

**IMPACT OF REFUGEES ON WILDLIFE HABITATS AND POPULATIONS IN
BURIGI AND KIMISI GAME RESERVES, NGARA DISTRICT, TANZANIA**

BY

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**A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE
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ABSTRACT

The study was conducted in and adjacent to Burigi and Kimisi Game Reserves in Ngara district between October 2006 and January 2007. The main objective of this study was investigating of the impact of refugee in the areas. Specifically, the study was to; i) determine anthropological activities leading to environmental degradation before and after refugees living in the study area, ii) Evaluate changes in wildlife population before and after refugees living in the study area, iii) Assess the changes in wildlife habitat before and after refugees living in the study area. Questionnaire survey, focus group discussion with key informants and participant observations were used in collecting primary data. Secondary data collection was done through review of different publications and reports. Satellite imageries were also employed as sources of secondary information. Simple correlation analysis was used in analysing information on the impact of refugees on wildlife populations. ERDAS Imagine and Arc View 3.1 GIS software were employed to analyse changes in wildlife habitats before and after influx of refugees in the study areas. Seven anthropological activities that lead to environmental degradation in the study area were identified namely; farming, settlements, poaching, bush fire, trees cutting, grazing and encroachment. The populations of eight species of large mammal were negatively significantly impacted by refugees' activities which led to the decrease of these populations. These species include buffalo (*Syncerus caffer*), bushbuck (*Tragelaphus scriptus*), eland (*Taurotragus oryx*), Bohor reedbuck (*Renduca renduca*), topi (*Damalisca lunatus*), warthog (*Phacochoerus africanus*), waterbuck (*Kobus defassa*) and zebra (*Equus burchellii*). Results from GIS analysis indicated that four wildlife habitats were

impacted by refugees namely; i) Riverine forest ii) Woodlands iii) Scrubland and iv) Grasslands. There was a differential decrease in vegetation cover for riverine forests and woodlands. Similarly, barelands/rocky areas increased with the increase in number of refugees in the influxed areas. From these results, it was concluded that refugees and their associated activities have negative impact on wildlife habitats and populations. It was recommended that refugees' camps should be established at least 30 km from protected areas boundaries. Alternative sources of proteins for refugees should be established. A wide range of stakeholders should be involved in addressing issues of refugees including rehabilitation of the degraded areas and the use of satellite images for resource monitoring and assessment.

DECLARATION

I, Faustine Ilobi Masalu do here by declare to the senate of Sokoine University of Agriculture that, this dissertation is the result of my own original work and that it has not been submitted for any degree award to any University.

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Date

The above declaration confirmed

Prof. Maganga, S. L. S.
(Supervisor)

Date

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LIST OF ABBREVIATIONS

CIMU	Conservation Information and Monitoring Unit
CITES	Convention on International Trade in Endangered Species of wild Fauna and Flora
FAO	Food and Agriculture Organization
GIS	Geographical Information System
GPS	Global positioning system
Ha	Hectare
MHA	Ministry of Home Affairs
MNRT	Ministry of Natural Resources and Tourism
Landsat TM	Landsat Thematic Mapper
PAs	Protected Areas
REDESO	Relief for Development Society
TAWIRI	Tanzania Wildlife Research Institute
UN	United Nations
UNEP	United Nations Environmental Programme
UNHCR	United Nations High Commission for Refugees
URT	United Republic of Tanzania
USGS	United States of America Geological Survey
WFP	World Food Programme

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Tanzania is endowed with a vast array of biodiversity and endemic species including 20 primates, 34 antelopes, 290 reptiles, 40 amphibians, and many fish (URT, 2005). According to URT (2001a), Africa's richest and most diverse flora is found in Tanzania. Overall, there are six biological hotspots that have value as centres of high species diversity and high levels of endemism, namely the Eastern Arc block mountain forests, the coastal forests, the great lakes for Cichlid fishes, the ecosystem of the Rift valley, the alkaline lakes and grassland savannahs for large mammals (ibid). Moreover Tanzania has 15 National Parks, 28 Game Reserves, 38 Game Controlled Areas and the Ngorongoro Conservation Area, which together cover 38.8 % of the country's total area (URT, 2001a).

Burigi and Kimisi Game Reserves are reserved areas for game production and conservation with good population and diversity of wildlife and critical water resources necessary to maintain ecological integrity and support the subsistence needs of communities outside the reserved boundaries. Burigi Game Reserve was gazetted in 1972 whereas Kimisi Game Reserve was gazetted in 2003 with areas of 2 941 and 1 026.2 km² respectively. During German and British regimes people who were living in the today Burigi and Kimisi Game Reserves were resettled outside these areas as the sleeping sickness (*Trypanomiasis*) disease control program (MNRT, 2006).

Trypanomiasis is the diseases spread by tsetse fly (*Glossina mortisans*). In 1990s Burigi and Kimisi Ecosystem was respected for her wildlife diversity and abundance. The Kimisi Game Reserve had been facing a problem of pastoralists who used to enter the area illegally from Rwanda. These were the Rwandese Tutsi pastoralists who used to cross the Kagera River and graze their livestock in the protected area illegally.

Since the 1950s to date Tanzania has been receiving refugees from neighbouring countries. The 1994 genocide war in Rwanda caused an influx of refugees who were settled in refugees' camps in Kigoma and Kagera regions. The large number and rapid influx of refugees may have different types of impact on the surrounding environment varying from deforestation resulting from the collection of fire wood to soil erosion, pollution of ground water, depletion of wildlife population and degradation of wildlife habitats such as National Parks, Game Reserves, Forest Reserves and Game Controlled Areas. The refugees got their basic needs from the resources in the surrounding environment. Surveys in western Tanzania found that refugees used an average of 2.8 kilograms of wood per day per person, whereas local host communities used just 1.7 kilograms per day per person (UNEP 2005a). In 1994, Burigi and Kimisi Game Reserves were very much affected by refugees' influx in terms of wildlife habitat quality and population status.

1.2 Problem Statement and Justification

The influx of refugees on the north-western Tanzania has resulted in marked environmental destruction in the Burigi and Kimisi Game Reserves (Mduma *et al.*, 2003); therefore the presence of refugees nearby these conserved areas is the bottleneck of wildlife conservation in the country. It has been documented that more than 2.0 million refugees caused impact on wildlife habitats in Rwanda and neighbouring countries during the Rwandan civil war of 1994 (Kanyabibwa,1998). Refugees that flooded the Kagera region as the result of civil war in Rwanda poached wildlife heavily in the surrounding game reserves (URT, 2003a). However, less has been documented on the impact of refugees on wildlife habitats and populations on the two reserves. Due to this fact, more efforts should be directed on finding the solutions to the problem caused by refugees on wildlife conservation. This study was necessary in order to fill the information gap about the status of wildlife habitats and populations in Kimisi and Burigi Game Reserves and the nearby surrounding villages.

1.3 Objectives of study

1.3.1 General objective

To investigate the impact of refugees on wildlife habitats and populations in Burigi and Kimisi Game Reserves.

1.3.2 Specific objectives

- To determine anthropological activities leading to environmental degradation before and after refugees living in the study area.

- To evaluate wildlife population changes before and after refugees living in the study area.
- To assess wildlife habitat changes before and after refugees living in the study area.

1.4 Research Questions

- What were the basic resources used by refugees and their characteristics?
- What are the characteristics of wildlife habitats changes before and after the refugees living in the area?
- What are the wildlife population trends before and after the refugees living in the area?
- What measures are taken to alleviate the situation?

1.5 Research Hypothesis

The influence of refugees in western Tanzania had a significant negative impact on wildlife habitats and populations in Burigi and Kimisi Game Reserves.

1.6 Conceptual Framework

The conceptual framework provides guidance towards realistic data collection, and binds facts (Kajembe, 1994). Research carried out without a conceptual framework is usually sterile for a reason that the researcher does not know well what data are to be collected, and when he/she has collected them, she/he cannot put them to use. The conceptual framework of this study was centred on anthropological activities that affected both wildlife habitats and populations. In 1994 there were five refugees camps adjacent to Burigi and Kimisi Games reserves with a population of 600 000 refugees. The presence of a large number of refugees near protected areas generated direct and strong

perturbations of wildlife (UNEP, 2005a). Figure 1 presents the framework that reflects the generalization of the issues under study.

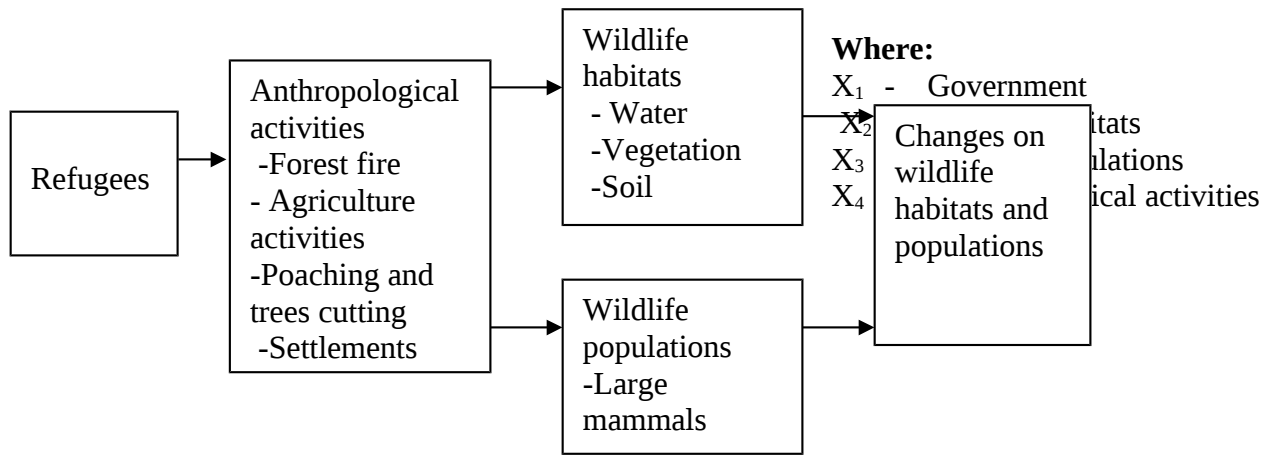


Figure 1: The impact of refugees on wildlife habitat and population frame work

1.7 Limitations of Study

1.7.1 Insecurity of the study area

The area was very dangerous to research because of the prevailing insecurity caused by armed robbers from neighbouring countries. During the study there was a police operation inside the Burigi and Kimisi Game Reserves to rid away the bandits. Any movement in the study area required police escort.

1.7.2 Wrong perception of the study

Some respondents were not open to give their views especially during focus group discussion with village key informants. Some village members feared that the research

was a means of identifying non-Tanzanian citizens. This is because the time of research coincided with an operation of identifying and repatriating illegal immigrants in Ngara district. This fear was due to the fact that some villagers had married refugee women. In order to waive this situation we agreed with village leaders that, for those who were to take part in focus group discussion should not reveal their names. With this technique we managed to convince the respondents to air out their opinions and understanding about the impact of refugees on wildlife population and habitats.

CHAPTER TWO

2 LITERATURE REVIEW

2.1 Human Activities and Wildlife

Human activities have a great impact on the environment of living organisms by causing land degradation into two spheres. The first is agricultural sphere which includes cropping and pastoral activities while the second are those activities that affect the ecology of natural quasi ecosystems (de Sherbinnin, 2002). Natural quasi-ecosystems are composed of plants and herbivore agents which are in relationship of parasitism (Hashimoto, 2005). In fact humans are increasingly being recognised as a dominant force in global environmental change (Hintjens, 2006; Barve *et al.*, 2005; de Sherbinnin, 2002). The increase in population creates more demand for arable land, grazing land and for settlements.

Local communities of a specific area have to acquire their daily needs from their surrounding environment. Communities living in proximity to natural resources such as forests and wildlife continue to rely (illegally or legally) on these natural resources for their livelihoods and for economic survival (Kaboggoza, 2000). The greatest human impact on biodiversity is the alteration and destruction of habitats, which occur mainly through changes in land use (de Sherbinnin, 2002). The changes in land use are often caused by human activities through agricultural activities, settlement establishment, and setting of forest fires and construction of dams. Land converted to agriculture to meet

global food demand comes from forests, grasslands, and other natural habitats (Tilman *et al.*, 2001).

Economic activities of any area will always determine the level of its environmental impact. The impacts of economic activities on conservation have been increasing with human population growth resulting into habitat loss and decline of wildlife population (Kideghesho *et al.*, 2006; Kideghesho *et al.*, 2005; Songorwa, 2004). Since the invention of agriculture about 10 000 years ago, the human population has increased from approximately 5.0 million to a full 6.0 billion people (Fegley, 2003). Human population increase resulted into pressure on land and other natural resources, such that wildlife resources have been and are still harvested from the pilot wildlife management areas, protected areas and natural forests are being converted into farmland and settlement (Madulu, 2005; Songorwa, 2004). In Africa slash and burn practices have contributed a lot in degrading the environment (Banda *et al.*, 2006). The human economic activities are believed to be the major cause in the loss of biodiversity in Tanzania (Shemwetta and Kidegesho, 2000).

2.1.1 Influx of refugees

According to UNHCR (1966), the term refugee shall apply to any person who:

(i) Has been considered a refugee under the Arrangements of UNHCR of 12 May 1926 and 30 June 1928 or under the Geneva Convention of 28 October 1933 and 10 February 1938, the protocol of 14 September 1939 or the Constitution of the International Refugee Organization.

(ii) As a result events occurring before 1 January 1951 and owing to well-founded fear of being persecuted for reasons of race, region, nationality, membership of a particular social group or political opinion, is outside the country of his/her nationality and is unable or, owing to such fear, is unwilling to avail himself/herself of the protection of that country; or who, not having a nationality and being outside the country of his/her habitual residence as a result of such events, is unable or, owing to such fear, to return to it.

In the case of a person who has more than one nationality, the term “the country of nationality” shall mean each of the countries of which he/her is a national, and a person shall not be deemed to be lacking the protection of the country of his/her nationality if, without any valid reason based on well-founded fear, he/she has not availed himself/herself the protection of one of the countries of which his is a national.

The global refugee population grew from 2.4 million in 1975 to 10.5 million in 1985 and 14.9 million in 1990 (UNHCR, 2007). A peak was reached after the end of the Cold War with 18.2 million in 1993. By 2000, the global refugee population had declined to 12.1 million (Castles *et al.*, 2003). Occurrence of refugees and internationally displaced persons in different parts of the world has caused negative impacts on available natural resources (UNEP, 2005a). According to Saintiapllai and Wijegamohan (2003), in Sri-Lanka, repatriated refugees were reported to cause environmental destruction when they were seeking for their basic needs from environmental resources.

In Africa, this problem is high due to political instabilities of the great lakes countries, which are Rwanda, Uganda, Burundi and Democratic Republic of Congo (UNEP,

2005a). According to URT (2001b), the war in these countries in the mid 1990s caused influx of refugees into Tanzania especially in Tabora, Kigoma and Kagera regions. In 1994, there were five refugees camps adjacent to Burigi and Kimisi Games reserves with a population of 600 000 refugees. The refugees who arrived in Tanzania in Ngara district from Rwanda in 1994 were mainly urban dwellers most of them businesspeople (Mduma *et al.*, 2003). According to the data collected from the Ministry of Home Affairs, in 1993 Ngara district hosted 100 000 refugees, this number increased to 750 000 refugees in 1994. This increase was the result of civil war in Rwanda which involved genocide. In 1998 the number of refugees dropped to 96 000 refugees whereas in 2000 the number stood at 91 000. During the period of this study the area was hosting only 35000 refugees. The influx of refugees in western Tanzania in 1994 increased the impact of human activities on the environment (MNRT, 2006).

2.1.2 Effect of refugees on wildlife habitat

Wildlife habitats are defined as the native environment of a wild animal which ideally provide all elements needed for life and growth; food, water, cover, and space (Maryland University, 1999). A Wildlife Conservation Union analysis of animal extinction since 1600 shows that loss of habitat ranks the second known cause of animal extinction to the introduced exotic species (IUCN, 2004). According to the World Conservation Monitoring Centre (1992) analysis, the habitat loss contributes to 36.0% of the extinction while 39.0% is contributed by introduction of exotic species. Following the current loss of wildlife habitats particularly through destruction of the tropical forests,

10.0% of world's species could become extinct in the year 2000 and 25.0% by 2009 (Lean and Hirinchen, 1986). For example, the resulting rapid and uncontrolled deforestation has left the refugees area in Pakistan remaining with only 20.0% of the original forest cover (Crush, 2001).

Establishment and maintenances of refugees' camps has a serious impact on natural wildlife habitats because it contributes to wildlife habitat loss and disturbs the natural environment of the wild animals and plants. The presence of refugee camps near protected areas disturbs the ecosystem by increasing the risk of transmitting diseases to wildlife (Kalpers, 2001).

In Africa, like other parts of the world, wildlife conservation experienced a great challenge which was caused by an outbreak of refugees encroachments to wildlife protected areas. A total of 600 000 refugees were hosted in camps set around and in the Virunga National Park (Biswas and TortajadaQuiroz, 1996). Refugees' activities involved cutting trees for firewood and clearing forests for cultivation. The wildlife habitats of Lake Edward, Virunga National Park and Rwenzori Snow capped mountain were badly affected by refugees at a large scale (Kalpers, 2001). The civil wars in the great lakes countries have produced a problem of refugees in protected areas (UNEP, 2005a). The larger number of refugees in a small area leads to over harvesting of the available environmental resources leaving the ecosystem unproductive (Kibreab, 1997). From 1990 to 2005, approximately 35 000 ha of timber have been used to support officially recorded United Nations refugees in the Sub-Sahara region (Glew and Hudson, 2007).

The 1994 genocide war in Rwanda caused an influx of refugees who were settled in refugee camps in Kigoma and Kagera regions whereby their camps were situated near protected areas (MNRT, 2006). The chimpanzees in Lilanshimba in Kigoma region are in eminent danger of extinction due to the Congolese refugees clearing their habitats (Ogawa *et al.*, 2006). The decline in wildlife population, local extinction for some wild species and low productivity of ecosystems manifest the effect of habitat loss in Tanzania (Kidegesho and Maganga, 2000). The main threats from refugee camps regarding wildlife observed in western Tanzania included modification of the natural habitats by establishing larger settlements, agriculture development and poaching (UNEP, 2005b). Mduma *et al.*, (2003) reported that there was an encroachment in Biharamulo, Burigi and Kimisi Game Reserves whereby a camp of 540 000 refugees was established just two kilometres from the Burigi Game Reserve.

2.1.3 Effects of refugees on wildlife population

The influx of refugees in different parts of the world has caused problems to wildlife conservation. The increased number of refugees increased the number of people who depend on wild meat for proteins (Draulans and Van Krunkenlsvan, 2002). In Afghanistan, it has been reported that the number of snow leopards had decreased due to refugee influx and Taliban fighters hiding in the mountains (Zahler and Graham, 2001).

In Africa refugees have been reported to cause impact on large mammals which are susceptible to hunting. Many million refugees resulting from internal wars between government forces and illegal movement rebels have affected wildlife populations in the

greatest lakes region (Kanyabibwa, 1998). Refugees' settlements established in host countries always exert pressure on available wildlife populations. Macrofauna species are more susceptible to wild meat offtake and habitat loss. These include African elephant *Loxodonta africana*, giraffe (*Giraffa camelopardalis*), buffalo (*Syncerus caffer*), eland (*Taurotragus oryx*), hippopotamus (*Hippopotamus amphibius*), impala (*Aepyceros melampus*), hartebeest (*Alcephalus buselaphus*), Bohor reedbuck (*Renduca renduca*), topi (*Damaliscus lunatus*) and warthog (*Phacochoerus africanus*) (Barnett, 2000). Although macrofauna are more susceptible to hunting, different species are affected differently according to their palatability to the hunters as it was observed in Democratic Republic of Congo (Biswas and Tortajada-Quiroz, 1996). Animal species which were heavily poached by armed refugees of the Muguga camp were antelopes, hippopotamus and buffalo in the Rutshuru and Rwidi rivers (Kalpers, 2001). Refugees' settlements have been associated with rapid unsustainable off-take of wildlife, threatening the viability and survival of many species including those in protected areas (Wolmer *et al.*, 2003).

The study conducted by CARE in western Tanzania during the peak influx of the Rwandese refugees revealed that the massive high scale of poaching estimated to supply wild meat into Ngora refugee camps approximately 7.6 metric tonnes of wild meat per week (Kyomi *et al.*, 1996). Most of the wildlife in Tanzanian protected areas are resident species, therefore uncontrolled hunting of these species threaten the populations' survival (Campbell and Hoffer, 1995; Mduma *et al.*, 1999)

2.1.4 Impact of refugees on socio-economic development

The heavy influx of refugees in any area has an impact on infrastructure and socio-economic development. The arrival of a larger number of refugees into an area previously containing few people or no people has an impact on the available environmental resources (Hintjens, 2006). In Afghanistan, war created intensive pressure on environment whereby refugees tried to find some source of income as well as food and shelters to sustain themselves (Zahler and Graham, 2001).

Deeply concerned about the influx of internally displaced persons, returnees and refugees to Monrovia and the enormous burden placed on the infrastructure and fragile economy of Liberia, WFP failed to provide food on time to refugees in Butuo because bridges could not support heavy loads to the refugee camps in Butuo (Sesay, 2003). The heavy influx of refugees in the early 1990s and the subsequent roll-in of international humanitarian agencies took its toll on local social and physical infrastructure in Tanzania where public buildings or any other infrastructure is destroyed as the result of refugees' presence (Washoma *et al.*, 2003; URT, 2002).

In the Kagera river basin a social service like availability of clean water was a problem for the people who depended on water from this river. But less attention was given to effects of refugees on the ecology, economy and politics of those already living in western Tanzania (Whitaker, 1999). Furthermore, the sudden presence of refugees and relief resources in western Tanzania altered the lives of the people who lived there by

providing cheap labour and market to their agricultural products (Andrew, 2003; Whitaker, 1999).

2.2 Mitigation Measures to Resolve Impact of Refugees on Wildlife

Different efforts have been conducted to arrest the impacts of refugees on natural resources in different parts of the world. Mitigation measures to conserve the degraded environment always involve different stakeholders, since conservation is a nexus of relationship between large organizations and governments, between scientists and local people and so forth (Brousius, 2006). UNEP in cooperation with UNHCR, United Nations Settlement Programme (Habitat), United Nations Development Programme and the World Bank made an assessment of the impact of refugees on environment in Guinea and prepared the assessment report (UNEP, 2005a).

In Tanzania, refugees hosted closer to protected areas used different types of weapons including automatic rifles for poaching wild animals (Kyomi *et al.*, 1996). In order to control this impact, the government of Tanzania had put in place the law requesting every asylum seeker or refugee who brings any firearm or ammunition into Tanzania to immediately surrender such firearms or ammunition to any authorized officer (URT, 2001b). Also, refugee camps should not have numbers exceeding 50 000 refugees, and the camps should be separated by a distance of not less than 30 kilometres apart (URT, 2002).

In order to avoid environmental degradation the Government of Tanzania had put in place a policy statement which states that, to avoid environmental destruction and for efficient service delivery, management and monitoring, so as to avoid imminent pressure on natural resources and minimize the burden placed on the shoulders of local authorities, refugees will not be allowed to own land. Nevertheless, plots will be temporarily allocated to them for the purpose of building their shelters and gardening. The maximum plot size will be 35 ×35 metres per household. Furthermore, where trees are being cut there must be corresponding tree planting activities (*Op cit*). In order to improve the declined wildlife population due to refugees' activities much effort should be directed on rehabilitating wildlife habitats.

CHAPTER THREE

3. METHODOLOGY

3.1 Study Area Description

3.1.1 Location of the study area

The study was carried in the Burigi and Kimisi Game Reserves and adjacent villages in Ngara district Kagera region in north-western Tanzania. The area is located between $1^{\circ} 56' - 2^{\circ} 05' S$ latitude and $30^{\circ} 00' - 32^{\circ} 04' E$ longitudes (Fig. 2). The district has a population of 334 939 people (URT, 2002). The Burigi and Kimisi Game Reserves have a total area of 2 941 and 1 026 km² respectively. Only 600.23 km² of the reserves which falls in Ngara district was studied. In 1994, the five refugee camps namely Lukole, Msuhura, Lumasi, K. 9 and Benaco with a total number of 600 000 refugees were established adjacent to the two reserves. The refugees secured their daily basic needs from natural resources which were within their reach as the result the area was over exploited. The Wildlife Division of the Ministry of Natural Resources and Tourism manages both reserves that are adjacent, to the refugee camps.

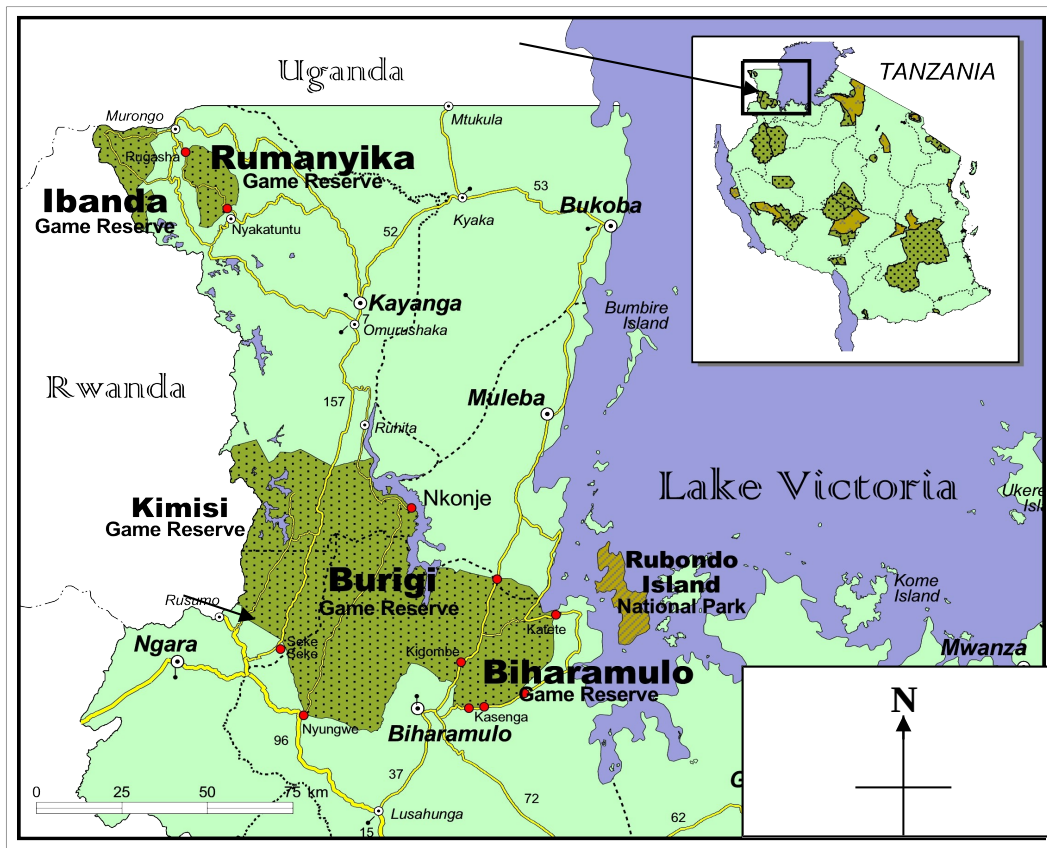


Figure 2: Location of Burigi and Kimisi Game Reserves
(Source: Burigi and Kimisi Game Reserves Project Manager's Office 2006)

3.1.2 Climate

The topography has strong influence on the climate which results into the mean maximum and minimum temperature of ranges from 26° to 16° C of Ngara district. The area receives bimodal rainfalls, long and short rains with an average annual rain of 850 mm. The rain season is principally in March through May and short rains in September to mid December (URT, 2006).

3.1.3 Geology and physical features

The study area is located between Lake Burigi and the western arm of the Rift Valley and the terrain is mostly rugged. The geology and topography generally follow an approximately northeast southwest direction, presumably caused by gradual movement of the Rift Valley which formed the Karagwe-Ankolean System. The rocks of the Karagwe-Ankolean System stretch from the western part of the reserves extending to Lake Burigi. According to MNRT (2006), these consist of deposits of sand and clay that has been consolidated by metamorphism into argillites, phyllites and slate. Argillites are abundant on the southern part of the study area, where they have weathered to form a red clay residue and extensive banks of laerite and reddish granular ironstone. Sandstones have metamorphosed into quartzites and occur together with quartz which being erosion resistant, have resulted into the formation of the many hills in Ngara district. Many large hills occur within the Karagwe-Ankolean system and these are separated into various landscapes. Ferralsols occur on the prevailing gentle moderate slopes of the south-western Kimisi Game Reserve while vertisols are found in valley bottoms and leptosols are restricted to the few stony hillsides (FAO, 1988).

3.1.4 Vegetation

Burigi and Kimisi Game Reserves support a great diversity of vegetation types including forest, thickets, woodland, bushland and swamps. These vegetation types are based on plant structure and composition (Mduma *et al.*, 2003). Plant species observed to be dominant in the study area during the study included trees, grasses, sedges and herbs. The trees included *Acacia gerrardii*, *A. seyal*, *A. polycantha*, *A. tortolis*, *Albizia amara*, *A. harveyi*, *A. petersiana*, *A. versicolor*, *Balanites aegyptiaca*, *Burkea africana*, *Bauhia thonningii*, *Brachystegia*

spiciformis, *B. boehmii*, *Cassia auriculata*, *C. falcinella*, *C. senguena*, *Combretum collinum*, *C. fragrans*, *C. molle*, *Commiphora africana*, *Crossopterix febrifuga*, *Dalbergia nitidula*, *Dichrostachys cinerea*, *Erythrina africana*, *Grewia bicolor*, *G. mollis*, *Harrisonia abyssinica*, *Lannea falva*, *L. schemperi*, *L. stuhlmannii*, *Lonchocarpus capassa*, *Makharmia obtusifolia*, *Terminalia mollis*, *T. cericea*, *Vitex bicolor*, *V. doniana*, *Vangueria acutiloba*, *Pericopsis angolensis*, *Vangueria infausta* and *Ximeria africana*. Dominant grasses included *Chloris gayana*, *Cynodon dactylon*, *Heteropogon contortus*, *Hyparrhenia collina*, *H. rufa*, *Panicum maximum*, *P. repens* and *Themeda triandra*. The dominant sedges were *Cyperus papyrus* and *C. tenax*. Dominant herbs were *Amaranthus dubius*.

3.1.5 Wildlife

The common wildlife species found in this area are: Mammals which are found include giraffe (*Giraffa camelopardalis*), olive baboon (*Papio anubis*), buffalo (*Syncerus caffer*), bushbuck (*Tragelaphus scriptus*) eland (*Taurotragus oryx*), elephant (*Loxodonta africana*), hippopotamus (*Hippopotamus amphibius*), impala (*Aepyceros melampus*), hartebeest (*Alcephalus buselaphus*), Bohor reedbuck (*Renduca renduca*), topi (*Damaliscus lunatus*), warthog (*Phacochoerus africanus*), waterbuck (*Kobus defassa*) and zebra (*Equus burchellii*) hedgehog *Erinaceus albiventri*, lesser bushbaby (*Galago senegalensis*), rock hyrax (*Heterohyrax syriacus*), dwarf mongoose (*Helogale parvula*). Birds which are found in the Burigi and Kimisi Game Reserves are; long-tailed cormorant (*Phalacrocorax africanus*), little grebe (*Tachybaptus ruficollis*), great cormorant (*Phalacrocorax carbo*), hammerkop (*Scopus umbretta*), white stork

(*Ciconia ciconia*), purple heron (*Ardea purpure*), Abdim's stork (*Ciconia abdimii*), black-headed heron (*Ardea melanocephala*), and grey heron (*Ardea cinerea*).

3.2 Research Methodology

3.2.1 Research design

The cross-sectional research design was adopted; the design allowed collection of data at one point in time without repetition from a sample selected to represent a large population. One time means that data are collected in as a short time as is feasible (Singleton *et al.*, 1993). This design was considered to be favourable because time for data collection was limited. The collected data were used for purposes of designation and determination of the relationship between the variables at one time of study (Babbie, 1990).

3.2.2 Sampling procedures

The multistage sampling technique was used to select the site for the study. Two divisions adjacent to the Burigi and Kimisi Game Reserves were purposefully selected of which the refugee camps were located. Three wards were purposely selected, two from Nyamiaga division and one from Rulenge division (Fig. 3 and Table 1). The selection of the wards was based on their closeness (≤ 24 km) to the refugees' camps and the Burigi and Kimisi Game Reserves. Therefore eight villages were selected from the three selected wards. Households were picked from the updated village register where all villagers and households are listed. At the village government office all village hamlets were picked for household sampling. In each hamlet, at least 5% of household leaders were randomly sampled for formal interview. According to Boyd

et al., (1981) a significant population representation is achieved when a random sample of at least 5% is taken.

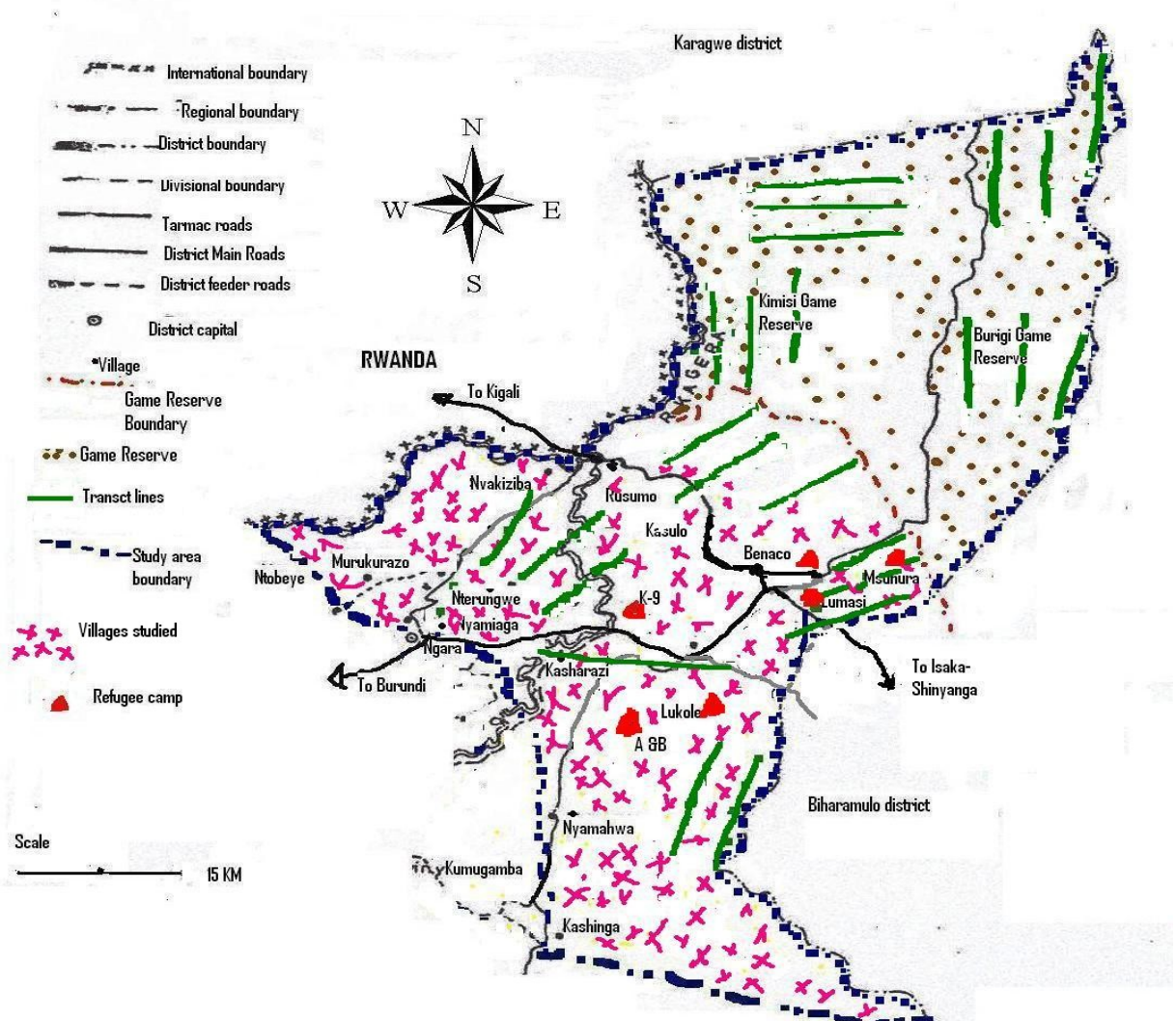


Figure 3: Sketch map of the study area. (Source: Ngora District Council Natural Resources Office, 2006).

Table 1: Surveyed divisions, wards and villages

Division	Ward	Village	Total household	Number of sampled household	Percentage (%) of sampled household
Rulenge	Nyakisasa	Kashinga	800	40	5.0
		Nyamahwa	480	24	5.0
Nyamiaga	Rusumo	Kasulo	1118	56	5.1
		Rusumo	486	25	5.0
	Nyamiaga	Kasharazi	400	20	5.0
		Murukurazo	519	26	5.0
		Nyakiziba	672	34	5.1
		Nterungwe	700	35	5.0

3. 3 Research Phases

The study was conducted in two phases. The first phase was the reconnaissance survey and the second phase involved questionnaire survey, animal counting and field observations. Reconnaissance survey was conducted to get a general picture of the research area. The questionnaire was pre-tested in Nyamiaga village in order to make necessary modifications while animal counting pre-test was conducted inside and outside the reserves. According to Jachmann (2002), an observer should have at least 80 hours of experience in counting the same animals in the same habitat.

3.4 Data Collection

3. 4.1 Primary data collection

Various methods were employed in collecting primary information which included (i) Questionnaire survey (ii) Participatory Rural Appraisal (iii) Participant observation (iv) Key informants (v) Animal counting.

3.4.2 Questionnaire survey

Questionnaire survey was conducted in eight villages adjacent to Burigi and Kimisi game reserves. The eight villages were purposively selected from the twelve villages which are within 24 kilometres from the Benaco refugees camps (Fig. 3). Household leaders from randomly picked households in each hamlet were interviewed. Structured questionnaire was used in data collection. The information collected through questionnaire included wildlife habitats and populations and related activities (Appendix 10).

3.4.3 Participatory rural appraisal

3.4.3.1 Resource mapping

Participatory rural appraisal tools included resources mapping to assess resources, e.g. vegetation cover, soil, larger mammals distribution and abundance. It also opened up discussions and facilitated the collection of key information and hypotheses about local conditions as quickly as possible (Kajembe, 1994). This was done for helping all participants to evaluate their own situation and familiarize the researcher with the real world of the local people in the area.

3.4.3.2 Focus group discussion

Focus group discussions were conducted using checklists. Village government leaders were invited in the meeting. This was used for cross checking the information obtained from the questionnaire survey. Group discussions are cheaper and quicker to conduct than individual interviews with the same number of respondents. The village

government leaders, prominent people in the village (preferably old people) and members of the Village Natural Resources Committee (VNRC) were invited to the discussion. Information related to refugees effect on wildlife habitats and populations which include poaching, deforestation, settlements and soil erosion were discussed.

3.4.4 Participant observation

Participant observation is distinguished from other methods of data collection by the fact that the observer becomes part of the situation that he/she is studying (Kajembe and Wiersum, 1998). Participant observation enables the researcher to gain more understanding on the local situation and their relationship with management and use of natural resources. Direct observation in the community of the study area on the aspect of household activities, refugees' relationship and their perceptions towards the refugees' impact on wildlife habitats and populations were considered. This was used to fill the gaps left by structured questionnaire interview through informal discussions. Data on wildlife habitat and population changes were collected; these included natural vegetation status, wetland status, forest fire and uses of the Burigi and Kimisi Game Reserves.

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3.4.5 Key informants

A key informant is an individual who is accessible, willing to talk and has a great depth of knowledge about the issue in question (Bernard, 1995). Key informants in this study were Kimisi and Burigi Game Reserves Project Manager, Ngora District Game Officer, District Agricultural Officer, District Forest Officer, Ward Executive Officers of the studied villages, District Immigration Officer, District Commissioner, Refugees Camp Manager,

World Food Programme Coordinator and Director General of the Tanzania Wildlife Research Institute. The information which were collected included wildlife habitat and population changes, anthropological activities which cause environmental degradation, types of food eaten by refugees and use of environmental resources (Appendix 11).

3.4.6 Animal counting

Ground animal counting was conducted inside and outside the two game reserves. Four blocks were set in each game reserve basing on vegetation type of the study area. Two blocks were set in scrubland which included land dominated by scrubs and grassland and the other two blocks were set in woodlands and riverine forest. Four blocks were set outside the two game reserves. Two of these blocks were set two in the village natural forests while the other two were set in cultivated area and settlements. Three strip transects of 10 kilometres long and 200 metres wide separated by distances of five and seven kilometres long were set in each block. A strip transect starting point was established by recording coordinates using the GPS receiver. A specific direction to be followed during animal counting was determined by using the GPS receiver. Large mammals were counted by recording the number of any animal sighted on both sides of the strip transects. This was adopted by fact that all animals in the strip transect are counted (Wilson *et al.*, 1996). A large mammal in this study means a wild animal with a weight of five kilograms and above.

3.5 Secondary data

These data included wildlife populations and habitats changes, number of refugees and anthropological activities. Data of larger mammals of the study area from 1981 to 2000 were obtained from Tanzania Wildlife Research Institute and Wildlife Division headquarters, these

data were obtained from already conducted fixed wildlife censuses. It was not easy to get more than these data because of limited time and resources. Three satellite imageries of Landsat TM of the years 1984, 1993 and 2002 on wildlife habitats changes were obtained from the USGS (USA Department of the Interior and USA Geological Survey). Data on anthropological activities were obtained from the District Commissioner, Game, Agriculture and Forest Officers of Ngara. The numbers of refugees were obtained from the Ministry of Home Affairs in Dar es Salaam and refugee relief organizations found in the study area.

3.6 Data Analysis

3.6.1 Analysis of qualitative and quantitative data

Qualitative and quantitative data were analysed using the Statistical Package of Social Science (SPSS) and MS Excel Computer Programmes. Frequency distribution tables, histograms, percentages, pictures and pie charts were used to summarize the data on the impact of refugees on large mammals. Since the numbers of wildlife were not collected in ordinal intervals, the simple correlation (Spearman's Rank Correlation Coefficient) was used to test the association between number of refugees who were living in the area and population changes of the large mammals of Burigi and Kimisi Game Reserves.

This was used because the secondary data of wildlife population were not ordinal. The data obtained from bivalent population that is far from the mean is correlated using Spearman's rank (Zar, 1998). The model is defined below:

$$\rho = 1 - \frac{6 \sum D^2}{N(N^2 - 1)}$$

Where: D = the difference between the ranks of corresponding values of X and Y , N = the number of pairs of values (i.e. refugees and large mammals) and ρ = Spearman's rank correlation coefficient. This tested the directional impact of refugees on the number of large mammals (positive or negative). ρ is always greater or equal to negative one and less or equal to positive one (ρ will always have values $-1 \leq \rho \leq 1$). Positive correlation means that increase of refugees leads to increase of number of large mammals whereas negative correlation means increase of refugees causes decrease in number of large mammals.

3.6.2 Analysis of large mammals diversity

Shannon-Weiner diversity index was used to determine species diversity and composition of large mammals in the study area. Diversity indices provided important information about rarity and commonness of the larger mammal species in the study area. Diversity was measured by using the following model:

$$H' = - \sum_{i=1}^S p_i \ln p_i$$

Where:

H' = Shannon-Weiner's diversity index

S = total number of large mammal species in the community (species diversity)

P_i = the proportion of total number of large mammal species made up of the i th large mammal species

E_H = Shannon's equitability (evenness)

Shannon's equitability (E_H) is calculated by dividing H''_{\max} by H' (here $H''_{\max} = \ln S$).

$\ln S$ = Natural logarithm of the total number of large mammal species in the community

Equitability assumes a value between 0 and 1 with 1 being complete evenness.

3. 6. 3 Analysis of wildlife habitats changes

Geographical Information System (GIS) data analysis was used to analyze wildlife habitats changes. Satellite imagery of the years 1984, 1993 and 2002 were scanned, digitized and enhanced by using ERDAS Imagine and ARC View GIS 3.1 software (Masudi, 2005). Wildlife habitats changes of the periods between 1984 and 1993 and 1993 and 2002 were analyzed. The enhanced images were digitized over screen to delineate different land covers. The supervised classification was then performed using ARC View GIS software package to prepare the vegetation covers/land uses for the given land use map of the study area, on which signatures of land use were established from satellite images and proved by field observation (ground truthing) using GPS receiver. In order to get a more detailed analyzed wildlife habitat an area of 66 600.6 hectares (666.01 km²) was scanned, digitized and enhanced to get land (vegetation) cover changes (Fig. 4). This area covered part of Burigi and Kimisi Game Reserves as

well as the adjacent areas of the two protected areas. This is the area where refugees used to acquire their daily basic needs. The area taken for satellite analysis considered normal walking distance of the refugees which ranges between 0.4 to 25.6 kilometers north of the great Benaco refugee camp.

Land cover changes in Burigi and Kimisi Game Reserves were analysed using three satellite images. Best results were obtained from maximum likelihood classifier after running different classifiers like minimum distance and parallel piped classifiers. The study area was then classified into five vegetation covers/land uses, namely; riverine forest, woodland, scrub, grassland/settlement and bare land/rock. For vegetation cover change detection, an overlay of the covers of the periods from 1984 to 1993, and 1993 to 2002 were performed to get change statistics (Mbilinyi *et al.*, 2007). Change detection analysis gives the type, amount and location of cover over a specified period of time (Murwira and Skidmore, 2006; Akbari *et al.*, 2006).

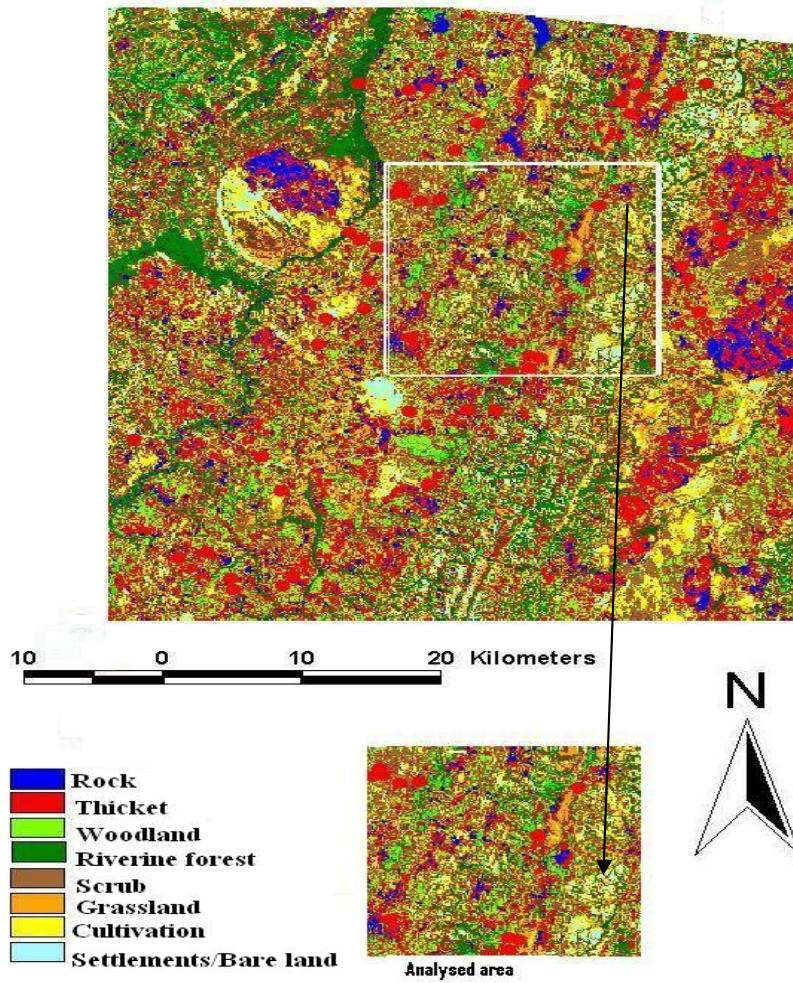


Figure 4: Satellite image of the study area of 1993
Source: USGS (USA Department of the Interior and USA Geological Survey).

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Anthropological Activities Before and After the Refugees

Before the refugees influxed the study area it was covered with natural forests. The major socio-economic activities of the local people were farming for subsistence and cattle herding in Nyamahwa and Kashinga villages. The refugees came to Ngara district since 1960s, whereby unknown numbers of refugees were hosted at Mbuba village about 30 kilometres from the current refugee camp complex the Benaco. Before the influx of 560 000 refugees from Rwanda in April 1994, the district in 1993 received 100 000 refugees from Burundi who were hosted at Lukole refugee camp. The large number of refugees in a small area raised the population density of the study area hence increased demand for resources because they depended on the natural environment for construction poles and ropes, withies, thatching grass, fuel wood, medicinal plants and various wild and cultivated foodstuffs. The arrival of this large number of people into a small area of which previously hosted about 53 000 people created intensive pressure on the environment (URT, 2003b). Environmental degradation was intensive during the period of refugees' influx in Ngara district due to poor land use activities (Plate 1).

The arrival of over 600 000 refugees in 1994 increased the number of people who were living in Ngara district from 334 000 in 1993 to over one million. This large number of residents increased the population density of the study area specifically the Rusumo

ward. The study area faced various degrees of human pressure including establishment of new settlements, farming, poaching, trees cutting, grazing, and forest fire.



Plate 1: The Benaco refugee camp with its surroundings deforested by refugee activities (Source: Biharamulo, Burigi and Kimisi Game Reserves Project Manager's Office 1995)

4.1.1 Farming

Results from Table 2 indicate that before refugees lived in the study area 30.4% of respondents owned 3 – 4 acres of land per household and 1.5% owned 13-14 acres of land per household. Furthermore, the results indicate that after refugees lived in the area 28.5% of respondents owned 3-4 acres of land per household and 2.3% owned 13-14 acres of land per household. These results show that the type of farming carried out by the local community in the area is small scale farming. These imply that most of the people in the study area are subsistence farmers because the majority of the respondents own land of between one and six acres. Similar observation had been reported by Nyamabondo (2005) in a study of economic and social changes in Ngara District that

most of the residents of Ngara are subsistence farmers. The majority of respondents explained to own more land for cultivation after refugees influxed the area (Table 2)

Table 2: Respondents views about house hold land owned before and after refugees' influx

Acreage (acres)	Before refugees influx (n=260)		After refugees influx (n=260)	
	Frequency	Percent	Frequency	Percent
1-2	49	18.8	48	18.5
3-4	79	30.4	74	28.5
5- 6	56	21.5	53	20.4
7 - 8	18	6.9	29	11.2
9 - 10	21	8.1	18	6.9
11 - 12	8	3.1	9	3.5
13 -14	4	1.5	6	2.3
15 and above	19	7.3	20	7.7
None	6	2.3	3	1.2
Total	260	100.0	260	100.0

Farming activities in the study area involved clearing of forests so as to have farms for both local host communities and refugees. Chi-squared test indicated significant difference ($\chi^2 = 759.566$, $p < 0.001$) in respondents' view between land size used by local host community before and after refugees lived in the area (Appendix 6).

Increased household land sizes and poor agricultural practices exercised by local host communities in the area such as cultivating in valleys and on steep slopes led to the clearing of the less closed and closed forests of Kigoyi, Chenjojo, Ngoma, Msuhura and Kisabule village forests (Plate 2). However, 23.8% of the respondents reported that refugees' influx in the area caused destruction of water sources by cultivating in the river valleys (Appendix 9). Cultivating in river valleys leads to environmental degradation. The same case was observed by Dungumaro (2006) in Kihansi catchments

area in Tanzania. Poor agricultural activities most likely contributed to environmental degradation because of unplanned land use practiced in the study area. Likely local host community household land size did not contribute to environmental degradation rather than poor cultivating practices and refugees activities.



Plate 2: The effect of agricultural activities to the Kigoyi community forest in Nyamahwa village

4.1. 2 Establishment of refugees settlements

In 1994, about 500 000 Rwandese refugees were allocated in the Benaco refugee camps together with other 100 000 Burundian refugees who were hosted at Lukole within Rusumo ward. This area was the settlement for about 600 000 refugees who acquired their basic needs from the surrounding environment. The questionnaire survey conducted to the host local communities revealed that before refugees influxed the area there was a closed forest which was reported by 21.0% of the respondents, less closed forest was reported by 43.8%, open forest 32.3% and those who said that there was no forest in the area were just 2.8%. However, 73.1% of the local people interviewed in the

study area indicated that after refugees lived in the area, it was left with no forest while 26.9% respondents reported that the area was left with an open forest (Table 3, Plates 1, 2 and Appendix 9).

The 500 000 Rwandese refugees fleeing to Tanzania in 1994 created the larger settlement at Benaco which threatened wildlife habitats in the area. Similar observation has been reported by Barve *et al.*, (2005) that human settlement, cattle and sheep populations were threats to wildlife conservation in southern India.

Table 3: Respondents views about natural vegetation status before and after refugees influx

Natural vegetation status	(n=260) Before refugees influx		After refugees influx	
	Frequency	Valid Percent	Frequency	Valid Percent
No forest	7	2.8	190	73.1
Open forest	84	32.3	70	26.9
Less closed forest	114	43.8	0.0	0.0
Closed forest	55	21.2	0.0	0.0
Total	260	100.0	260	100.0

The Lukole, Msuhura, Benaco, Lumasi and K-9 refugees' camps were established in the natural village community forests of Kasulo and Kasherazi villages. The refugees and the local host communities used the resources around their living environments for their basic needs. The refugees extensively cut down both dead and live vegetation for fuel wood, temporary house building poles, ropes and thatch for roofing materials. It was estimated that in July 1995 there was a consumption of approximately of 1 000 metric tonnes of fuel wood per day in the Biharamulo and Ngara refugees' camps (Kyomi *et*

al., 1996). Probably the establishment of refugees camps in Rusumo ward contributed to environmental degradation in the study area.

4.1.3 Poaching

In 1990, dry-season wildlife census in Burigi Game Reserve and Kimisi Game Controlled Area revealed three poachers' camps within Burigi Game Reserve which were estimated to have 17 poachers in the whole surveyed area (Mduma *et al.*, 2003). For the period of three years from 1991 to 1993 only 44 poachers were apprehended in both Burigi Game Reserve and the then Kimisi Game Controlled Area compared with 510 poachers arrested in the period of 1994 to 1996 (Appendix 2). Subsistence hunting has been carried out for decades in the study area. According to Kyomi *et al.*, (1996), small scale hunting was therefore the order of the day in Kimisi and Burigi Game Reserves. This kind of hunting was regarded as insignificant due to the high diversity and abundance of wildlife in Burigi and Kimisi Game Reserves (URT, 2006).

Results show that poachers apprehended before refugees influx (1991 to 1993) were just 8.0% of all poachers arrested in a period of six years from 1991 to 1996 (three years before and after refugees influx) (Fig. 5). However, only 27.0% of all wild animals were poached before refugees lived in the area. Moreover, 73.0% of the large mammals were poached between the period of 1994 and 1996 (Fig. 6 and Appendix 2). Before refugees influxed the area there was no poaching practices using snares (Fig.7). Snare poaching was rampant after refugees influxed the study area (Figs. 8 & 9, Plate 3 and Appendix 2). However, field survey indicated that no larger mammal was sighted in block H

during animal counting (Appendix 1). Possibly poaching activities contributed to the decline of wildlife populations in Burigi and Kimisi Game Reserves and the adjacent areas.

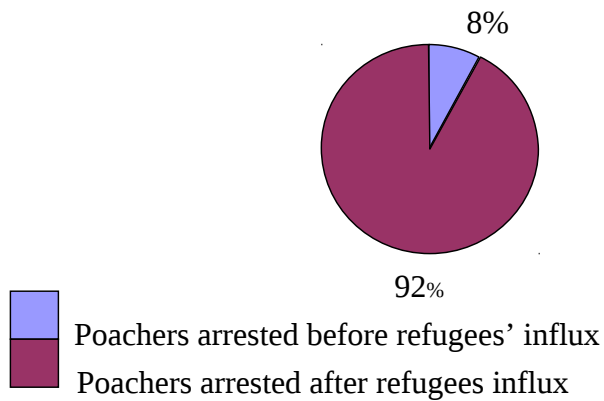


Figure 5: Poachers arrested in Burigi and Kimisi Game Reserve before and after refugees influx.

(Source: Biharamulo, Burigi and Kimisi Game Reserves Project Manager's Office 2006).

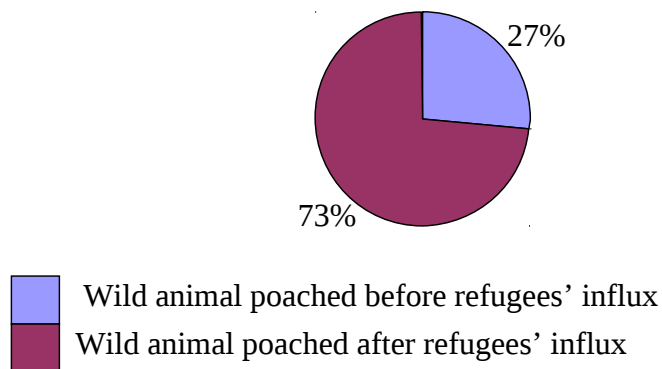


Figure 6: Number of poached wild animals in the Burigi and Kimisi Game Reserves (1991-1996).

(Source: Biharamulo, Burigi and Kimisi Game Reserves Project Manager's Office 2006)

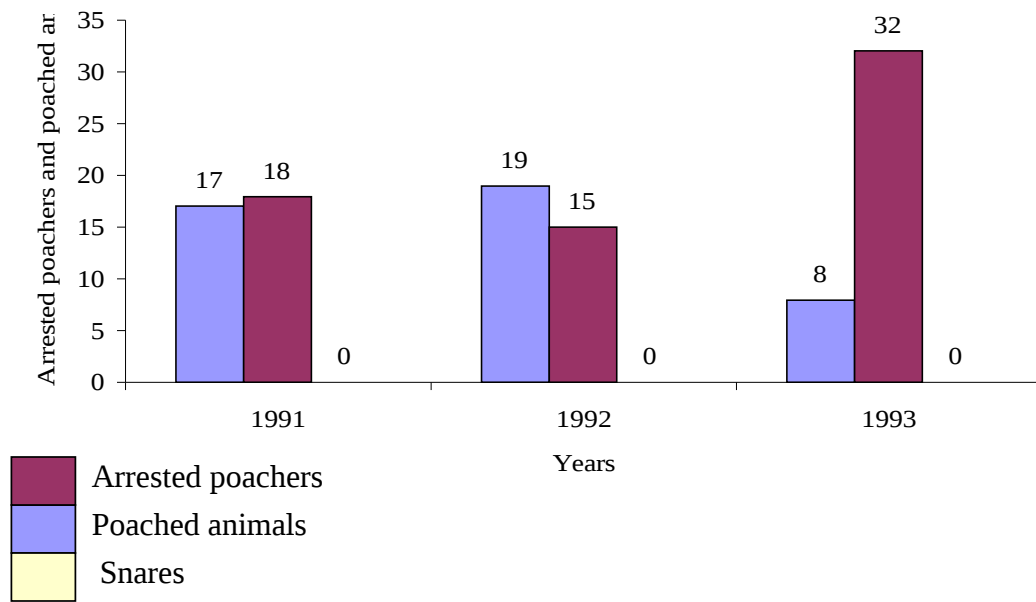


Figure 7: Number of arrested poachers, poached animals and snares collected from Burigi and Kimisi Game Reserves before refugees' influx. (Source: Burigi and Kimisi Game Reserves Project Managers Office 2006)

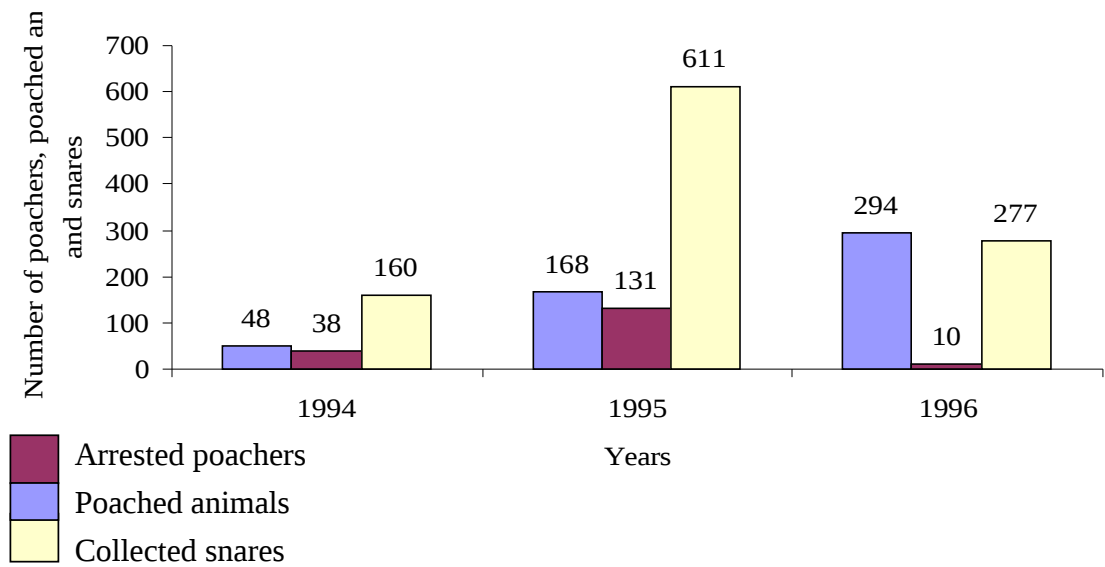


Figure 8: Poachers, poached wild animals and snares in Burigi and Kimisi Game Reserves after refugees' influx. (Source: Burigi and Kimisi Game Reserves Project Manager's Office 2006)

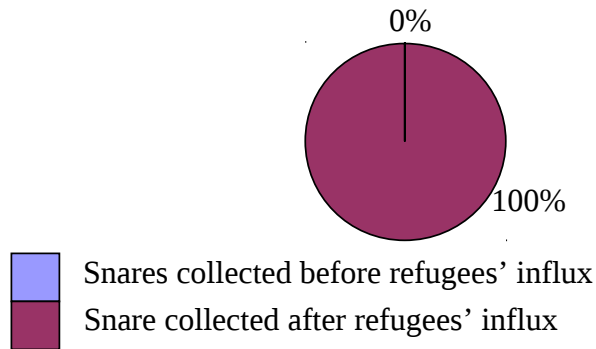


Figure 9: Snares collected from Burigi and Kimisi Game Reserves between 1990 and 1996

(Source: Biharamulo, Burigi and Kimisi Game Reserves Project Manager's Office 2006).



Plate 3: An impala killed by a snare in Burigi Game Reserve in 1995.

(Source: Biharamulo, Burigi and Kimisi Game Reserve Project Manager's Office 1996).

During the refugees' crisis, large scale illegal hunting occurred in and out of the Burigi and Kimisi Game Reserves. The Msuhura refugee camp was located very close to Burigi Game Reserve just two kilometres from the boundary of the game reserve. However, the

refugees were so many that their control was not easy. Eight hundred policemen were deployed by the Government of Tanzania to maintain law and order for seven hundred thousand refugees. This was an average of 875 refugees per policeman instead of 450 people per policemen which is the Police Force International Standard (URT, 2007). Moreover, in 1995 the then Kagera Regional Commissioner allowed refugees to move freely within a radius of four kilometres from the camp in order to collect firewood. This directive encouraged refugees to enter the Burigi and Kimisi Game Reserves which were within four kilometres distance. Therefore hunting of edible wildlife was inevitable for the refugees who were provided with only beans as source of proteins. This affected the diversity of wild animals in the areas especially outside protected areas.

Shannon Weiner's diversity index test indicated high diversity of large mammals inside PAs than that of outside PAs, ($H_E = 1.891$ and $H_E = 1.085$) respectively. This finding is re-enforced by questionnaire survey, which also shows local extinction of large mammal species following refugees' presence in the area (Appendix 7 and 8). The lower diversity index indicated by large mammals outside the protected areas is probably due to activities of refugees who were settled in that area. The same case has been reported by Santipillai and Wijeyamohan (2003) that in Sri Lanka subsistence hunting for edible wildlife was common in areas where refugees have been resettled. In 1994, more than 600 000 refugees were accommodated in the Benaco refugees' complex and supplied with beans, peas and maize. Beans and peas were their only source of proteins. The majority of the 600 000 Rwandese refugees were Hutu. Traditionally, Hutu people are farmers and hunters unlike the Tutsi who are traditionally pastoralists. The Hangaza of

the Shubi clan and the Subi people are traditionally hunters. The majority of the refugees who were settled at the Benaco complex were the Hutus who are hunters by nature. They poached the wildlife from their surrounding environments. Wildlife depletion in Burigi and Kimisi Game Reserves is strongly correlated to refugees' activities. These refugees were using guns, snares and nylon rope traps to kill animals (Plate 3 and Appendix 2).

Interviews suggest that refugees' occupancy is responsible for the decreased wildlife population in the study area (Appendix 8). Field observation revealed that no wild large mammal was sighted in block H, which was within the range of refugees' activities just two kilometres from Lukole refugee camp (Appendix 1). The same observation was made by Ogawa *et al.*, (2006) in Kigoma region where the population of mammals in Lilashamba disappeared after the refugees' camps were built. Probably refugees activities caused the declined of wildlife population in the study area.

4.1.4 Deforestation

The study revealed that 95.8% of respondents get building materials and medicine from village community natural forests (Appendix 4). The refugees like the local host communities, also depended upon the natural village community forests of Kasulo and Kashaazi where their camps were established. In order to acquire their daily basic needs they utilized any available forest resource within their vicinity. Utilization of vegetation by refugees started around the camps and later on moved into the nearby wildlife

protected areas of Burigi and Kimisi (Plates 4 and 5). Moreover, field observation revealed that areas around where refugees' camps were established were deforested (Plates 4 and 5).



Plate 4: Refugees carrying bundles of fire wood at the Lumasi refugee camp in 1995 (Source: Biharamulo, Burigi and Kimisi Game Reserve Project Manager's Office 1995).

Uncontrolled felling of trees to provide building materials, production of honey and beeswax, provision of energy (firewood) and provision of medicine to the refugees in the inhabited natural village forests of Kasulo and Kasharazi villages imposed the serious environmental problem in the area. The same case was reported by UNEP (2005a) in the Democratic Republic of Congo (former Zaire) that deforestation was the most serious environmental problem imposed by two million Rwandese refugees. It is presumed that this great change has been brought about by refugees' activities of cutting trees in order to get their daily basic needs.

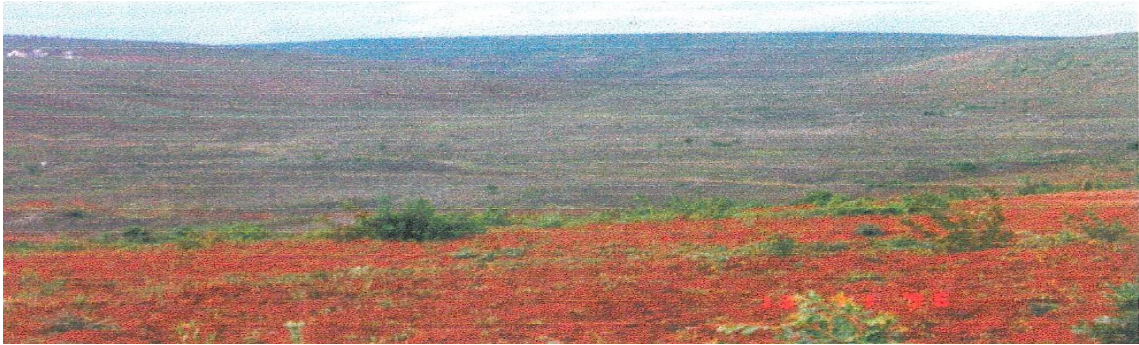


Plate 5: The cleared village natural forest around Benaco refugee camp in Kasulo.

(Source: Biharamulo, Burigi and Kimisi Game Reserve Project Manager's Office 1995).

Likewise, focus group discussion conducted in Kasulo and Rusumo villages revealed that the conversion of forests, grasslands, and wetlands for agricultural purposes during refugees' influx coupled with the multiplication and growth of urban centres along the Isaka-Kigali road such as the Benaco, Rusumo and Ngara Township, created reliable market for local communities' agricultural products. Similar findings have been reported by Schwart and Caro (2003) that where there was non selective tree felling but large scale clearing, trees regeneration is difficult and such places result into reduced number of trees per unit area. Most likely tree cutting is among anthropological activities which led to environmental degradation in the Burigi and Kimisi PAs and the surrounding areas.

4.1.5 Bush fire

During animal counting, approximately 400 km² out of the 600 km² total surveyed area of the Burigi and Kimisi Game Reserves were found burnt. Most of the observed dominant woody trees were fire resistant with high coppicing capacity or have high

capacity of sucker building such as *Acacia polyacantha* subspecies *compylacantha*, *Combretum molle*, *Dalbergia nitidula*, *Brachystegia boehmii*, *B. spiciformis*, *Lanea schimperi* and *Parinaria curatellifolia*. Sucker in this study mean a new growth on existing plant that develops under ground root or the main stem below a ground. The burnt shrubs were observed to be wilted by fire but sprouting suckers were common among the burnt species. The majority of these shrubs were those with thick corky barks. The common observed shrubs were *Acacia hockii*, *Anona senegalensis*, *Cassia senguena*, *Combretum collinum*, *C. fragrans*, *C. zeyheri* and *Terminalia mollis*. The same observations have been reported by Bloesch (2001) that the dominance of fire resistant woody and shrub species indicates the frequent bush fire in an area. The interviewed local communities in the study area indicated that forest fire is one of the factors causing environmental degradation in the Burigi and Kimisi ecosystem.

Results indicated that 51.9% of respondents mentioned forest fire to have an effect on the Burigi and Kimisi ecosystem (Table 4). However, local communities regarded forest fire to be not among the activities which can cause environmental degradation in their area because forest fire has been used by the local people as a tool for preparing land for farming. Its impact was not higher before the refugees came because of low population of people who were living in the closed and less closed forests who used the slash and burn method. The similar observation has been reported by Nyamabondo (2005) that local community in Ngara district used slash and burn method to prepare land for cultivating. Forest fire was regarded as a problem after the arrival of the refugees in the area. They used to set forest fire in order to create an open area with green regenerating

grasses which are favoured by herbivorous animals. Moreover, poacher refugees used fire in drying bush meat which resulted into unplanned forest fire. Bush fire cases were common in the Burigi and Kimisi ecosystem before the 1994 refugees' influx.

Table 4: Respondents views on activities which caused environmental degradation in the Burigi and Kimisi Ecosystem

Human activity	Frequency (n=260)	% (Percentage)
Cutting trees	179	68.8
Poaching	125	48.1
Setting of forest fire	135	51.9
None	65	25.0
Total	504	193.8

* The total percentages is more than 100% because the respondents gave more than one answer (multiple response)

The use of fire by local people during preparation of land for cultivating sometimes developed into uncontrolled fires which invaded the Burigi and Kimisi Game Reserves. In order to control unplanned bush fire in the reserves, the management of Burigi and Kimisi Game Reserves had been practising early burning of some parts of the reserves as the means of controlling late unplanned bush fire in the reserves. Similar observations have been reported by Manson (2007) in moist montane grassland in South Africa that fire can be used in range management.

According to the MNRT (2006) bush fire originates from settlements and public roads. However poachers have a contribution to the bush fire occurring in the Burigi and Kimisi Game Reserves. Fire started within the reserves is by poachers and hunter operators MNRT (2006). Unplanned forest fire always destroys untargeted non fire resistant plant species by causing infertile land with lower biodiversity in terms of flora and fauna. Setting of unplanned and uncontrolled fire in the district is probably one of the activities which cause environmental degradation.

4.1.6 Encroachment to protected areas

According to the Kasulo village focus group discussion, it was revealed that the refugees entered Tanzania through Kimisi Game Controlled Area by crossing Kagera River at Kashasha where they were temporarily gathered as a reception point before they were taken to the designated refugee camps. About 400 000 Rwandese refugees out of about 600 000 Rwandese refugees passed through Kimisi Game Controlled Area on their way to the Benaco refugee camps complex. The massive influx of Rwandese refugees through Kimisi Game Controlled Area caused enormous impact on the ecology of the Kimisi and Burigi ecosystem.

Field visits revealed that encroachment by refugees from Burundi was vivid in Kigoyi village natural forest (Plate 6). However, one encroacher, a refugee from Burundi, revealed that they (refugees) had been cultivating in the village forest and harvested their products without being noticed. Moreover, he said that he was allocated a piece of land

to cultivate in the community forest by one villager whom he paid in form of harvests after harvesting. The same cases have been reported by Whitaker (1999) in Karagwe district, and Andrew (2003) in Kasulu district that refugees have been cultivating in the village forests and harvested their products without being noticed.

The proximity of refugees to the protected areas of Burigi and Kimisi encouraged refugees' encroachment in the reserves. The refugees used the available resources to meet their daily needs by acquiring them from the Kimisi Game Controlled area and the Burigi Game Reserve (Appendix 5). The key informants at Kasulo village revealed that the refugees encroached the protected areas for the sake of hunting, collecting of wild fruits, searching of medicinal plants and collecting of firewood as well as cultivating in the village natural forests (Plate 6).



Plate 6: Encroachment to the degraded regenerating Kigoyi village natural forest in Nyamahwa village

Refugees' encroachment in village natural forests is amongst the anthropological activities which cause environmental degradation in the study area.

4.1.7 Overgrazing

Results on Tables 5 and 6 indicate that before refugees lived in the study area, overgrazing was not a problem since the area had a small number of livestock although Nyamiaga had the largest number of livestock in Ngara district (Table 5).

Table 5: Livestock population of the study area in the year 1993 and 2006

Ward	Cattle		Goats		Sheep	
	1993	2006	1993	2006	1993	2006
Nyakisasa	1933*	3658*	3087**	5100**	61**	79**
Nyamiaga	1221*	1055*	7136**	11273**	565**	735**
Rusumo	147*	6104*	381**	1315**	31**	84**
Total	3301*	10817*	10604**	17688**	657**	898**

* One cow/bull is equivalent to one livestock unit, one livestock unit requires 1.2 hectare for grazing. ** Two goats/sheep is equivalent to one livestock unit
(Source: Ngara District Council Livestock Development Office 2006)

In 1993, Nyakisasa ward had 1 933 cattle, 3 087 goats and 61 sheep at the same time Nyamiaga ward had 1 221 cattle, 7 136 goats and 565 sheep. These two wards had a large number of livestock compared with Rusumo ward which had only 147 cattle, 382 goats and 31 sheep. The number of livestock is said to have rapidly increased in Rusumo ward, the area around where refugee camps were situated.

The coming of refugees brought about the change of land use in the ward whereby local native communities indulged in animal husbandry. The host local community bought livestock from refugees who came with a good number of livestock. This is because the refugees were not allowed to enter the country with a large number of livestock. Therefore refugees sold some of their livestock at the border on entering Tanzania.

Refugees were allowed to live at the camp with a limited number of livestock; therefore they sold some of their livestock on entering the country (Lusesa, J. personal communication, 2006).

Table 6: Change in livestock unit and grazing land size between 1993 and 2006

Wards	Livestock unit		Land required for grazing in hectares		% change in land requirement
	1993	2006	1993	2006	
Nyakisasa	3507.0	6247.5	4208.4	7497.0	82.2
Nyamiaga	5071.5	7059.0	6085.8	8470.8	39.2
Rusumo	353.0	6803.5	423.6	8163.6	182.7.
Total	12438.5	20110.0	10717.8	21431.	100.0

4

Source: Ngara District Council Livestock Development Office 2006

Apart from this, registers from Ngara District Council Livestock Development Office showed that Rusumo ward had 6 104 cattle, 1 315 goats and 84 sheep. Two herds of cattle averaging 500 cattle each were observed during the survey. Results indicate that livestock population of Rusumo ward had increased than before refugees influxed the area. In 2006, the study area had 10 817 cattle, 17 688 goats and 898 sheep compared with that of 1993 which were 3 301 cattle, 10 604 goats and 657 sheep (Table 5).

Moreover, key informants interviews revealed that refugees came with unknown number of livestock. This is because the government of Tanzania directed her efforts on people's welfare rather than livestock. Comparable observation has been reported by UNEP (2005a) that Rwandese refugees entered into Tanzania with an estimated 500 000 heads of cattle. However, the number of cattle owned by the refugees at Benaco refugee camps

complex was unknown. The majority of these cattle were with the Rwandese refugees settled in Karagwe district.

During the exercise of wild animals counting in the study area, seven cattle trails were observed in Kasulo village, four of them were adjacent to Burigi Game Reserve and the other three were adjacent to the Kimisi Game Reserve. Vegetation on these trails were affected by frequent movement of livestock. These observations concurs with that of Masoud and Maganga (1996) that on average 76.0% of trees on livestock trails had roots exposed or damaged compared with only 5.0% of trees away from trails. Refugees' influx caused the increase of livestock population in the study area. Presumably this is the result of increased livestock in the Rusumo ward from 147 cattle in 1993 to 6 104 in 2006. Results indicated that land required for livestock grazing in the study area increased from 10 717.8 hectares in 1993 the period before the refugees lived in the study area to 21 431.4 hectares in 2006 after the refugees lived in the area (Table 6).

During the period from 1993 to 2006 Rusumo ward had the greatest increase in number of livestock unit in the study area. In 2006, Rusumo ward had 6 803 livestock units compared with 353 livestock units in 1993 (Table 6). During the same period livestock units of Nyakisasa and Nyamiaga wards increased from 3 507.0 to 6 274.5 and from 5 071 to 7 059.0 respectively. This went simultaneously with the increase in grazing land. According to Kideghesho *et al.*, (2005) one livestock unit requires 1.2 hectares for grazing. The increase rate of grazing land from 1993 to 2006 was 140.6% per year equivalent to 628.0 hectares per year. Moreover, the overall change between 1993 and

2006 was 153.7%. The poor livestock management practiced by pastoralists in Kasulo village may be contributed to environmental degradation especially through overgrazing and uncontrolled livestock movement

4.2 Wildlife Population Changes Before and After Refugees

Over the years there has been a great change in the immigration of refugees in Ngara district. The Ministry of Home Affairs Office of the Director of Refugees reported that in Ngara district influx of refugees was observed between 1993 and 1994. Table 8 shows that, up to 1990 there were no refugees around Burigi and Kimisi Game Reserves. The wildlife survey conducted by TAWIRI between the years of 1990, 1998 and 2000 indicated decrease in wildlife populations in the Burigi and Kimisi Game Reserves (Table 7). Therefore it is likely that the presences of a large number of refugees in this area caused a rapid decrease in wildlife populations with exception of elephants and impala between the period of 1993 and 2000.

Table 7: Wet season wildlife trend from 1974 to 2000 in Kimisi and Burigi Game Reserves

Year	1974	1982	1990	1998	2000
No. of refugees	0	0	0	96000	91000
Species					
African elephant	1500	0	0	3400	1266
Bohor reedbuck		0	67	32	10
Buffalo	2000	1493	1600	22	78
Eland		8543	603	72	0
Giraffe		420	127	150	19
Impala		2214	4663	2818	1480
Waterbuck		191	670	16	9

Warthog	1776	1313	65	82
Sitatunga	0	490	0	1
Topi	1585	3403	114	178
Zebra	5599	2800	622	1213

(Source: TAWIRI, CIMU Office 2006 and MHA Office of the Director of Refugees 2006). * TAWIRI Tanzania Wildlife Research Institute, CIMU Conservation Information and Monitoring Unit. MHA Ministry of Home Affairs'

There are chances that an increased number of refugees had contributed to the general decrease in number of wildlife populations. The eleven large wild mammal species suspected to be affected by refugees' activities were statistically tested by using Spearman's rank correlation to assess the association of wild large mammals decrease with the number of refugees adjacent to the Burigi and Kimisi Game Reserves. The results indicated statistical significance to the buffalo ($\rho = -0.894$, $p < 0.05$), warthog ($\rho = -0.949$, $p < 0.05$), topi ($\rho = -0.949$, $p < 0.05$), sitatunga ($\rho = -1.00$, $p < 0.001$) and zebra ($\rho = -0.949$, $p < 0.05$).

Although statistically these results indicated not to have significant impact on wildlife populations of eland, Bohor reedbuck and waterbuck it does not mean that these species were not affected by refugees. The populations of these species appeared biologically to have a significant impact because during physical survey they were observed to be very few in number. They are biologically significant due to the fact that the populations of waterbuck and Bohor reedbuck have decreased to 10% and 48%, respectively. Similar observations have been reported by Fowler *et al* (2002), that sometimes an apparently strong correlation may be regarded as not significant whilst a weak correlation may be statistically highly significant (Table 8).

The results are consistent and suggest strongly that the refugees have an impact in most of the species (Table 8). This can be due to refugees' activities which included clearing of forests in search of building materials and land for cultivating, setting of forest fires and cultivating around water sources which resulted into wildlife habitat degradation. Moreover, wildlife populations were affected by refugees who poached the wildlife species indiscriminately in order to get meat.

Table 8: The spearman's rank correlation test on wildlife population with number of refugees

Number	Animal species	ρ -value	Significance level
1	African elephant	-0.632	ns
2	Bohor reedbuck	0.105	ns
3	Buffalo	-0.894	*
4	Eland	-0.738	ns
5	Giraffe	-0.211	ns
6	Impala	-0.112	ns
7	Waterbuck	-0.738	ns
8	Warthog	-0.949	*
9	Sitatunga	-1.000	**
10	Topi	-0.949	*
11	Zebra	-0.949	*

Note: **statistically significant at $p < 0.01$, *statistically significant at $p < 0.05$, ns = statistically not significant at $p > 0.05$

Moreover, key informants interviews revealed that the further the distance from the Burigi and Kimisi Game Reserve Game posts the more the poaching. This was observed to be due to preparedness and timeliness of the game reserve management to combat poaching. Thus poachers took advantage of poaching in the area far away from the Game Reserves Project Manager's Office which is based in Biharamulo. Moreover, during the period of 1994 to 1996 the reserves had only 38 staff in 1994 and 31 staff between 1995 and 2004 with only three vehicles. The reserve patrol capacity was 20.2% in 1994 and 16.8% in 1995 up to 2004 (Appendix 3). The decrease in wildlife populations probably occurred because refugees have poached the larger mammals for subsistence and commercial purposes.

4.2.1 The impact of refugees on African elephant population

Results from Table 8 indicate that, the African elephant population decreased from 3400 in 1998 to 1266 in 2000. In 1974, there were 1500 elephants which were estimated to be present in the Burigi and Kimisi Game Reserves whereas during the 1982 and 1990 wet season wildlife census no elephant was sighted. These results can be explained by the behaviour of the African elephant. According to Estes, (1992) African elephant has a wide home range ranging from 14 km² to over 3 500 km² due to this behaviour, it is possible that during the 1982 and 1990 wet season census, the elephants had probably migrated to Akagera National Park in Rwanda or Moyowosi Game Reserve in Tanzania which are within the range of less 3 500km² from the Burigi and Kimisi Game Reserves.

During the 1998 wet season wildlife census 3 400 elephants were estimated to be present in the reserves. The 2 000 wildlife survey indicated that 1 266 elephants were present in the area. The Spearman's rank correlation test indicated no significant negative correlation ($\rho = -0.632$, $p > 0.05$) between the number of African elephant and the number of refugees lived in the study area (Table 8).

African elephants are very defensive social animals which help one another if one member of a family is injured. A similar observation has been reported by and Poole Moss (1981) that the sudden loss of the matriarch by shooting completely disturbs and disorients her followers. They often squeeze around her and let themselves be shot rather than abandoning her. Due to this altruism developed behaviour in African elephant, poacher refugees feared to hunt them.

In any insecurity occasion elephants tend to band together forming a big group which is made up of several related families as a means of defending themselves. This was also reported by Bere (1966) as cited by Estes (1992) that elephants stressed by range compression and hunting pressure tend to band together in larger groups of reunited families of for the short term aggregation of up to 2000 individuals. Due to the defensive behaviour of the elephant, poachers opted for other none risk mammal species such as eland, topi, zebra, Bohor reedbuck and sitatunga. Perhaps elephants were not affected by refugees' influx in the study area.

4.2.2 Impact of refugees on Bohor reedback population

According to the wet season wildlife census conducted in years 1990, 1998 and 2000 the estimated Bohor reedback populations in Burigi and Kimisi Game Reserves were 0, 67, 32 and 10 in the respective years (Table 7). Results indicate that there was a population decrease during the period of 1990 and 2000. In 1982, no Bohor reedback was sighted in the Burigi and Kimisi Game Reserves. Spearman's rank correlation test indicated no significant positive correlation ($\rho = 0.105$, $p > 0.05$) between the number of refugees that influxed the area and the number of Bohor reedbucks found in the study area (Table 8). Results indicate absence of association between the numbers of refugees who lived in the study area and the decline of the Bohor reedback population in the study area.

The results have been affected by three factors which include the ecology of Bohor reedback, the behaviour of the species and the method used to collect data (method of animal counting). Bohor reedbucks are more difficult to sense from the air because of their preference in the denser habitat. Similar observations have been reported by Estes (1992) that Bohor reedbucks frequently inhabit grassland habitats which are tall enough to hide. Bohor reedbucks are mostly abundant in floodplains and therefore aerial wildlife survey cannot give good results, because most of the hiding animals will not be counted. Also the species is more active at night. Likewise findings of Jugius (1971) indicated that in Kruger National Park reedbucks were mostly nocturnal during the rain and early dry seasons. Bohor reedback was mostly impacted because of its anti-predatory behaviour of crouching and creeping. Similar observations have been reported by Estes

(1992) that if a standing reedbuck sees a predator it acts as if it is undetected. It will crouch or creep into hiding if it is on the edge of cover. This type of behaviour gives a chance to a hunter to ambush the animal easily. Although the statistical test on this species is not supporting the correlation between refugees and decrease of population, it is almost certainly true that the indiscriminate hunting conducted by refugees in the protected areas between 1994 and 1996 had caused a great decrease in the reedbuck population of Burigi and Kimisi Game Reserves.

4.2.3 The impact of refugees on buffalo population

The results from five wet season wildlife surveys by aerial census conducted from 1974 to 2000 indicated the association of number of refugees and decrease of the number of buffaloes. The 1998 wildlife survey in Burigi and Kimisi Game Reserves indicated that the buffalo population had declined from estimated 1600 in 1990 to only 22 buffaloes in 1998. There was an increase of the population from 22 buffaloes in 1998 to 78 buffaloes in 2000. The Spearman's rank correlation indicated a significant negative correlation ($\rho = -0.894$, $p < 0.05$) between the number of refugees and buffalo population. This implies that an increase in number of refugees resulted in a decrease of buffalo populations. Since refugees used whichever natural resources within their reach to acquire their basic needs, therefore buffaloes were not excluded.

The refugee poachers favoured buffalo species because with a single kill they would have enough meat to sell to the camps by using little effort. Also it was easy to the refugee poachers

to kill buffaloes because of their defensive behaviour. When the buffalo herd is fleeing from predators or hunters, they have to crowd together and run at a lower speed. Moreover, buffaloes travel long distances by walking. Since refugee poachers were non selective killers, the crowding together of buffaloes created an opportunity for the refugee poachers to kill them by using minimum efforts. Similar observations have been reported by Barnett (2000) that macrofauna species are more susceptible to wild meat off-take and habitat loss. Therefore buffaloes like other macrofauna species were affected by wild meat offtake and habitats loss. The establishment of refugees' camps adjacent to the protected areas encouraged the refugee poachers to kill the buffaloes. The minimal effort used by refugee poachers to hunt buffaloes may be caused a decline of buffalo population.

4.2.4 The impact of refugees on eland population

The 2000 wet season wildlife census indicated that no eland was sighted in the two reserves (TAWIRI, 2000). In 1998, only 72 elands were estimated to be present in the Burigi and Kimisi Game Reserves. According to aerial wildlife survey conducted by TAWIRI in 1990, the eland population was estimated to be 603 in the reserves. This indicates that eland population was reduced from 603 individuals in 1990 to only 78 individuals in 1998 (Table 7). It is very difficult to establish an association between the refugees' influx and the decrease of eland population. This is because there was a sharp decrease of the population that was observed in 1990, whereby the population dropped to 7.1% in 1990 of its original population of 1982. These results indicate a long term decrease of the species even before the refugees lived in the study area.

The questionnaire survey conducted in the study area indicated only 8.5% of respondents reported that eland was common in the study area before refugees influx (Appendix 7). Moreover, 8.1% of the host local community interviewed indicated that the species was no longer found in the area (Appendix 8). The Spearman's rank correlation test indicated no significant negative correlation ($\rho = -0.738$, $p > 0.05$) between the number of refugees and decrease of eland population (Table 9). The combinations of these findings do not support the existence of association between refugees and decrease of eland species. The reason as why eland species seemed not to be impacted by refugees is the abrupt decrease of the species population in 1990 to just 7.1% of the original population within a period of eight years.

Elands are not tolerant to human activities; therefore it is possible that hunting (poaching) carried out by local people for a long time has affected the population trend of eland species. Similar observations have been reported by Estes (1992) that eland is intolerant to human settlements. It is possible that the most unusual feature of an eland becoming tired within one kilometre of flight run has been the reason which had subjected the species being hunted to declining point. The slow speed is caused by its bulkiness as reported by Blaine (1922) as cited by Estes (1992). It is possible that poaching of eland by the local people of Ngara, the Basubi and Hangaza (Bashubi) tribes has led to the decline of the species population to almost nil in the area

4.2.5 The impact of refugees on giraffe population

Results of four aerial wildlife survey conducted between 1982 and 2000 indicated that there was no population decrease of giraffe between 1990 and 1998, the period which was with a major problem of wildlife non selective killing by refugees in the study area (Table 7). The 1982 and 1990 wildlife census indicated that there were 420 and 127 giraffes in the reserves respectively, whereas in 1998 and 2000 it was estimated that 150 and 19 giraffes existed in the two reserves respectively. The population decrease was observed to be serious in the 2000 wildlife census, whereby only 19 giraffes were estimated to be present in the Burigi and Kimisi Game Reserves (Table 7). The Spearman's rank correlation test indicated no significant negative correlation ($\rho = -0.211$, $p > 0.05$) between the number of refugees and the decrease of giraffe population (Table 9). These results suggest that giraffe was the last species to be targeted by refugee poachers in Burigi and Kimisi Game Reserves, after the majority of other species have been poached to declining stage. The decrease of giraffe from estimated 150 individuals in 1998 to only 19 individuals in 2000 indicates that the species was not previously poached until after 1998.

The reason as why giraffe was lastly targeted by refugee poachers is may be because giraffes are not found in Rwandese and Burundi's protected areas. Similar observation has been reported by Fegley (2003) that animals found in Rwandese National Parks are elephants, hippopotamuses, crocodiles, forest pig, leopards and antelopes. These animals are found in Akagera National Park whereas mountain gorillas are found in Virunga

National Park. Animals found in Burundi's protected areas are leopards, hippopotamuses, crocodiles, forest pig, antelopes and monkeys. Therefore giraffes by being not familiar to the refugees perhaps were not considered as the source of wild meat in the presence of other animal species unless in the absence of any other alternative. The refugees who were settled to Benaco were Hutus from Rwanda and Burundi. Hutus are not used to eat giraffe meat but antelope's meat. These people were more familiar with antelopes rather than giraffes.

Another reason is the anti-predatory behaviour of a giraffe of having superior vision for both night and day time as well as its high speed within a distance of a kilometre. The same case has been reported by Pellew (1984) as cited by Estes (1992) that the great size, superior vision (day and night), speed and formidable hooves make grown up giraffes invulnerable to predators. Giraffes are sensitive to danger so that they easily spot out their enemies and escape with high speed. Hunting of a giraffe requires much energy of chasing or ambushing. Therefore poachers opted to other species which can be easily trapped by snares or hunted with minimum energy rather than giraffe which cannot be trapped easily by snares due to its large size and required much energy to ambush or chase. Due to these reasons, conceivably giraffes were last targeted by refugee poachers

4.2.6 The impact of refugees on impala population

The wet season wildlife census conducted in Burigi and Kimisi in 2000 indicated a decline in impala population from 4 663 in 1990 to an estimate of 1 480 in 2000. This was a decrease of 68.3% of the 1990 population. However, impala population increased by 111.6% between 1982 and 1990 and decreased by 39.6% between 1990 and 1998. The Spearman's rank correlation test indicated no significant negative correlation ($\rho = -0.112, p > 0.05$) between the number of refugees who lived in the area and the number of impala found in the study area (Table 8). The insignificant correlation between the impala population and the number of refugees in the Burigi and Kimisi Game Reserves is addressed by three major factors which are behaviour of impala, quantity of wild meat per impala (dressed carcass weight of impala) and the ability of impala to sustain hunting pressure and modified habitats.

Impalas are edge (ecotone) species preferring light wooded habitats with little undergrowth and grassland of low to medium height. Similar observation has been reported by Estes (1992) that impala prefer light wooded habitats with little undergrowth and grassland. However, these habitats make impala more alert and quick to take flight hence they have a well adapted tactic to detect enemies. Impala has a well adapted tactic to detect a stalking lion or leopard. This type of behaviour discourages hunters because maximum efforts are needed in order to kill a single impala. Always poachers tend to hunt species which are easily killed with minimum efforts. Probably refugee poachers

opted to hunt impala after other species which are hunted with minimum efforts had been poached to a deterioration point.

Although impalas are liked by many subsistence hunters due to their meat having a taste which is closer to that of a goat, poachers who are afraid of being arrested tend to hunt animals with larger dressed carcass weight with minimum effort. The period between 1994 and 1996 refugee poachers used to hunt and sell wild meat to the refugee camps in Ngara district. In order to get enough wild meat to sell they targeted animals with larger dressed carcass weight like buffalo, eland, waterbuck and topi. This caused impala to be less affected by refugee poachers relative to large sized animals. The same finding has been reported by Barnett (2000) that most popular smaller and more available species accounted for a limited proportion of overall quantity trade of wild meat in Mozambique due to their small dressed carcass weights.

Impala has the ability to thrive in areas where the natural vegetation has degenerated because of overgrazing or bush encroachment. Similar observation has been reported by Dasmann and Mossman (1962) in Mopaneveld of Zimbabwe where perennial grasses were largely eliminated by burning and overstocking, impala increased while pure grazers like hartebeest, wildebeest and zebra disappeared. However, impala has medium ability to sustain the modified habitats. The same case has been reported by Barnett (2000) that impala has no ability to sustain hunting (poaching pressure) but with medium ability to sustain the modified habitats. Possibly impala was last targeted by refugees after other relatively larger sized species had been reduced in the study area (Table 7).

4.2.7 Impact of refugees on waterbuck population

Only nine waterbucks were seen during the 2000 wet season wildlife aerial survey compared to 16 individuals that were seen in the 1998 wet season aerial survey (Table 8). The 1990 wildlife aerial survey recorded a highest number of 670 waterbucks in Burigi and Kimisi Game Reserve. However, the population trend is indicating a continuous decrease of the species in the period of 1998 and 2000. The Spearman's rank correlation test indicated no significant negative correlation ($\rho = -0.738$, $p > 0.05$) between the waterbuck populations and the number of refugees who lived in the study area (Table 8). In spite of the insignificant negative correlation between the number of refugees and waterbuck populations in Burigi and Kimisi Game Reserve, the species population has significantly decreased from 670 individuals sighted in 1990 to only 9 individuals sighted in 2000.

The ecology of waterbuck makes them vulnerable to poaching because of their water and open grassland restricted home range. These findings support the study conducted by Taylor *et al.*, (1969) who argued that waterbuck is possibly the most water dependent of all antelopes with even less than a domesticated steer to withstand dehydration in hot weather. Likewise, Estes (1992) reported that the combination of requirement for cover, open grassland and water makes a patch of ecotone distribution along drainage lines and within valleys for waterbucks.

Therefore waterbuck is easily hunted because of its restricted habitat and small home range which is associated with water sources. Normally poachers set their camps near water sources (Muzee, E. B. personal communication, 2006). Due to the indiscriminate hunting which used combinations of methods that include snare, nylon rope nets (amakila), setting of forest fires and shooting would not exclude the waterbucks from being poached to declining point. Most likely refugees poaching activities contributed to the decline of waterbuck population in the study area.

4.2.8 The impact of refugees on warthog population

Estimates of 82 for warthog were made during wet season of 2000 which is indicating the continuation of population depression from 1990 (Table 7). Moreover, the population has not recovered since 1998. During the 2006 animal counting no warthog was sighted in and out of the Burigi and Kimisi Game Reserves. The Spearman's rank correlation test indicated significant negative correlation ($\rho = -0.949$, $p < 0.05$) between the number of refugees and the population of warthog in the study area (Table 8). The negative correlation supports the impact of refugees on warthog population (Table 8).

Two factors which led the species to decline included meat preference and inability of the species to adapt to modified environment. The taste of warthog resembles that of the forest pig which is a common species in both Rwanda and Burundi, the countries of origin of the refugees who were hosted adjacent to the Burigi and Kimisi Game Reserves during a period of 1994 to 2000. Similar observation has been reported by

Wolmer *et al.*, (2003) that the refugee settlements have been associated with rapid and unsuitable offtake of wildlife threatening the viability and survival of many species including those which are in protected areas. Warthog has no ability to sustain hunting and modified habitat. Therefore warthogs were hunted and consumed in refugees camps as one of the preferred wild meat. Conceivably refugees hunting activity has led to the decrease of warthog population.

4.2.9 Impact of refugees on sitatunga population

Only one sitatunga was observed in Burigi and Kimisi Game Reserves during the 2000 wet season wildlife aerial survey (Table 7). Population estimate was not possible due to smallness of the observed number of the species. The population of sitatunga was heavily reduced from 490 individuals in 1990 to only one sitatunga in 2000. However, no sitatunga was observed in the two reserves during the 1982 and 1998 wet season wildlife aerial surveys. The Spearman's rank correlation test indicated perfect significant negative correlation ($\rho = -1.00$, $p < 0.001$) between the number of refugees and the number of sitatunga found in the study area (Table 8). This supports the association that, the increase in number of the refugees in the study area caused rapid decrease in the population of sitatunga in the Burigi and Kimisi Game Reserves. Similar observations have been reported by Kyomi *et al.*, (1996) that the study conducted by CARE in western Tanzania during the peak influx of the Rwandese refugees revealed massive high scale of poaching estimated to supply into Ngora refugee camps approximately 7.6 metric tonnes of wild meat of different species per week.

The behaviour of sitatunga to use regular path ways and having small home range restricted to swamps caused the species to be targeted so easily by poachers using snares and nylon rope nets. Vulnerability of the species due to the behaviour has been previously reported by Kington (1982) cited by Estes (1992). Snares were used by refugees to catch animals for wild meat (Appendix 2). The refugees influxed the area between 1994 and 2000 probably caused great impact on the sitatunga population in and outside the Burigi and Kimisi Game Reserves.

4.2.10 Impact of refugees on topi population

During the 2000 wet season wildlife aerial survey in the Burigi and Kimisi Game Reserves showed no improvement in the population of topi. The population trend of the 1990 to 2000 indicates a drop to only 5.0% of that of 1990 (Table 7). The population dropped from the estimated 3 403 individuals in 1990 before the refugees influxed the study area to only estimated 178 individuals in 2000. The Spearman's rank correlation test indicated significant negative correlation ($\rho = - 0.949$, $p < 0.05$) between the numbers of refugees and the number of topi present in the area (Table 8). The significant negative correlation implies that as the number of refugees who were living in Ngara refugee camps increased, the population of topi decreased in the study area, as the result the population of topi dropped to only 5.0% of the population after refugees influxed the area.

Topi was the target species for refugees because they were living closer to the protected areas of Burigi and Kimisi Game Reserves at Benaco refugee camps. The nearest camp to the protected area was Msuhura which was just two kilometres from the Burigi boundary. Moreover, the presence of a large number of refugees near protected areas generated direct and strong perturbation of the wildlife; in most cases involved poaching and hunting of animals especially the antelopes and buffaloes. The same case has been reported by UNEP (2005a) that all larger herbivores in the Virunga National Park were extensively poached following the arrival of the Rwandese refugees in 1994. The species was badly impacted because of its preference to grassland habitat which ranges from vast treeless plains to lightly wooded bush and tree savannah. This type of habitat simplified the poaching activities of the refugees who were using snares, nylon rope nets and by setting forest fire. Moreover, topi meat was favoured by refugees and the local communities (Johnston, E. personal communication 2006). Probably the influx of refugees near the Burigi and Kimisi Game Reserves caused the decline of topi population in the study area.

4.2.11 Impact of refugees on zebra population

The 1982, 1990, 1998 and 2000 wet season wildlife aerial surveys in the Burigi and Kimisi Game Reserves showed that there was a dramatic decline in zebra population by 50.0% from 1982 to 1990, and 77.8% from 1990 to 1998. Moreover, there was an increase in zebra population from 1998 to 2000 by 95.0% (Table 7). In 2000, the population decreased to 56.7% of that of 1990. The Spearman's rank correlation test

indicated a significant negative correlation ($\rho = -0.949$, $p < 0.05$) between the number of refugees and the populations of zebra in the study area (Table 8).

Zebra like other impacted herbivores in the Burigi and Kimisi Game Reserves were intensively poached by refugees because of their pioneer behaviour of leading the way into taller more wooded habitats and prepare it for other antelopes in the area. Similar observations have been reported by Bell (1971) that the zebra is often the pioneer that leads the way into taller and more wooded habitat or wetter pasture and prepares it for the wildebeest, gazelles and other associated antelopes. In the process of leading the way to taller and more wooded habitats the zebra used to encounter snares or nylon rope nets set by poachers.

The refugees hunted the animals extensively for subsistence and commercial purposes. Poaching for wild meat has clearly escalated and is alarming in the Burigi and Kimisi ecosystem as the result has caused population decrease in many species by using snares and nylon nets. Similar observations have been reported by Kalpers (2001) that even the use of traditional methods; such as the hunting nets woven from liana fibres used by (Mbuti) pygmies in the Okapi Fauna Reserve and the southern sector of the Virunga National Park in the Democratic Republic of Congo caused impact on wildlife population. Probably zebra population had been reduced by refugees poaching for subsistence and refugee poachers selling of meat to fellow refugees.

4.2.12 Impact of refugees on small mammals

Small mammals like large mammals which include lesser bushbaby (*Galago senegalensis*), rock hyrax (*Heterohyrax syriacus*) and dwarf mongoose (*Helogale parvula*) were very much impacted by refugees in terms of populations and diversity. Deforestation, water sources destruction and setting of forest fire in the study area destroyed their habitats. Poaching conducted by refugees in the area lowered the population and the species diversity of the small mammals like that of large mammals.

4.3 Impact of Refugees on Wildlife Habitats

4.3.1 Land cover classification

Land cover classification in Tanzania is yet to be standardized. This situation makes it difficult to compare different studies and use the previous studies as a baseline for subsequent studies (Kikula, 1980). In this study classes of land cover established by classification of satellite images were riverine forest, woodland, scrubland, grassland/settlement and bareland/rock. Riverine forest is an area characterised by woody vegetation taller than 20 feet where soil is at least periodically saturated or covered by water. Woodland is a land covered with vegetation community that includes widely spaced large trees; tree crowns are typically more spreading in form than of forest trees and do not form a closed canopy, grass, health or scrub may be developed between them. Scrub is a land covered with stunted trees and shrubs, grassland/settlement is a land covered with grass without or with very few trees and with

human settlements, and bare land /rock is a land without vegetation cover (soil exposed or rocks) or rocky area.

4.3.2 Land cover changes before and after refugees influx

Analysed satellite images of Landsat TM of the years 1984, 1993 and 2002 indicate five different land covers (wildlife habitats) types (Tables 9 and 10). Results indicated that land cover in the study area have undergone some changes before and after the refugees influxed the area.

Table 9: Area coverage and changes of different land covers between years 1984 and 1993 in Kimisi and Burigi Game Reserves

Land cover/use	1984 Area (ha)	1993 Area (ha)	1984-1993 Changed area (ha)	1984-1993 % Change	% Change rate per year
Riverine forest	5174.0	9539.2	4365.1	84.6	9.4
Woodland	12216.1	11375.7	-840.4	-6.9	-0.8
Scrubland	27688.3	23111.9	-5576.3	-16.3	-1.8
Grassland/settlements	14012.0	12443.0	-1569.0	-11.2	-1.2
Bareland/rocks	7510.2	10130.8	2620.6	34.9	3.9
Total	66600.6	66600.6	-1000.0	85.1	9.5

Table 10: Area coverage and changes of different land covers between years 1993 and 2002 in Kimisi and Burigi Game Reserves.

Land cover/use	1993 Area (ha)	2002 Area (ha)	1993-2002 Changed area (ha)	1993-2002 Overall % change	% Change rate per year
Riverine forest	9539.2	4930.4	-4608.8	-48.4	-5.4
Woodland	11375.7	10001.1	-1374.6	-12.1	-1.3
Scrubland	23111.9	29007.0	5895.1	25.5	2.8
Grassland/settlements	12443.0	15735.3	3292.3	26.5	2.9
Bareland/rocks	10130.8	6926.9	-3203.9	-31.6	-3.5
Total	66600.6	66600.6	0.1	23.1	-4.5

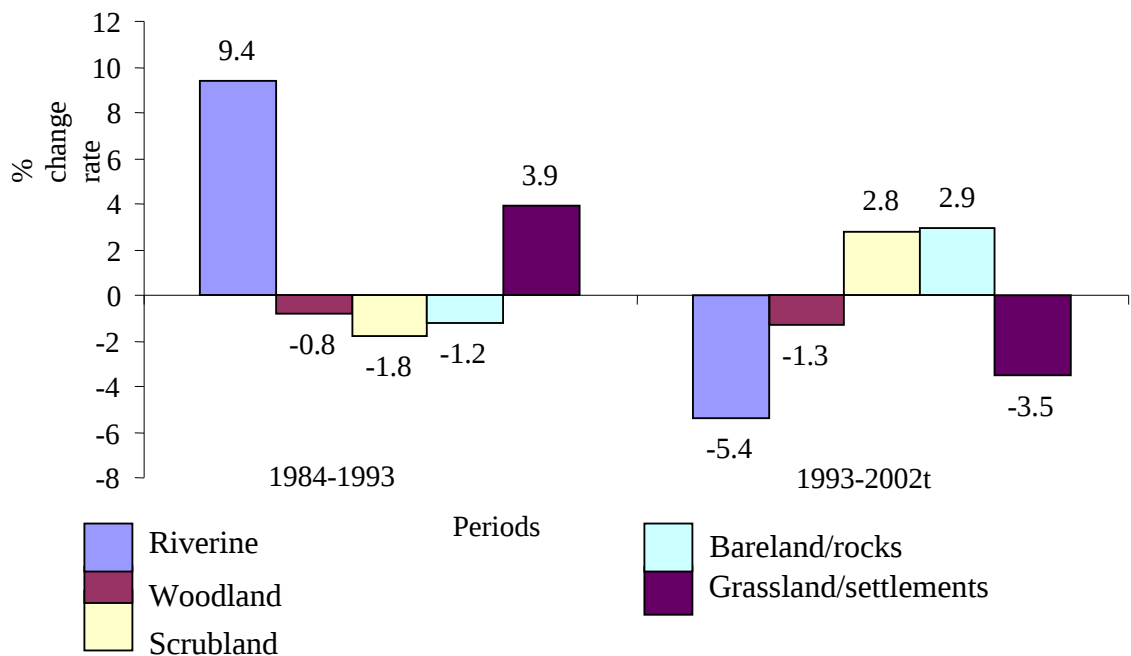


Figure 10: Land cover change rates between the periods of 1984 to 1993 and 1993 to 2002 Burigi and Kimisi Game Reserves.

4.3.2.1 Riverine forest

Tables 9, 10 and Figure 11 revealed that the riverine forest had increased from 5 174.0 hectares in 1984 to 9 539.2 hectares in 1993 with an overall increase of 84.4% (4 365.2 ha) equivalent to an average increase rate of 9.4% per year. However, the riverine forest decreased from 9 539.2 hectares in 1993 to 4 930.3 hectares in 2002 with an overall decrease of 48.4% which is equivalent to an average decrease rate of 5.4% per year. In the period between 1984 and 1993 the area experienced a high increase (regeneration) of the riverine forest as the result of minimal disturbances from human activities (Table 11). During this period the area accommodated very few people who couldn't affect the regeneration of the riverine forest. The increase of riverine forest was due to low disturbance caused by human activities in the study area. Vegetation regeneration in this study means a dynamic process by which vegetation recovers the degraded land cover when the land cover has been partially or totally destroyed, or vegetation recovers the degraded land cover through the mechanism of the succession of plant species.

Between 1984 and 1993, a total of 9 055.1 hectares of four different land covers regenerated into riverine forest. These included 2 834.6 hectares of woodland, 2 648.3 hectares of scrubland, 2 827.4 hectares of grassland/settlement and 744.8 hectares of bare land/rock (Table 12). The changed (regenerated) woodland, scrubland, grasslands/settlements and bareland/rocks into riverine forest during this period added to the 484.1 hectares of unchanged riverine forest (Table 12 and Fig. 12) to make up 9 539.2 hectares of riverine forest for the year 1993. The overall change of woodland,

scrubland, grassland/settlement and bareland/rock to form riverine forest (regeneration) during this period was due to minimal disturbances on riverine forest.

Table 11: Regenerated land covers between the periods of 1984 to 1993 and 1993 to 2002 in the Kimisi and Burigi Game Reserves.

Types of land covers changed to other land covers	1984-1993 Regenerated vegetation (ha)	1984 % Regenerated cover in	1993-2002 Regenerated vegetation cover (ha)	1993 % Regenerated cover
Woodland to Riverine forest	2834.6	23.2	660.2	5.8
Scrub to Riverine forest	2648.3	9.6	1937.4	9.6
Scrubland to woodland	3714.3	13.4	2279.0	11.3
Grassland/Settlement to Riverine forest	2827.4	20.2	1025.1	8.2
Grassland/Settlement to Woodland	2714.4	19.4	2064.8	116.6
Grassland/Settlement to Scrub	5000.7	35.7	4164.0	33.5
Bareland/Rock to Riverine forest	744.8	1.9	371.4	3.6
Bareland/Rock to Woodland	1376.7	18.2	1272.8	12.6
Bareland/Rock to Scrubland	2232.3	29.7	3337.8	32.9
Bareland/Rock to Grassland/Settlement	2476.4	33.0	3672.8	36.2

Results from Table 11 and Figure 11 indicate that there was a decrease of riverine forest from 9 539.3 hectares in 1993 to 4 930.4 hectares in 2002. The difference in the area of riverine forest change between the periods before and after refugees lived in the study area was a decrease of 8 973.9 hectares (Table 13). This decrease probably had been caused by refugees' activities in the study area. The establishment of refugee camps

adjacent to the Burigi and Kimisi Game Reserves attracted the refugees to enter the protected areas and cut trees from the riverine forest. The same observation has been reported by Kalpers (2001) that in DRC 6 000 hectares of low and high altitude forests had been cleared by refugees. Likewise, Santipillai and Wijeyamohan (2003) observed environmental destruction from repatriated refugees in Sri-Lanka.

Table 12: Unchanged land covers between the periods of 1984 to 1993 and 1993 to 2002 in the Kimisi and Burigi Game Reserves.

Types of land cover	1984-1993 Unchanged land cover (ha)	% change cover in 1984	1993-2002 Unchanged land cover (ha)	% Cover change in1993
Riverine forest	484.1	9.4	936.3	9.8
Woodland	3164.3	25.9	2214.0	19.5
Scrubland	11052.2	39.9	10584.0	45.8
Grassland/Settlement	1814.4	12.9	4164.0	33.5
Bareland/Rock	680.0	9.1	3672.8	36.3

Table13: Differences in the rates of change between the periods of 1984 to 1993 and 1993 to 2002 in the Kimisi and Burigi Game Reserves.

1984-	1993-	1984-1993	1993-2002	1993-	1984-1993
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Land cover	1993 Area changed (ha)	2002 Area changed (ha)	and 1993-2002 Difference in changed area (ha)	% change rate	2002 % change rate	and 1993-2002 Difference in change rate
Riverine forest	4365.1	-4608.8	-8973.9	9.4	-5.4	-14.8
Woodland	-840.4	-1374.6	-534.2	-0.8	-1.3	0.5
Scrubland	-5576.3	5895.1	11471.4	-1.8	2.8	4.6
Grassland/ settlement	-1569.0	3292.3	3661.3	-1.2	2.9	4.1
Bareland/ rock	2620.6	-3203.9	-5824.8	3.9	-3.5	0.4
Total	-1000.0	0.1	-200.2	9.5	-4.5	-5.2

4.3.2.2 Woodland

Results indicate that the area covered with woodland in the study area decreased from 12 216.1 hectares in 1984 to 11 375.4 hectares in 1993. The overall decrease during this period of nine years was 840.4 hectares with an average decrease rate of 0.8% per year (Table 9 and Fig. 10). The reason for this decrease is perhaps due to human activities in the Kimisi Game Reserve which by then was a Game Controlled Area. In Game Controlled Areas human activities such as residence, grazing, tree cutting, settlement and farming are not prohibited by the Wildlife Conservation Act No. 12 of 1974 (URT, 1974).

Results indicate that the period after refugees lived in the study area there was a decrease in woodland from 11 374.7 hectares in 1993 to 10 001.1 hectares in 2002 with the decreased area of 1374.2 hectares with an average decrease rate of 1.3% per year

(Tables 9, 10 and Fig. 11 and 12). The 534.2 hectares is the difference between the changes in woodland before and after refugees lived in the area (Table 13). The results imply that during this period there were many disturbances to the woodlands. The expected rate of change in the period after refugees lived in the area should be the same as that of the period before refugees lived in the area which is 0.8% per year if other factors were to remain the same as those of the period before refugees lived in the area.

The difference in percentage change rate per year between the periods before and after refugees influxed the study area is 0.5 % (Table 13). Therefore the difference in the rate of change between the two periods is probably due to refugees activities in the study area. Similar observations have been reported by Glew and Hudson (2007) that approximately 35 000 ha of timber were used to support officially recorded UN refugees in the Sub-Saharan region. Refugees' activities involved tree cutting for firewood and clearing forests for cultivation. Likewise, UNEP (2005a) reported that surveys in western Tanzania found that refugees used an average of 2.8 kilograms of wood per person per day, whereas local host communities used just 1.7 kilograms of wood per person per day. The refugees who were hosted at the great Benaco refugees' camp cleared the woodland in order to get their daily basic needs which included firewood, building poles and settlement area. Therefore the 0.5% decrease rate per year is possibly associated with refugees' activities in the area from 1994 to 2002.

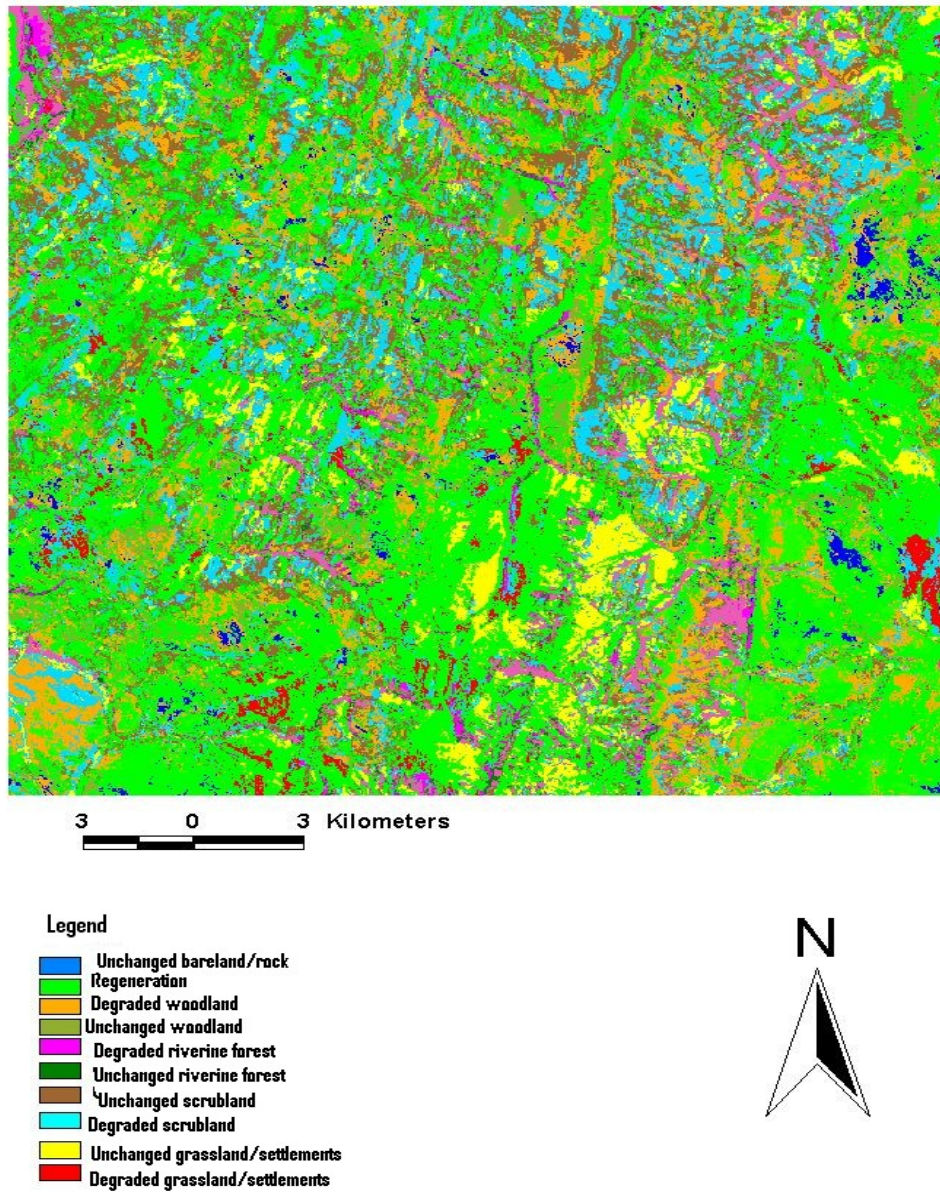


Figure 11: Land cover detection map from satellite image between the period of 1984 and 1993 in the Burigi and Kimisi Game Reserves.

(Source: USGS USA Department of the Interior and USA Geological Survey 2006).

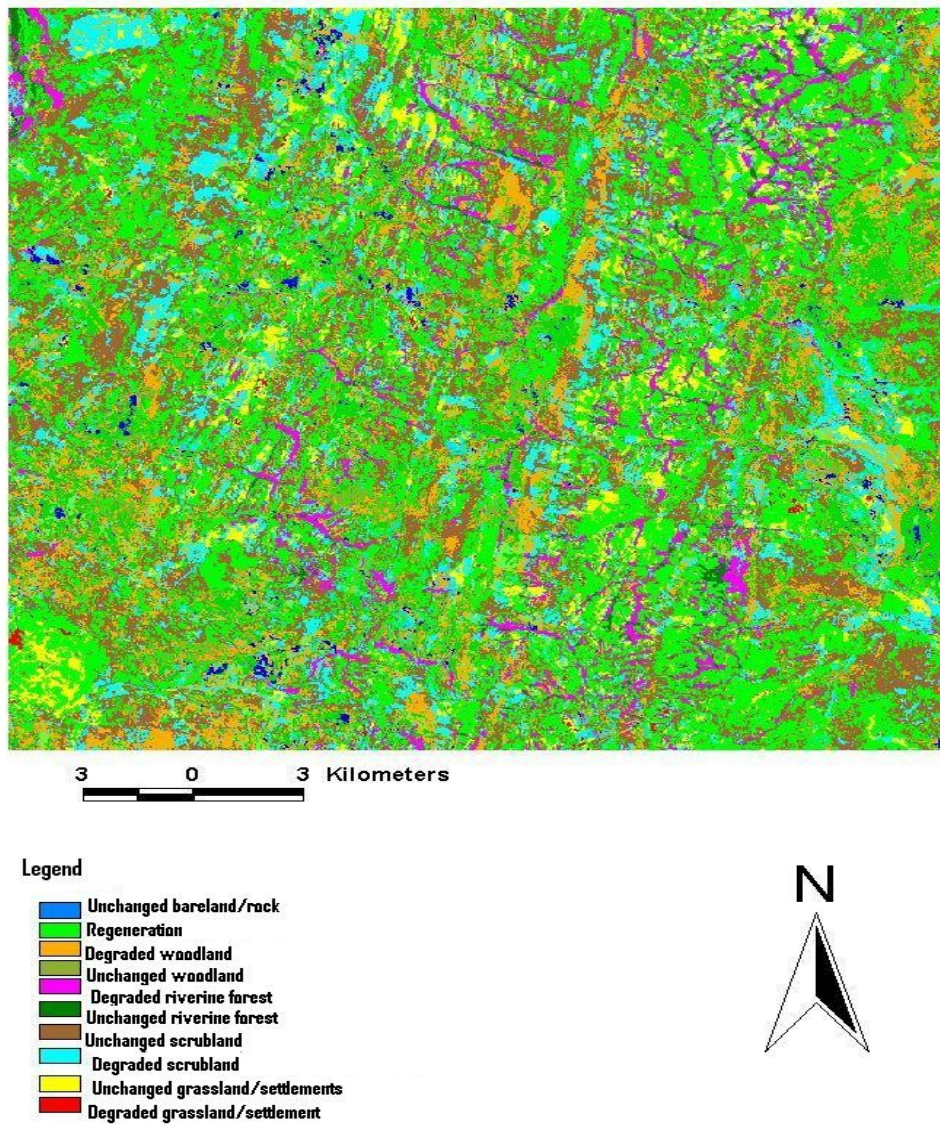


Figure 12: Land cover detection map from satellite images between the period of 1993 and 2002 in the Kimisi and Burigi Game Reserves.

(Source: USGS (USA Department of the Interior and USA Geological Survey 2006))

4.3.2.3 Scrubland

Results indicate that there was a decrease of scrubland from 27 688.3 hectares in 1984 to 22 111.9 hectares in 1993 (Table 10). The overall decrease during this period was 16.3%

with a decrease rate of 1.8% per year. The decrease of scrubland most likely had been caused by fewer disturbances in the area which led to the change of 2 648.3 and 3 714.3 hectares of scrubland into riverine forest and woodland respectively (Table 11 and Fig. 11). However, within the same period 6 525.2 and 4 648.3 hectares of scrubland were changed (degraded) into grassland/settlement and bareland/rock respectively (Table 14 and Fig.12).

Table 14: Degraded land covers between the periods of 1984 to 1993 and 1993 to 2002 in the Kimisi and Burigi Game Reserves.

Types of degraded land covers to other covers	1984 – 1993 Degraded land cover (ha)	% of cover of 1984	1993-2002 Degraded land cover (ha)	% of cover of 1993
Riverine forest to woodland	406.1	7.8	2 170.6	22.7
Riverine forest to Scrubland	1 706.8	33.0	3 349.9	35.1
Riverine forest to Grassland/settlements	621.7	12.0	2 203.6	23.1
Riverine forest to Bareland /Rocks	1 955.3	37.8	878.8	9.2
Woodland to Scrubland	3 020.0	24.7	5 643.6	49.6
Woodland to Grassland/Settlements	2 005.4	16.4	1 598.9	14.0
Woodland to Bareland/Rock	1 191.8	9.7	1 259.1	11.0
Scrub to Grassland	6 525.2	23.6	5137.0	22.2
Scrub to Bareland/Rocks	4 648.3	16.8	1 674.6	7.2
Grassland/Settlement to Bareland/Rocks	1 655.3	11.8	1 638.4	13.2

In 2002 it was observed that the area covered with scrubs increased to 29 007.1 hectares compared with 23 111.9 of 1993 with an overall increase of 25.5% equivalent to an

average increase rate of 2.8% per year (Table 10 and Fig.10). The area covered with scrubs during the period of 1993 and 2002 increased by 5 895.1 hectares. This increase is the outcome of (degrading) changing of riverine forest and woodland into scrubland and changing (regenerating) of grassland/settlements and bareland//rock into scrubland (Tables 10, 11 and Fig. 11).

The degraded scrubland during this period was 29.4% of the 1993 scrubland and the unchanged scrubland was 39.9% (Table 12 and 14). The increased scrubland during the period of 1993 and 2002 is most likely due to disturbance of refugees to the study area. Moreover, the 11 471.4 hectares difference in the changed area between the periods before and after refugees lived in the area is probably due to refugees' activities to the scrubland (Table 13).

The difference in riverine forest and woodland degraded area between these two periods implied higher rate of riverine forest and woodland utilization in the study area. The total of 4 266.7 hectares which were added to scrubland during the period of 1993 and 2002 was the outcome of refugees activities on riverine forest and woodland. Refugees' activities involved cutting trees for firewood and clearing forests for cultivation. This is because refugees used whichever available environmental resources in order to acquire their basic needs. Similar observations have been reported by UNEP (2005a) that the DRC government estimated that the South Kivu region lost 3 750 hectares of woodland within three weeks of arrival of refugees.

4.3.2.4 Grassland/settlement

Results indicate that grassland decreased from 14 012.0 hectares in 1984 to 12 443.0 hectares in 1993 with a decreased area of 1 569.0 hectares at an overall decrease of -11.2% with an average rate of decrease of -1.2% per year (Table 9 and Fig. 10). This implies fewer disturbances in the study area. The decrease in grassland within this period is likely to be caused by to regeneration (Table 11 and Fig. 11). A total of 10 542.5 hectares of grassland/settlement changed (regenerated) into scrubland, woodland and riverine forest. These changes included changing of 2 827.4 hectares of grassland/settlement to riverine forest, 2 714.4 hectares of grassland to woodland and 5 000.7 hectares of grassland/settlement to scrubland (Table 10). However, only 1 814.4 hectares of grassland/settlement remained unchanged (Table 12).

It is evident from Tables 11 and 14 that grassland increased from 12 443.0 hectares in 1993 to 15 735.3 hectares in 2002. The average rate of increase during this period was 4.1% per year higher than that of the period before refugees influxed the area which was -1.2% per year (Tables 9 and 13). The difference in land covered by grassland/settlement between the periods before and after refugees influxed the study area was 3 661.3 hectares (Table 14). This change possibly had been caused by refugees' activities.

4.3.2.5 Bare land/rock

Results indicate that bare land/rock area increased to 10 130.1 hectares in 1993 from 7 510.2 hectares in 1984 at an average increase rate of 3.9% per year. Moreover, the bare land/rock area decreased to 6 926.9 hectares in 2002 from 10 130.1 hectares in 1993

with a decreased area of 3 203.2 hectares at the average decrease rate of 3.5% per year (Fig. 10, Table 9 and 10). Bareland/rock decreased by 583.3 hectares in a period of eighteen years from 1984 to 2002. This was a decrease rate of 0.1% per year. The difference between the rate of change before and after refugees lived in the area is negative, this implies that there was a decrease in bare land/rock area during the period of 1993 to 2002 (Table 13).

The cause of decreasing rate of bareland/rock before and after refugees' influx is not clear probably this can be due to the increase of the world temperature by 0.5°C in the early 1990s and the heavy El-Nino rains respectively. These findings are supported by findings of Hansen *et al.* (1999) that in the 1990s the world was hotter than any time in record history, whereas the global surface temperature has increased by 0.5° C since 1975.

During the period of 1984 to 1993 the increase in world temperature may be contributed to the drying up of the grass (*Loudetia simplex*), and so increased the bare land/rock areas. The Kasulo village is the area, where refugees were residing (Lukole refugee camp) was the only place that was observed to be bare during the study. Since refugees were not settled inside the Burigi and Kimisi Game reserves it is not possible to say that they contributed to the decrease of the bare land in the reserves, because no cultivation is allowed inside the game reserves (URT, 1974). Moreover, no settlement or cultivation activity was reported or observed in the reserves. During the survey it was observed that the steep hilly slopes of Burigi and Kimisi Game Reserves were rocky with shallow soils. Likewise it has been reported by URT (2006) that, the areas which are mostly

found bare in the Burigi and Kimisi protected areas are the extensive steep rocky hill slopes. Perhaps refugees did not cause an increase of the bareland/rock area in the reserves.

CHAPTER FIVE

5. CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The findings from this study show that establishment of refugees camps, farming, hunting, grazing, tree cutting, setting of forest fire and encroachment to protected areas resulted into a decrease in wildlife populations and habitats of the Burigi and Kimisi Game Reserves. The slash and burn practices of the Ngara district local communities was also reported to affect wildlife habitats of the Burigi and Kimisi ecosystem along with the influx of refugees.

The populations of buffalo, bushbuck, eland, Bohor reedbuck, topi, warthog, waterbuck and zebra was negatively impacted by refugees activities in the Burigi and Kimisi Game Reserves. These species were hunted for meat by refugees from the Msuhura, Benaco, Lukole, Lumasi and K-9 refugee camps. This could be attributable to the camps being close to the game reserves. For instance, Msuhura camp was just two kilometres from Burigi Game Reserve. However, elephant and impala populations were not impacted by refugees, whereas the giraffe population was the last target after all other species had declined.

Results of this study derived from satellite land use/cover detection analysis showed that four types of wildlife habitat with total area of 24 640.8 hectares were affected by refugees. These wildlife habitats were riverine forest 8 973.9 hectares, woodland 534.2 hectares were deforested, scrubland increased by 11 471.4 hectares and an area of 3 661.3 hectares was changed to grassland from other wildlife habitat types. However, refugees did not cause bareland in the Burigi and Kimisi Game Reserves.

This study demonstrates the impact of refugees on wildlife populations and habitats. This is especially obvious for edible and megafauna which cannot sustain hunting offtake and modified environment. The increase of population of elephant in the Burigi and Kimisi Game Reserves was not necessarily due to natural increase, instead could be attributable to immigration from Akagera National Park of Rwanda and Ruvubu National Park of Burundi. The emigration could have been caused by rebels disturbances in the Akagera and Ruvubu National Parks in the early 1990s. Nonetheless, remote sensing and GIS were found to be very useful tools for quantifying and locating degradation and regeneration of wildlife habitats such which included riverine forest, woodland, scrubland, grassland, bareland and rocks) in the study area.

5.2 Recommendations

The following recommendations are based on the current study:

- Refugees' camps should be established at least thirty kilometres from boundaries of protected areas to reduce the negative impact of refugees on protected natural resources.
- UNHCR, WFP and other relief international organizations should provide refugees with varieties of protein foods instead of providing them with only beans and peas as it was done on the refugees at the great Benaco refugees camps. Provision of varieties of proteins to the refugees could minimize

temptations for them to poach in PAs. This will help to protect wildlife populations of host countries to from being heavily poached by hosted refugees.

- Mitigating the loss of wildlife habitats and biodiversity need conservation authorities, institutions, politicians, academicians and all local Tanzanians to work together as a team without leaving the burden of improving the degraded areas to the government.
- Before starting rehabilitation process in the degraded areas, thorough environmental impact assessments should be conducted involving key stakeholders starting from village level to national level, instead of leaving this activity to conservation organizations, NGOs, UNHCR and central government only.
- The Wildlife Division Data bank of Tanzania should be equipped with satellite images of all her game reserves at least one scene per year for resource monitoring and management purposes.
- A study is required to specifically find out the cause of eland decline in the Burigi and Kimisi Game Reserves.

- Further ecological studies/fire ecology should be undertaken in order to understand the role of fire in the maintenance of vegetation of Burigi and Kimisi Game Reserves.
- The Wildlife Division should prepare and implement an operational fire Management Plan in the Game Reserves.

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APPENDICES

Appendix 1: Animal counting in and outside of Burigi and kimisi Game Reserves

Name of species	Sighting frequencies	Remarks
Aardvark (<i>Orycteropus afer</i>)	3	Sighted in the protected area only Burigi block D
Olive baboon (<i>Papio anubis</i>)	15	Sighted in and outside protected area within the buffer zone of Kimisi Game Reserve
Buffalo (<i>Syncerus caffer</i>)	6	Sighted only in protected area Kimisi block C.

Common duiker (<i>Sylvicapra grimmia</i>)	13	Sighted in protected area only (blocks B& D)
Elephant (<i>Loxodonta africana</i>)	50	Sighted in and outside the Reserves within the buffer zone of Kimisi Game Reserve.
Bohor Reedbuck (<i>Renduca renduca</i>)	32	Sighted in all blocks except block H
Roan antelope (<i>Hippotragus equines</i>)	1	Sighted in protected area block E
Oribi (<i>Ourebia ourebi</i>)	3	Sighted in and outside protected area within the buffer zone of Kimisi Game Reserve
Zebra (<i>Equus burchellii</i>)	7	Sighted in protected area only in Block B

Appendix 2: Poachers arrested for the period of 1990 – 2006 in Burigi and Kimisi game reserves

Year	Poachers arrested	Refugee poachers arrested	Local poachers arrested	Number of animals poached	Species of poached animals	Collected Snares, machetes, bows & arrows	Types of firearms Rifles and muzzle loaders	Automatic guns
1990	3	0	3	2&10 baskets of fish	2 Impala & 10 baskets of fish	-	-	-
1991	17	0	17	20	16 Impala & 2 Topi	-	-	-
1992	18	0	18	15	11 Impala, 1 Topi, & 3 Warthogs	-	-	-
1993	8	0	8	33	1 Lesser Kudu, 24 Impala, 5 Topi, 2 Bushbuck & 1 Zebra	-		-
1994	48	40	8	38	2 Waterbuck, 1 Buffalo, 1 Bushbuck, 17 Warthogs, 6 Zebra & 11 Impala	160 Snares	1 *ML	1 SMG *Rwd RFG
1995	168	104	68	130	43 Topi, 78 Impala, 7 Zebra, 2 Oribi, & 2 Bushbuck	611 Snares	1 *ML	1 G3 & 1 Magazine of SMG
1996	294	224 Escapees (Rwandese refugees)	70	10	1 Hippo & 9 Impala	279 Snares & 51 Bows and arrows	3 *ML	
1997	21	1	20	6 & 1 Basket of Cat fish	1 Baskets of fish, 1 Warthogs, 1 Reedbuck, 1 Buffalo,	30 Snares 26 Bows and arrows	9 *ML	-

Year	Poachers arrested	Refugee poachers arrested	Local poachers arrested	Number of animals poached	Species of poached animals	Collected Snares, machetes, bows &	Types of firearms Rifles and muzzle loaders	Automatic guns
					1 Zebra & 2 Impala			
1998	54	27	27	8 & 1 Basket of Catfish	1 Impala, 3 Zebra, 4 Reedbuck & 1 Basket of Catfish	79 Snares & 69 Bow and arrows	1 *ML	-
1999	56	28	28	20	1 Leopard, 1 Topi, 9 Impala, 2 Baboons, 2 Porcupines, 1 Duiker, 2 Warthogs & 2 Oribi	78 Snares & 36 Bows and arrows	2 *ML	1 SMG
2000	25	13	22	18 & 3 Baskets of fish	5 Impala, 1 Buffalo, 1 Hyena, 1 Bush pig, 4 Zebras, 1 Waterbuck, 2 Bushbucks, 1 Oribi & 3 Basket of Fish	217 Snares & 42 Bows and arrows	5 *ML	-
2001	58	10	48	12	2 Warthogs, 1 Buffalo, 1 Elephant, 1 Topi & 7 Impala	113 Snares & 42 Bows and arrows	6 *ML	-
2002	40	10	30	17 & 3 Baskets of fish	2 Warthogs, 12 Impala, 1 Zebra, 1 Reedbuck, 1 Duiker & 3 Baskets of Fish	321 Snares and 37 Bows and arrows	3 *ML	-
2003	34	11	23	18	10 Impala, 5 Bushbucks, 1 Zebra, 1 Duiker & 1 Warthogs	128 Snares & 17 Bows and arrows	2 *ML	-

Year	Poachers arrested	Refugee poachers arrested	Local poachers arrested	Number of animals poached	Species of poached animals	Collected		
						Snares, machetes, bows &	Types of firearms Rifles and muzzle loaders	Automatic guns
2004	32	6	26	8	1 Dik dik & 7 Impala	47 Snares & 19 Bows and arrows	1 *ML	-
2005	64	11	53	20	1 Zebra, 4 Impala & Warthogs	206 Snares & 25 Bow and arrows	-	-
2006	29	15* Rwandese citizens		2 and 2 Baskets of fish	2 baskets of fish, 1 Reedbuck & 1 Bushbuck	-	-	-
Total	969	522	447					

*ML Muzzle loader

SMG Sub -Machine Gun

G3 Automatic Gun

Appendix 3: Game rangers patrol capacity for Burigi and Kimisi from 1993 to 2006

Number of game rangers	Year	Patrol area per game ranger (km ²)	Total patrol area (Burigi and Kimisi) km ²	Reserves patrol capacity in percentage	Extra area for a game ranger km ²
38	1993	25	4 698.2	20.2	98.6
38	1994	25	4 698.2	16.5	98.6
31	1995	25	4 698.2	16.5	126.6
31	1996	25	4 698.2	16.5	126.6
31	1997	25	4 698.2	16.5	126.6
24	1998	25	4 698.2	12.8	170.8
24	1999	25	4 698.2	12.8	170.8
24	2000	25	4 698.2	12.8	170.8
24	2001	25	4 698.2	12.8	170.8
24	2002	25	4 698.2	12.8	170.8
24	2003	25	4 698.2	12.8	170.8
24	2004	25	4 698.2	12.8	170.8
25	2005	25	4 698.2	13.3	162.9
25	2006	25	4 698.2	13.3	162.9

* Game ranger patrol capacity is 25 km² per game ranger per day. This is the Wildlife Division patrol standard.

Appendix 4: Main sources of wood products (fuel wood, building materials etc.) (n=260 Respondents)

Source	Frequency	Percentage
Community forest*	249	95.8
Homestead woodlots	56	5.8
Village forest reserves**	15	21.5
Burigi and Kimisi Game Reserves	11	4.2
Clan forest	4	1.5
Others	3	1.2
Total	338	130.0

* Utilization of the resources like fire wood and no forest product is allowed

**Utilization of forest resources is strictly prohibited by village government.

Note: The total responses for frequencies 338 and percentage (130.0%) are greater than 260 and 100% respectively due to multiple responses.

Appendix 5: Natural resources harvested illegally from Burigi and Kimisi Game Reserves (n=260 Respondents)

Type of resource	Frequency	Percentage
Fish	5	1.9

Charcoal	1	0.4
Timber	26	10.0
Building material	3	1.2
Wild meat	42	16.2
Skins	18	6.9
Firewood	3	1.2
Honey	7	2.7
Medicinal plants	4	1.5
Fruits	7	2.7
None	198	76.2
Total responses	340	110.0

Note: The total responses for frequencies 340 and percentage (110.0%) are greater than 260 and 100% respectively due to multiple responses

Appendix 6: Chi-square tests respondents' views on land size used by households

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	759.566	64	0.000
Likelihood Ratio	408.583	64	0.000
Linear-by-Linear Association	167.319	1	0.000
N of Valid Cases	260.000		

Appendix 7: Animal species which were commonly found in the study area before refugees influxed the area (n=260 Respondents)

Animal species			
Common name	Scientific name	Frequency	Percentage
Lion	<i>Panthera leo</i>	70	26.9
Buffalo	<i>Syncerus caffer</i>	183	70.4
Bush pig	<i>Potaocherus porcus</i>	179	68.8
Bushbuck	<i>Tragelaphus scriptus</i>	171	65.8
Zebra	<i>Equus burchellii</i>	35	13.5

Elephant	<i>Loxodonta africana</i>	49	18.8
Vevet monkey	<i>Cercopithecus aethiops</i>	118	45.4
Olive baboon	<i>Papio anubis</i>	155	59.6
Impala	<i>Aepyceros melampus</i>	203	78.1
Eland	<i>Taurotragus oryx</i>	22	8.5
Porcupine	<i>Hystrix afriaeaustrallis</i>	27	10.4
Topi	<i>Damaliscus korrigum</i>	22	8.5
Waterbuck	<i>Kobus defassa</i>	41	15.8
Leopard	<i>Panthera pardus</i>	26	10.0
Warthog	<i>Phacochoerus africanus</i>	52	20.0
Bohor reedbuck	<i>Renduca renduca</i>	17	6.5
Duiker	<i>Sylvicarpa gramma</i>	51	19.6
Hippo	<i>Hippopotamus amphibius</i>	15	5.8
Total		1436	552.0

Note: The total responses for frequencies 1436 and percentage (552.0%) are greater than 260 and 100% respectively due to multiple responses.

Appendix 8: Animal species which were commonly found in the study area after refugees influxed the area (n=260 Respondents)

Animal species			
Common name	Scientific name	Frequency	Percentage
Lion	<i>Panthera leo</i>	70	26.9
Buffalo	<i>Syncerus caffer</i>	174	66.9
Bush pig	<i>Potamochoerus porcus</i>	149	57.3
Bushbuck	<i>Tragelaphus scriptus</i>	131	50.4
Zebra	<i>Equus burchellii</i>	35	13.5
Elephant	<i>Loxodonta africana</i>	46	17.7
Vevet monkey	<i>Cercopithecus aethiops</i>	80	30.8
Olive baboon	<i>Papio anubis</i>	122	46.9
Impala	<i>Aepyceros melampus</i>	135	51.9
Eland	<i>Taurotragus oryx</i>	21	8.1
Porcupine	<i>Hystrix afriaeaustrallis</i>	23	8.8
Topi	<i>Damaliscus korrigum</i>	22	8.5
Waterbuck	<i>Kobus defassa</i>	39	15.0
Leopard	<i>Panthera pardus</i>	23	8.8
Warthog	<i>Phacochoerus africanus</i>	48	18.5
Bohor reedbuck	<i>Renduca renduca</i>	15	5.8

Duiker	<i>Sylvicapra gramma</i>	35	13.5
Hippo	<i>Hippopotamus amphibius</i>	13	5.0
Total		1181	454.2

Note: The total responses for frequencies 1181 and percentage (454.2%) are greater than 260 and 100% respectively due to multiple responses.

Appendix 9: Problems caused by refugees in the study area (n=260 Respondents)

Category label	Count	Percentage of cases
Deforestation	226	86.9
Insecurity	267	102.7
Diseases	95	36.5
Destruction of water sources	62	23.8
Poaching	176	67.7
Raping	38	14.6
Soil erosion	41	15.8
Food shortage	65	25.0
House abandoning	43	16.5
Forest fire	23	8.8
None	12	4.6
Total	1048	403.0

Note: The total responses for frequencies 1048 and percentage (403.0%) are greater than 260 and 100% respectively due to multiple responses.

Appendix 10: Household leader questionnaire

Date District

Division Ward

Village Respondent's number

1. Household background information
 - 1.1 Household leader characteristics:
 - a) Sex: 1. Male
 2. Female.....
 - b) Age
 - c) Tribe
 - 1.2 Size of household
 - a) What are the main household sources of environmental resources? (Fuel wood, forest fruits, building materials),.....,
 - 1.3 Do you own land?
 - 1.4 What was the size of your land before refugees influx?.....
 - 1.5 What is the size of your land now.....
 - 1.6 How did you acquire your land?
 - 1.7 Who own the household land?
 - 1.8 Who traditionally owns the land in your area?
 - 1.9 Who allocate land
 - 2.0 Food
 - 2.1 Do you use environmental resources to supplement the family food? eg fruits,
 1. Yes 2. No
 - 2.2 If Yes, from what sources?
 - Forest reserve 2. Public forests.....3. Sacred forest.....
 4. Family/clan forest
 5. Game reserve..... 6. Other type
 - 3.0 Uses of Burigi and Kimisi Game Reserves.
 - 3.1 What do you get from Burigi and Kimisi Game reserves?
 - 1.....2.....34.....

3.2 Which plant species are no longer found in your village after refugees in fluxed the area? 1..... 2..... 3
4..... 5..... 6.....

3.3 What was the vegetation cover status before and after the refugees living in the area?

		Before refugees	After refugees
Highly deforested	1		
Moderate deforested	2		
Less deforested	3		
Not deforested	4		

3.4 Are the Human activities of the have negative impact to the Burigi and Kimisi ecosystem?

1. Yes 2. No.

3.5 If yes, mention the activities, how they affect the species, water, environment etc?

<u>Activity</u>	<u>Effect</u>
.....
.....

4.0 Wildlife population

4.1 What were the common animal and bird species found in your village before the refugees in-fluxed the area? 1..... 2.....
3..... 4.....5
6.....

4.2 Of the above mentioned species which ones are no longer common found in the area after the refugees' influx? 1..... 2.....
3..... 4.....
5.....6.....

5.0 Social impact of refugees

5.1 Do you know any problems, which were caused by refugees in the Reserves and in your village?

Yes.....No.....

5.2 If yes, what are the problems?

1.2.....3.....

5.3 How many wetlands sites were there in your village before the refugees lived in the area?

5.4 How many wetlands remained after the refugees in fluxed the area?

5.5 What is the soil status before and after the refugees in-fluxed the area?

	Before refugees	After refugees
Highly eroded	1	.
Moderate eroded	2	
Less eroded	3	
No erosion	4	

Appendix 11: Check list for key informants

Number of respondent.....Title.....Organization.....

What are the environmental problems caused by refugees’ influx in the Burigi and Kimisi ecosystem?

a)b).....c).....e).....

2.0

2.1 Did the refugee’s activities in the area have negative impact to the game reserves, and community at large?

If yes, what are these impacts?

.....

2.2 What are the major factors that accelerate refugees’ activities which negatively affected environment?

Lack/ inadequate income..... Key= Rank the factors according to their
 Ignorance about refugees’ problems..... priorities 1-5
 Inadequate personnel.....
 Inadequate funding.....
 Uncoordinated police.....

3.0 Are there any costs involved in rehabilitating area under refugee’s activities?

4.0 If yes who is incurring the costs.....

5.0 Is the money available always and enough for such activity?

1= Yes.....

2=No.....

6.0 How many refugees were received in the refugee camps between 1994 and 2006?

.....

7.0 What are their countries of origins?

8.0 If there is any problems/issue regarding refugees, does your institution collaborate to solve the issue

9.0. What are the sources of energy for refugee camps?

10. What quantity of fuel wood needed by each refugee camp per week, per month and per year?

11. What are the types of foods eaten by refugees?

12 What is the source of proteins for the refugees?

13. What animal species were common before refugees in fluxed your area?

14. What animal species are now common in your area?

15. What plant species were common in your area before refugees’ influx?

16. What plant species are no longer found in your area after refugees’ influx?

17. What human activities cause environmental degradation in your area?