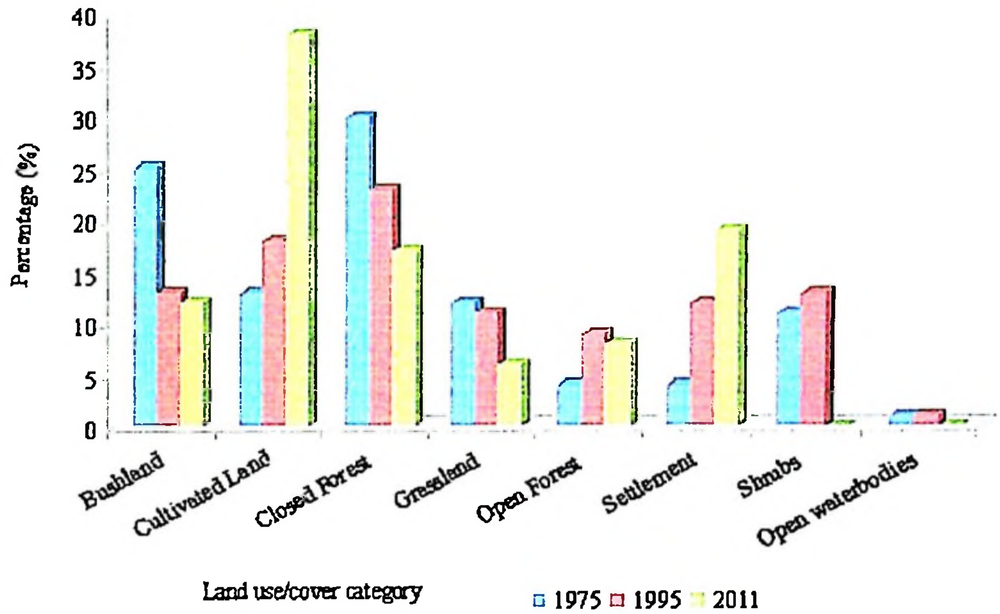

Figure 6: Land use/cover distribution for Saadani-Wami-Mbiki wildlife corridor between 1975 and 2011

Fig. 7 shows that in 1995, closed forest continued to occupy the largest land cover. It comprised 23% (46 681 ha) of the total land cover, followed by cultivated land 18% (35 608 ha). Bushland and shrubland occupied 13% (26 616 ha) and 13% (25 362 ha) respectively. Others included settlement and grassland which occupied 12% (24 474 ha) and 11% (22 812 ha) respectively. The open forest occupied 9% (18 493 ha) and open water bodies 1% (1095 ha).

In 2011, the cultivated land occupied 38% (76 791 ha) followed by settlement which counted for 19% (37 282 ha) of the total area. Furthermore, the closed forest occupied 17% (33 392 ha) followed by bush land 12% (24 509 ha), open forest 8% (15 577 ha), grassland 6% (12 690 ha), and open water bodies that occupied 0.01% (900 ha). Areas used for cultivation and settlement seemed to be increasing gradually throughout the study period from 26 165 ha (13%) and 7618 ha (4%) in 1975 to 76 791 ha (38%) and 37 282 ha (19%) in 2011 while closed forest, grassland and bush land decreased from 59 413 ha (30%), 24 278 ha (12%) and 50 788 ha (25%) in 1975 to 33 392 (17%), 12 690 ha (6%) and 24 509 ha (12%) in 2011 respectively. The combined land cover areas of closed forest, grassland and bush land decreased from 1 343 479 ha (67%) in 1975 to 70 591 ha (35%) in 2011. The areas used for cultivation increased from 26 165 ha (13%) to 76 791 ha (38%) in the same period. Also the area used for settlement increased tremendously from 7618 ha (4%) in 1975 to 37 282 ha (19%) in 2011.

4.2 Changes in Land Use/Cover in the Saadani-Wami-Mbiki Wildlife Corridor

According to Table 1, the period between 1975 and 1995 show that the cultivated area increased by 9443 ha (5%); bush land decreased by 24 172 ha (12%) while the area for grassland shrunk by 1466 ha (1%). In the same period, settlement increased significantly by 16 856 ha (8%) as opposed to closed forest which indicated a decrease by 12 732 ha (6%) while open forests and shrubs recorded an increase by 9894 ha (5%) and 3355 ha (2%) respectively.

Moreover, in the period between 1995 and 2011, the closed forest decreased by 13 289 ha (7%), grassland by 10 122 ha (5%), shrubs by 25 362 ha (13%) and bush land by 2107 ha (1%) while the open forest decreased by 2916 ha (1%). However, the cultivated land increased by 41 183 ha (20%) and settlement by 12 808 ha (6%).

Table 1: Changes in different land use/cover in the Saadani-Wami-Mbiki wildlife corridor 1975 - 1995 and 1995 – 2011.

	1975		1995		2011		Relative Change (1975-1995)		Relative Change (1995-2011)	
Vegetation Types	Area ha	%	Area ha	%	Area ha	%	Area ha	%	Area ha	%
Bushland	50 788	25	26 616	13	24 509	12	-24 172	-12	-2107	-1
Cultivated land	26 165	13	35 608	18	76 791	38	9443	5	41 183	20
Closed forest	59 413	30	46 681	23	33 392	17	-12 732	-6	-13 289	-7
Grassland	24 278	12	22 812	11	12 690	6	-1466	-1	-10 122	-5
Open forest	8599	4	18 493	9	15 577	8	9894	5	-2916	-1
Settlement	7618	4	24 474	12	37 282	19	16 856	8	12 808	6
Shrubs	22 007	11	25 362	13	0	0	3355	2	-25 362	-13
Open waterbodies	2273	1	1095	1	900	0	-1178	-1	-195	0
Total	201 141	100	201 141	100	201 141	100				

4.3 Rate of Land Use/Cover Change in the Saadani-Wami-Mbiki Wildlife Corridor

Tables 2 and 3 show the rate of land use/cover change in the Saadani-Wami-Mbiki wildlife corridor. It was found that grassland decreased at a rate of 73 ha (0.1%) per year between 1975 and 1995 and continued decreasing at the rate of 633 ha (0.3%) per year between 1995 and 2011. Furthermore, it was revealed that the closed forest decreased at the rate of 637 ha/year (0.3%) between 1975 and 1995 while decreasing at the rate of 831 ha/year (0.4%) in the period between 1995 and 2011.

Moreover, it was found that cultivated land increased at a rate of 472 ha (0.3%) per year between 1975 and 1995 and at a rate of 2574 ha (1.3%) per year between 1995 and 2011. Bush land decreased at the rate of 1209 ha (0.6%) per year between 1975 and 1995 and 132 ha (0.1%) per year between 1995 and 2011. In addition, settlement increased at the rate of 843 ha (0.4%) per year between 1975 and 1995 and 801 ha (0.4%) per year between 1995 and 2011. The open forest increased at the rate of 495 ha (0.3%) per year between 1975 and 1995 and continued increasing at the rate of 182 ha (0.1%) per year between 1995 and 2011. The other land cover that seemed to be changing was shrubs which indicated that they increased at the rate of 168 ha (0.1%) per year between 1975 and 1995 and decreased at the rate of 1585 ha (0.8%) per year between 1995 and 2011.

Table 2: Area Cover, Area Change and Rate of Change Between 1975 and 1995

	1975		1995					
Vegetation Types	Area (ha)	%	Area (ha)	%	Area change (ha)	%	Annual rate of change (ha/yr)	Annual rate of change (%/yr)
Bushland	50 788	25	26 616	13	-24 172	-12	-1209	-0.6
Cultivated Land	26 165	13	35 608	18	9443	5	472	0.3
Closed Forest	59 413	30	46 681	23	-12 732	-6	-637	-0.3
Grassland	24 278	12	22 812	11	-1466	-1	- 73	-0.1
Open Forest	8599	4	18 493	9	9894	5	495	0.3
Settlement	7618	4	24 474	12	16 856	8	843	0.4
Shrubs	22 007	11	25 362	13	3355	2	168	0.1
Open water bodies	2273	1	1095	1	-1178	-1	-59	-0.1
Total	201 141	100	201 141	100				

Table 3: Area Cover, Area Change and Rate of Change Between 1995 and 2011

	1995		2011					
Vegetation Types	Area (ha)	%	Area (ha)	%	Area change (ha)	%	Annual rate of change (ha/yr)	Annual rate of change (%/yr)
Bush land	26 616	13	24 509	12	-2 107	-1	-132	-0.1
Cultivated Land	35 608	18	76 791	38	41 183	20	2574	1.3
Closed Forest	46 681	23	33 392	17	-13 289	-7	-831	-0.4
Grassland	22 812	11	12 690	6	-10 122	-5	-633	-0.3
Open Forest	18 493	9	15 577	8	-2916	-1	-182	-0.1
Settlement	24 474	12	37 282	19	12 808	6	801	0.4
Shrubs	25 362	13	0	0	-25 362	-13	-1585	-0.8
Stream	1095	1	900	0	-195	-0	-12	-0.0
Total	201 141	100	201 141	100				

4.4 Changes Detection Matrix of Different Land Use/Cover

The change detection of land cover/use in the corridor between 1975 and 1995 is presented in Table 4. During this period, 5202 ha of closed forest was converted to bush land, 3980 ha to cultivated land, 759 ha to settlements, 7412 ha to grassland, 10 ha to open forest, 10 226 ha to shrub land while 15 851 ha remained unchanged. The bush land experienced the same sequence whereby 3530 ha were converted to grassland, 3230 ha to cultivated land and 874 ha to settlements while 5331 ha remained unchanged.

Furthermore, 1268 ha of open forest was converted to bush land, 330 ha to cultivated land, 728 ha to grassland, 1373 ha to shrub land and 40 ha to settlement while 750 ha remained unchanged. About 6167 ha of shrub land was converted to cultivated land, 1733 ha to settlements, 3337 ha to grassland while 1792 ha remained unchanged.

Table 4: Change detection matrix for 1975 – 1995

	Classes in 1975								
Classes in 1995	BL	CL	CF	GL	OF	SE	SB	OW	Total
Bushland	(5331)	3230	6955	3515	3816	874	2752	143	26 616
Cultivated Land	13 560	(5018)	6717	2722	1704	1589	1591	262	35 608
Closed Forest	5202	3980	(18 565)	7412	10	759	10 226	527	46 681
Grassland	6760	3874	6627	(1884)	15	1396	1652	604	22 812
Open Forest	1268	330	6008	728	(750)	40	1373	114	18 493
Settlement	5598	3448	5304	3950	2202	(1186)	2526	360	24 474
Shrubs	12 783	6167	8995	3337	10	1733	(1792)	239	25 362
Open waterbodies	286	118	342	97	92	41	95	(24)	1095
Total	**50 788**	**26 165**	**59 413**	**24 278**	**8599**	**7618**	**22 007**	**2 273**	**201 141**

BL=Bushland, CL=Cultivatedland, CF=Closed Forest, GL=Grassland, OF=Open Forest, SE=Settlement, SB=Shrubs, OW=Open waterbodies

The analysis of land use/cover change detection for the period between 1995 and 2011 is presented in Table 5. The closed forests changed by 1716 ha to grasslands, 4190 ha to cultivated land, 1491 ha to settlements, 2090 ha to bush land, 4 ha to open forest, 4480 ha to shrub land while 1457 ha remained unchanged.

Table 5: Change detection matrix for 1995 - 2011

	Classes in 1995								
Classes in 2011	BL	CL	CF	GL	SE	OF	SB	OW	Total
Bushland	(393)	5155	4399	4865	3780	833	4965	119	24 509
Cultivated Land	10 846	(12 254)	18 724	10 689	8381	1835	13 547	515	76 791
Closed Forest	090	4190	(1457)	1716	1491	4	4480	149	15 577
Grassland	1936	1959	3877	(1347)	1240	205	2061	65	12 690
Settlement	3750	8260	7057	3574	(5042)	584	8753	262	37 282
Open forest	8047	4058	9167	3483	3950	(4117)	500	70	33 392
Open waterbodies	3	76	0	11	9	300	1	(500)	900
Total	27 065	35 952	44 681	25 685	23 893	7878	34 307	1680	201 141

BL=Bushland, CL=Cultivatedland, CF=Closed Forest, GL=Grassland, OF=Open Forest, SE=Settlement, SB=Shrubs, OP=Open waterbodies

About 8047 ha of the open forest was converted to bush land, 4058 ha to cultivated land, 3483 ha to grassland and 3950 ha to settlements while 4117 ha remained unchanged. About 4865 ha of bush land was converted to grassland, 5155 ha to cultivated land while 393 ha remained unchanged. Also, 1959 ha of grassland was converted to cropland, 1240 ha to settlements while 1347 ha remained unchanged.

4.5 Land Use Practices Along Saadani – Wami-Mbiki Wildlife Corridor

Results in Table 6 show various land use practices carried out within and along Saadani–Wami-Mbiki wildlife corridor. Shifting cultivation took 23%, livestock keeping 21%, charcoal making 17% and settlement 11% respectively. Other activities included poles extraction, lumbering, poaching, firewood collection, mining, sand extraction, infrastructure development and fishing accounted for 28% of the total responses.

Table 6: Main activities practised along and within the corridor

Category label	Code	Count	Percentage of responses
Shifting cultivation	1	44	23
Livestock grazing	2	40	21
Charcoal making	3	33	17
Settlement	4	22	11
Illegal hunting (poaching)	5	15	8
Poles extraction	6	11	6
Firewood collection	7	11	6
Lumbering	8	6	3
Mining	9	4	2
Sand/gravel extraction	10	4	2
Fishing	11	3	2
Infrastructure development	12	1	1
90 Valid cases	**Total responses**	**194**	**100**

Source: Field data (2011)

Plate 2: Showing destruction of corridor for grazing, charcoal and poles extraction

Photo by: Lawrence Kileo **Date:** 22/12/2011

CHAPTER FIVE

5.0 DISCUSSION

Saadani-Wami-Mbiki like any other wildlife corridors in Tanzania has a special ecosystem importance towards the survival of many wildlife species living along the coast. The area is shrinking due to increased human activities on strive for livelihood. The results obtained from this study identified factors towards land use changes that can also be in any other wildlife corridors.

The rate of land cover change observed from satellite imageries of 1975, 1995 and 2011 indicated an extremely utilization of Saadani-Wami-Mbiki corridor by humans; this could be attributed to an increase of human population from 173 871 in 1988 to 311 740 in 2012 with an average annual growth rate of 2% (URT, 2013). The increase in population and associated activities within and along the corridor seeking for livelihood, expanded towards the natural vegetation resulting in narrowing the corridor width.

The result from this study indicated that, cultivated land increased from 13% (26 165 ha) in 1975 to 18% (35 608 ha) in 1995 and 38% (76 791 ha) in 2011 respectively. The continuous increase in land use is also reflected in an increased area under settlements from 4% (7618 ha) in 1975 to 19 % (37 282 ha) in 2011. Settlement expansion has an implication on increase in population size; as a result demand for more resources and area for cultivation and other economic activities. In this period of about 36 years, three new villages of Gongo, Kimange and Kifleta were also emerged in the area.

The emergence of new settlements and agriculture in wildlife corridors has been reported in other studies to have an adverse impact on the natural land cover and wildlife habitat. Noe (2003) on wildlife corridor between Mount Kilimanjaro and Amboseli National Park, Tanzania found that settlements and agriculture expanded into wildlife grazing and dispersal areas which reduced the actual size of the corridor from approximately 21 km^2 in 1952 to approximately 5 km^2 in 2001. Ntongani *et al.* (2009) on land use changes and conservation threats in the eastern Selous–Niassa wildlife corridor, Nachingwea, Tanzania found that cultivated land and settlement increased from 3.1% (6 286.1 ha) and 0.7% (1 373.7 ha) in 1978 to 12% (24 138.6 ha) and 1.4% (2 835.1 ha) in 2005 respectively.

Furthermore, the introduction of Structural Adjustment Programmes in the country's economy in the 1990s where trade liberalization reforms went hand in hand with removal of farm input subsidies is likely to have contributed to land use changes in the study area. The field survey indicated that pineapples prices have been increasing since the year 2000 to date which attracted more people to engage in agriculture which created demand for more land. Mbonile *et al.*, (2003) on land use change and root causes on the southern slopes of Mount Kilimanjaro, Tanzania agreed that, removal of subsidies on farm inputs had an impact on land resource use. Ntongani *et al.*, (2009) said that, unstable land tenure and attractive prices from commercial crops forces farmers to an extensive agriculture, which caused land use changes.

Field data from the interview responses indicated that business of charcoal making, lumbering and firewood accounted for 3%, 6.7% and 6% has been encouraged by existence of all weather road, high prices of alternative energy i.e. gas, kerosene, electricity and population increment to neighbouring towns like Chalinze. Bagamoyo and Dar es Salaam. Most of trees extracted (*Acacia polyacantha, Acacia robusta, Afzelia quanzensis, Pterocarpus angolensis* and albizia *species*) have an adverse impact to the ecological status of the corridor which consequently hampers the proper function of the entire ecosystem. Whitty, (2007) and Blacke *et al.*, (2009) showed that, encroaching of wildlife corridors interrupt and affecting interspecies dependencies which could eventually lead to extinction depending on the stability of the ecosystem. WWF (2009) also reported that high prices of alternative domestic sources of energy influences the majority of local communities to rely heavily on charcoal and firewood for cooking.

Moreover livestock keeping associated with pastoralism was the most practiced activity that accounted 21% of the responses which has been the source of biodiversity destruction in the corridor. The pastoralists mainly Sukuma, Mang'ati and Maasai migrate to this corridor to access pastures and water. DPMS, 2001 and Shaw *et al.* 2002 revealed that grazing resulted in removal of new growth from the dieback condition causes trees and other ecosystem decline in health and die if poor/failed recruitment occurs. Mpanduji (2002) documented that Selous-Niasa wildlife corridor has already been encroached by humans for various activities and their population density in 2004 was about four people per km^2. It has also been noted that small East African protected areas would most likely lose larger mammal species in the future as a result of their increasing isolation (Bennet and Mulongoy, 2006).

Therefore, the loss of wildlife corridor may result into massive death and/or extirpation of migratory species (Newmark *et al.*, 1991; Whitty, 2007). The occurrence of land use changes in areas along and within Saadani-Wami-Mbiki wildlife corridor has not only reduced wildlife habitat that is rich in plant species but also may result into local extinction of wildlife population in the future if the situation is left unattended.

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

Generally the study has shown that although the Saadani-Wami-Mbiki wildlife corridor forms an important link between Saadani National Park and Wami-Mbiki WMA. its status has been decreasing over the past 36 years. Closed forest decreased at the rate of 637 ha/year (0.3%) between 1975 and 1995 and 831 ha/year (0.4%) between 1995 and 2011. Cultivated land and settlement increased at a rate of 472 ha/year (0.3%) and 843 ha/year (0.4%) between 1975 and 1995 and at a rate of 2 574 ha/year (1.3%) and 801 ha/year (0.4%) between 1995 and 2011 respectively. This indicated an extreme utilization of the corridor by humans striving for livelihood.

The existence of all weather road and population increase in neighbouring towns and city i.e. Chalinze, Bagamoyo and Dar es Salaam has been the core influence of charcoal making, lumbering and firewood that accounted for 17%, 3% and 6% respectively. The increased land use changes in areas along and within Saadani-Wami-Mbiki wildlife corridor has reduced wildlife habitat that consequently may result into local extinction of wildlife population.

6.2 Recommendations

Based on the findings and discussion of this study, the following recommendations are proposed as strategies to minimize encroachment to the Saadani-Wami-Mbiki corridor.

- Deliberate measures are needed to address about poverty of local communities around the corridor. The area has various economic potentials which could be used by poverty alleviation programmes hence reducing dependency to natural resources in the corridor. Among these potentials include ecological and cultural tourism and beekeeping.
- Measures are needed to encourage communities around the corridor and in neighbouring towns to make use of gas as alternative sources of energy and iron bars and aluminium rather than charcoal and timber. This may reduce dependency to the corridor.
- Local communities should be sensitized on the role of conservation through extension services that will restrain shifting cultivation and charcoal making observed in the area and reduce pressure on the corridor.

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APPENDICES

Appendix 1: Questionnaire for Household Based Interview

Questionnaire number……………………

Date:…….……./……………./ 2011

Interviewee's

name……………………………………………………………………………...

Location:

a)Village……………………… b).Ward…………………

c).Division………………………… d).District…………………………

d). 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. Education status: a) None………………b) Primary education…………….

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

6. Major economic activity: a) Farming………….. b) Livestock……………

c) Charcoal burning………….. d) Hunting…………………..

e) Logging........................ f) Lumbering..................

g) Employed..................... h) Business....................

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

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

c) Charcoal burning...(..........) d) Hunting..................(..........)

e) Logging............(..........) f) Lumbering...............(..........)

g) Employed..........(..........) h) Business.................(..........)

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

9. If you are an immigrant, how long have 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 status/use of the corridor in the past

....

....

13. Do you think people are now practicing different land use systems in the corridor than in the past?

a) Yes ....b) No ....

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

a) Excellent.................. b) Good....................

c) Fair........................ d) Bad.....................

e) Worse......................

15. Where do you cultivate the crops?

a) Near the corridor........................ b) Far from the corridor.........................

16. What are the activities that hamper/threat the integrity of the corridor? List them according to their importance in conservation activities.

a) ....

b)...

c).. ...

17. What are the consequences of these activities to;

a) Wild animals conservation..

b) Habitat..

18. What is the current conservation status of the corridor

....

19. What are the current or the future plans conservation activities carried out in the corridor?...

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

a) Yes............................. b)No ....

Elaborate..

C: Human-Wildlife Interaction

21. Do you see wild animals in that area?

a)................................ b)..............................

22. If Yes, name them in major categories of wild animals that are seen in recent times, seen their signs, pellets, foot prints or heard of being exist here:

a).Herbivores...

b).Predator...

c).Primates...

23. What animals currently not seen but used to be seen and

....

....

Why?...

24. In which season of the year normally has high population of wild animals in the area?

a) Dry season......................... b) Wet season..........................

c) Both seasons.......................... Reasons.................................

25. What is their direction during their movement?

a) From Saadani National Park to Wami-Mbiki Wildlife management Area.................

b) From Wami-Mbiki Wildlife management Area to Saadani National Park....................

c) From both direction...

d) No idea..

26. Based on the list of animals above which are resident of the corridor and which are migratory?

a)Resident animals...

b)Migratory animals...

27. What is your comment on the trend of animals?

a) Buffalo a)Increasing..............b) Decreasing.............. c) No idea...........

b) Zebra a)Increasing.................... b) Decreasing.....................

c) No idea.................

c) Wildebeest a) Increasing.............. b) Decreasing.................

c) No idea................. Reason.....................................

D: Human activities

28. What are the land use systems carried out along the corridor?

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

c) Charcoal burning........... d) Hunting..................................

e) Logging......................f) Lumbering................................

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

29. What is the intensity/state of these land use systems in the corridor?

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

d) Low..........................e) Very low................. f) No idea.....................

30. Do these activities carried out legally?

c) Yes.......................b) No....................No idea............................

31. Why people prefer to take economic activities along the corridor rather than in other areas?

a) ....

b) ....

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

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

d) Low.........................e) Very low..................f) No idea......................

33. What are the cultural activities carried out in the corridor?

a) Ritual.......... b) Medicinal......... c) Others (specify)................................

34. Is there any traditional method of conservation?

a) Yes................................ b) No.....................................

35. If yes, what is (are) the method(s)?

a)...

b)...

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

....

....

E: Suggestions about Conservation

37. Do you think is important to let the area (Wildlife corridor) to wildlife rather than human being? a) Yes....................... b) No.......................

38. Support your answer (s) above:

....

....

39. What do you think should be done in order that conservation of natural resources in the corridor becomes successful?

....

....

Appendix II: Checklist for Key Informants

1. What is the conservation status of the corridor?
2. Is there any policy or law or regulation that protects the corridor?
3. What are land use systems carried out along the corridor?
4. What is the extent of land use practices along the corridor?
5. How these activities do affect the conservation strategies of buffalo. zebra and wildebeest?
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?
13. What do you think should be done in order that conservation of natural resources in the corridor becomes successful?

Appendix III: The trends of animal species in the corridor over the past 36 years

Common name	Scientific name	Swahili name	Trend/Status	Identified through
Lion	*Panthera leo*	Simba	Decreased	FGD, QBI
Buffalo	*Syncerus caffer caffer*	Mbogo/Nyati	Decreased	QBI, DKI
Elephant	*Loxodonta africana*	Tembo	Decreased	FGD,QBI
Red duiker	*Cephalophus natalensis*	Funo	Decreased	DKI.FGD
Steinbok	*Raphiceros campestris*	Dondolo	Decreased	DKI.FGD
Striped Polecat*	*Ictonyx striatus*	Kicheche	Increased	DKI.FGD
Can rat*	*Thryonomys swinderianus*	Ndezi	Decreased	DKI.FGD
Colobus monkey	*Colobus polykomos*	Mbega	Decreased	DKI.FGD
Reedbuck	*Redunca redunca*	Tohe	Decreased	DKI.FGD
Hippopotamus	*Hippopotamus amphibius*	Kiboko	Increased	DKI,FGD
Crocodile	*Crocodilus niloticus*	Mamba	Increased	DKI.FGD
Civet cat	*Civettictis civetta*	Fungo	Decreased	DKI,FGD
Wildebeest	*Connochaetes taurinus*	Nyumbu	Disappeared	DKI.FGD
Sable antelope*	*Hippotragus niger*	Palahala	Decreased	DKI,FGD
Rhinoceros	*Diceros bicornis*	Faru	Disappeared	DKI.FGD
Cheetah	*Acinonyx jubatus*	Duma	Disappeared	DKI.FGD
Dikdik	*Madoqua kirkii*	Digidigi	Decreased	DKI.FGD
Bushbuck	*Tragelaphus scriptus*	Pongo/Mbawala	Decreased	DKI.FGD
Hare	*Lepus capensis*	Sungura	Maintained	DKI.FGD
Bushpig	*Potamochoerus porcus*	Nguruwe pori	Increased	DKI.FGD
Banded mongoose	*Mungos mungo*	Nguchiro	Decreased	DKI.FGD
Jackal	*Canis mesomelas/adutus*	Mbweha	Decreased	DKI,FGD
Vervet monkey	*Cercopithecus aethiops*	Tumbili	Maintained	DKI.FGD
Hergehog	*Erinaceus eurapaeus*	Karunguyeye	Decreased	DKI,FGD

Porcupine	*Hystix cristata*	Nungunungu	Decreased	DKI.FGD
Yellow baboon	*Papio cynocephalus*	Nyani	Increased	DKI.FGD
Aardvark	*Orycteroptus afer*	Muhanga	Decreased	DKI.FGD
Hyena*	*Crucuta crucuta*	Fisi	Decreased	DKI.FGD
Hyena*	*Hyaena hyaena*	Fisi	Decreased	DKI.FGD
Ratel	*Mellivora capensis*	Nyegere	Maintained	DKI.FGD
Eland	*Taurotragus oryx*	Pofu	Disappeared	DKI.FGD
Giraffe	*Giraffa camelopardalis*	Twiga	Decreased	DKI,FGD
Leopard	*Panthera pardus*	Chui	Decreased	DKI.FGD
Wild dog	*Lycaon pictus*	Mbwa mwitu	Disappeared	DKI.FGD
Zebra	*Equus burchelii*	Pundamilia	Decreased	DKI.FGD
Waterbuck	*Kobus ellipsiprymus*	Kuro	Decreased	DKI.FGD
Warthog	*Phacochoerus asthiopicus*	Ngiri	Increased	DKI.FGD
Coke Hartebeest	*Alcelaphus buselaphus cokei*	Kongoni	Decreased	DKI,FGD
Impalla	*Aepyceros melampus*	Swala pala	Disappeared	DKI.FGD
Blue duiker	*Cephalophus monticola*	Ndimba	Disappeared	DKI,FGD
Monitor lizard*	*Varanus indicus*	Kenge	Increased	DKI.FGD

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

Appendix IV: Tanzania Wildlife Corridors and their conservation status

S/N	Name of the corridor	Region	Threats/Conservation status
1	Bujingijila (Mt Rungwe-Livingstone)	Mbeya	Encroachment, logging, illegal hunting and charcoal making
2	Burigi-Akagera	Kagera	Following the refugee influx in 1994, great reductions in all large herbivore species were noted as refugees sought meat and firewood from the GRs.
3	Burigi-Moyowosi/Kigosi	Kagera, Shinyanga, Kigoma	Influx of refugees into Benaco resulted in heavy poaching. Cattle grazing, saw pits and agriculture.
4	Gombe-Kwitanga	Kigoma	Forest and woodland loss to farmland, charcoal and human settlements are the main threats. Poaching was probably a major factor in the decline of chimpanzees and other mammals in the area as well.
5	Gombe-Mukungu-Rukamabasi	Kigoma	Severely affected by the destruction of forest and woodland habitats outside the Gombe National Park driven by rapid population growth and immigration of refugees fleeing wars in Burundi and Congo. Agriculture and charcoal production. Poaching was probably a major factor in the decline of chimpanzees and other mammals in the area.
6	Greater Gombe Ecosystem-Masito-Ugalla	Kigoma	Charcoal and farming has been the main drivers of deforestation in this region.Poaching is probably also a major threat because of the high population density in settlements and proximity to Lugufu refugee camp.
7	Igando-Igawa	Iringa	Threats include clearance for agriculture, charcoal manufacture, burning and hunting.
8	Katavi-Mahale	Rukwa, Kigoma	Logging, one dirt road from Mpanda to Karema that has a bus service bisects this corridor. All three routes are potentially

			threatened by proposed road developments.
9	. Katavi/Rukwa/Lukwati-Rungwa/Kisigo/Muhesi	Rukwa. Mbeya. Iringa	Extensive logging. Hunting blocks have opened up roads to loggers and poachers. Expansion of agriculture from the south along the Chunya-Rungwa Road with new villages appearing rapidly. Miombo is being cleared for crops. tobacco cultivation and charcoal manufacture. Road in between Ntakatta and Kakungu and people are rapidly moving into the Kakungu area to farm so this route is probably already disturbed. Cattle move through the area with temporary bomas all along the main road and along the road from Lupa NE to the borders of the Usangu GR.
10	Kilimanjaro-Amboseli (Kitendeni)	Kilimanjaro. Arusha	Encroach by people. agriculture. settlement. illegal hunting
11	Loazi-Kalambo	Rukwa	Charcoal, timber and subsequently ploughed agriculture. This is on-going and will probably be all finished very soon. Sanctioned charcoal manufacture exascerbates the problem
12	Loazi-Ntantwa-Lwafi	Rukwa	Charcoal manufacture and cultivation. Presence of Congolese bushmeat hunters who have temporarily settled in Tanzania, and exploit this area's remote and unmanaged status. Bushmeat (including chimpanzee) is exported from Tanzania across Lake Tanganyika for sale in the Democratic Republic of Congo.
13	Manyara Ranch-Lake Natron	Manyara	Increased cultivation in the 4 km strip of land between TNP and Manyara Ranch. There is also an increasing threat from cultivation where the corridor crosses the Makuyuni – Mto-wa-Mbu road and along the lower slopes of Lolsimongori. The land further north near Lake Natron is too arid for cultivation. However plans to tarmac the road to Loliondo via Natron are likely to negatively impact wildlife movement

14	Manyara-Ngorongoro (Upper Kitete/Selela)	Arusha, Manyara	Increased human settlement and cultivation caused interruption to the movement of elephants, buffalo, and other large animals from the northern Highland FR to the lowlands below the escarpment. Livestock grazing
15	Muhezi-SwagaSwaga	Dodoma	Cultivation is probably the largest single threat to the area. Clearing of thicket for charcoal may eliminate local refuges within the corridor. Some mining occurs in the area, with known uranium anomalies and calcrete deposits around the Bahi Swamp
16	Selous-Niassa (Western and Eastern Routes)	Ruvuma	Ribbon strip development of settlements along the major roads leads to the blockage of the corridor. Uncontrolled and unplanned conversion of land for agriculture and settlements on the major migratory routes leads to fragmentation of the ecosystem and increased human–wildlife conflicts. Illegal logging, fishing with poison) including the high value poaching of ivory across the national boundaries, uncontrolled fires and prospecting/mining for uranium and other minerals are severe threats to its continued existence.
17	Makuyuni	Manyara	Loss of habitat through tree felling for charcoal production and increasing cultivation.
18	Mkungunero/Kimotorok	Manyara	Not yet under threat from agricultural expansion, though there is increasing agricultural production south of Makame which may impact the area in future years. Construction of a main road from Babati to the Simanjiro will bisect the corridor at the southern end of the park and will is likely to lead to increased immigration and settlement.
19	Tarangire-Simanjiro	Manyara, Arusha	Agriculture, cattle grazing, sport and illegal hunting

20	Tarangire-Manyara (Kwakuchinja)	Manyara	Agriculture, livestock keeping invasion and settlement, phosphate mining, fishing
21	Udzungwa-Mikumi	Morogoro	Poaching, cleaing of habitats for farms, extensive grazing
22	Udzungwa-Ruaha	Iringa	Poaching, grazing, cultivation
23	Udzungwa-Selous	Iringa, Morogoro	Invasion by Sukuma for grazing, Intensive cultivation, Lumbering,Charcoal burning, settlements, poaching,
24	Uzungwa Scarp-Kilombero NR (Mngeta)	Iringa, Morogoro	Cultivation, settlements
25	Uluguru North-South	Morogoro	Encroachment, village expansion, tree cutting
26	Usambaras, East (Derema)	Tanga	Cultivation of black pepper and banana, firewood extraction, non timber forest products extraction
27	Usambaras, West	Tanga	Agriculture, invasive exotic species i.e. Lantana *sp.*
28	Wami Mbiki-Handeni (Southern Masai Steppe)	Morogoro, Tanga	Illegal hunting (poaching)
29	Wami Mbiki-Jukumu/Gonabi /Northern Selous	Morogoro	Poaching, Road kill along Morogoro road. increased human population, settlement
30	Wami Mbiki-Mikumi	Morogoro	Cultivation, road kill along high way
31	Wami Mbiki-Saadani	Morogoro	Human settlement, timber exploration and charcoal burning