IMPLICATIONS OF BIODIVESITY CONSERVATION ON FOOD SECURITY AROUND VOLCANOES NATIONAL PARK, RWANDA

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DECLARATION

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This thesis is my original work and has not been presented for a degree in any other university or for any other award.

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DEDICATION

This thesis is dedicated to my late father and my mother for their love and wisdom that made me who I am today. I also, dedicate it to my husband, children, extended family members and friends for their lovely support.

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ACRONYMS

ACF	Advocacy Coalition Framework
CARI	Consolidates Approach for Reporting Food Security Indicators
CBD	Convention on Biological Diversity
CFSVA	Comprehensive Food Security and Vulnerability Analysis
COVID-19	Coronavirus Disease 2019
DFGFI	Dian Fossey Gorilla Fund International
DFID	Department for International Development
ENVI	Environment for Visualizing Images
ESRI	Environmental Systems Research Institute
FAO	Food and Agriculture Organization of United Nations
GIS	Geographical Information System
GPS	Global Positioning System
HH	Household
ICDP	Integrated Conservation and Development Projects
IFAD	International Fund for Agriculture Development
IGCP	International Gorilla Conservation Programme
ILF	Integrated Landscape Framework
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IUCN	International Union for Conservation of Nature
KRC	Karisoke Resaerch Center
MAB	Man and Biosphere Reserves

MGVP	Mountain Gorilla Veterinary Project
MIGEPROF	Ministry of Gender and Family Promotion
MINAGRI	Ministry of Agriculture and Animal Resources
MOE	Ministry of Environment
LPG	Liquefied Petroleum Gas
LULC	Land Use and Land Cover
NGOs	Non-Government Organizations
NISR	National Institute of Statistics of Rwanda
NOAA	US National Oceanic and Atmospheric Administration
NST1	National Strategy for Transformation-1
OECD	Organization for Economic Cooperation and Development
ORTPN	Office Rwandais du Tourisme et des Parcs Nationaux
PAs	Protected Areas
PES	Payments for Ecosystem Services
RDB	Rwanda Development Board
REMA	Rwanda Environment Management Authority
RWF	Rwandan Francs
SACOLA	Sabyinyo Sustainable Livelihoods Association
SDGs	Sustainable Development Goals
SL	Sustainable Livelihoods
SLF	Sustainable Livelihoods Framework
SWOT	Strengths, Weaknesses, Opportunities and Threats
UK	United Kingdom
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization

UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
USD	United States Dollars
VNP	Volcanoes National Park
WFP	World Food Program
WWF	World Wide Fund for Nature

DEFINITION OF KEY TERMS

Biodiversity: A variety of animal and plants living in a given habitat or in the world.

Conservation: Protecting biological diversity, maintaining and restoring biodiversity habitats, protecting species from extinction and enhancing provisioning of ecosystem services.

Food security: food security means that everyone has social, physical and economic access to safe, sufficient and nutritious food that fits their dietary needs and food preferences for a healthy and active life at all times (FAO, 1996).

Integration: Act of combining different things into one effectively.

Institutional framework: the system of regulations, laws, procedures and stakeholders and their norms and roles, that shape socioeconomic behavior and activity.

Land use change: A process by which humans modify the natural landscape.

National Park: A natural area created by governments to protect and conserve biodiversity.

Policy: A set of ideas or a plan that a government, a business company, a group of people or a political part has publicly committed to.

Sector: Also referred to as administrative unit: Administrative units in Rwanda include Villages, Cells, Sectors, Districts, Provinces and finally Country.

ABSTRACT

This study investigated the implications of biodiversity conservation on food security around Volcanoes National Park in Rwanda. The objectives of this study were to examine existing policy and institutional framework in relation to biodiversity conservation at Volcanoes National Park and local food security, examine the effects of changes in land use on Volcanoes National Park and evaluate the contribution of benefits from Volcanoes National Park to local food security. It was guided by the Sustainable Livelihoods and Integrated Landscape Frameworks. To address the research objectives, it used mixed research methods. First, quantitative data involved conducting a survey with a sample size of 400 households, and collection of remote sensed data. Secondly, qualitative data was collected from 21 key informants and 10 focus groups. The study area comprised of a belt of 0km-5km and 5.1km-10km from the park edge to outside to enable comparison of findings in the vicinity of the park and places far away. Policy action gaps and institutional challenges were analyzed using desk review while trends in land use and cover changes from 2000 to 2019 were analyzed using Exelis Environment for Visualizing Images software. Furthermore, food security was analyzed using the Consolidated Approach to report the Food Security Indicators. Analyzed data were statistically presented in the form of figures, tables and maps for easy interpretation. The findings revealed that several policy documents do not mention food security and different institutions did not consider food security in their interventions. Out of the 7 policy documents analyzed, only the wildlife and biodiversity policies, mentioned food security in relation to conservation of protected areas. The study reveals that the geospatial dynamics that took place in the past 19 years inside the park and in a 10-kilometer belt around the park caused big transformations in the landscape. Over time, in some areas, forests and woodlots have been replaced by agriculture and grassland, while in other areas they have been taken over by buildings. The 5.1km-10km belt lost 92.29% of its forest and woodlots while the 0km-5km radius lost 92.52% between 2000 and 2019. Although reforestation efforts are more in 0km-5km belt than in 5.1km-10km belt, deforestation-re-afforestation ratio remains wide around the park (12:1 in 5.1km-10km and 6:1 in the 0km-5km). The Volcanoes National Park's biodiversity is at risk as local people continue to enter the park for trees and bamboo harvesting for firewood, construction and bean poles. Therefore, re-afforestation efforts need to be increased in the two belts around the park to reduce human pressure on its resources. This study reveals that while food security is an important issue that has received a lot of attention in different Rwandan government institutions, its application in Volcanoes National Park's conservation is minimal. The results also show that 71% of local people around the Volcano National Park, are food insecure with most food insecure households located in the vicinity of the park, within the 0km-5km belt. Although the number of households that benefit from the National Park is still small at 38%, about 72% of them are found in the 0km-5km belt. This reveals that the community conservation and revenue sharing programmes are more invested in the vicinity of the park. Possible entry points to integrate food security into the conservation of Volcanoes National Park include the revision of existing policies, laws and ministerial orders and park management plans. It would also be important to raise local awareness about the

provisions of the policies, solve the crop raiding issue, create off-farm jobs around the park, increase access to clean water and improve agricultural production.

CHAPTER ONE

INTRODUCTION

1.1 Background to the study

Loss of biodiversity and food security are key issues of the twenty-first century (Glamann et al., 2015). Food insecurity remains a global challenge (FAO, IFAD, UNICEF, WFP, 2021). Estimates show that feeding the growing world population will require about 70% food production increase by 2050 (FAO, IFAD, & WFP, 2015). This puts a lot of pressure on both protected areas and arable land (WFP, 2015). Forest dependence by local people is the major cause of biodiversity loss and a big threat to natural resources in different parts of the globe (WWF, 2016; FAO, 2014). For years, rural communities have relied on wild animals, insects and plants for food. Bush meat and wild vegetables, honey, mushrooms, fruits, seeds and tubers provide a diet rich in nutrients to households around protected areas (FAO, 2014).

As the world population grows, human pressure on biodiversity will increase (Ganivet, 2020), thus threatening more species with extinction than ever before worldwide (Díaz et al., 2019). Humans continue to convert natural forests and other landscapes to farms, heavily poach wildlife and overexploit fish stocks (WWF, 2016). Since 1900s, native species have started to decline in major biodiversity habitats (CBD Secretariat, 2020) and there is no sign yet that this rate will decreased (WWF, 2016). For instance, Díaz et al. (2019) reports that in the tropics including Africa, where most biodiversity of global importance are found, about 32 million hectares of natural forests were cut down between 2010 and 2015 and indigenous species in major terrestrial habitats have reduced by about 20% with an average of about 25% of plant and animal species threatened. The same report suggests that around 1 million species worldwide are facing extinction and the situation can be restored only if the root causes of biodiversity loss are addressed. Otherwise, the rate of species extinction on the planet that is today tens to hundreds of times higher than it was 10 million years ago, will continue to rise, and this will heavily affect the contribution of ecosystem processes to people's livelihoods (Ceballos et al., 2015).

Concurrently, land degradation has caused the reduction of agricultural productivity in about 23% of the global terrestrial area (FAO, 2017). Human activities have altered about 75% of land surface leading to significant changes in ecosystems and rapid biodiversity loss (IPBES, 2019). Since 1970s, natural environment has been negatively impacted by land use changes, followed by excessive exploitation of plants, animals, and other organisms, primarily through unsustainable harvesting, poaching, hunting logging and fishing (Brouwer et al., 2023). The most common type of land use change is agricultural expansion, cropping and animal husbandry occupying more than a third of the earth's land surface. In addition, since 1990s, the rapid population growth has caused rapid urbanization and infrastructural development to the detriment of natural forests, grasslands and wetlands (CBD Secretariat, 2020).

The increasing shrinking of natural ecosystems and degradation of agricultural land exposes landscapes to climate change effects (Muluneh, 2021). This leads to failure of crops and biodiversity extinction due to increased frequency of extreme weather events (Díaz et al., 2019; Brussaard et al., 2010), thus, increasing food insecurity.

International policy commitments to simultaneously address biodiversity loss and food insecurity exist since decades and are reviewed over time. The recent ones comprise Convention on Biological Diversity (CBD)'s 20 targets for 2020 (CBD Secretariat, 2020) and Sustainable Development Goals (SDGs) (UNDP, 2015; Reed et al., 2016). In 2016, 193 countries of the world started implementing the ambitious, integrated 17 SDGs targeted to be reached by 2030. The aim of these goals was to get a sustainably developed planet where everybody will get what they need to survive and thrive while preserving natural resources so that our children and our children's future generations can enjoy them (UNDP, 2015, Reed et al., 2016). SDG 2 talks about achieving zero hunger through promotion of sustainable agricultural practices: allow equal access to land, support small holder farmers, allow markets access and, investing in technology and infrastructure to increase agricultural productivity (UNDP, 2015). On the other hand, SDG 15 stresses the need for action that would urgently reduce the loss of natural habitats

and biodiversity. The world failed to meet the Aichi biodiversity targets and it is off track to achieve the 2050 Vision for Biodiversity (CBD Secretariat, 2020). Many future scenarios show that trends of biodiversity loss will continue to worsen in response to rapid human population growth (Díaz Díaz et al., 2019).

Different scholars argue that the world should fight for hunger reduction and biodiversity conservation in a more integrated way because there is no way for overlooking one over the other (Mandima et al., 2011; Brussaard et al., 2010). Sustainable integration requires multi-dimensional and multi-sectoral approaches that treat biodiversity conservation and people as a unity (Mandima et al., 2011; Gaesing, 2009; Wondimu, 2006) in the broader context of rural development and sustainable livelihoods (Mandima et al., 2011).

As many other African countries, Rwanda adopted the international move to consider sustainability in the country development agenda. For instance, the strategy on climate resilience and green growth states that due to high population increase and changes in climate that have negative impacts on food production, energy resources and water, the future of socio-economic development of Rwanda is uncertain (Republic of Rwanda, 2011b). Also, the Rwanda Vision 2050 is for the country to become a high-income economy that is green, climate resilient and carbon neutral. Rwanda also recognizes that the country viability will dependent on biodiversity conservation and its contribution to food sovereignty, livelihoods, environment, health, country economy and cultural diversity (Republic of Rwanda, 2014).

The Rwanda national parks offer different kinds of benefits and prospects for local livelihoods, national economic growth and ecosystem services provision. For instance, before the COVID-19 pandemic, tourism was the country's top income earner with USD 489 million in 2019 (Butera, 2020). However, the challenge before the country is to manage these parks sustainably. Studies show that most of Rwandans still rely on biological resources for subsistence livelihood, including poaching and harvesting plants that they use as food, medicine, construction materials, fuel and sale for income (Republic of Rwanda, 2014; Munanura, 2013).

Despite this anticipated role and the current contribution to the national economy, natural resources in Rwanda especially national parks remain under pressure caused by rapid increase of the population (Plumptre et al., 2004). Protected areas have lost a considerable size of their surface over decades. Since 1950s, Nyungwe mountain forest lost 21% of its surface area (from 114,125 hectares to 90,000 hectares in 2005); the Gishwati natural forest 97% (from 21,000 hectares to 600 hectares in 2002); the Akagera National Park 73% (from 331,000 hectares to 90,000 hectares in 2005) and VNP 57% (from 35,000 hectares to 15,000 hectares in 2000) (Republic of Rwanda, 2014). In total, Rwanda lost over 60% of its national parks' land area over the past 40 years mainly due to agriculture development (Republic of Rwanda, 2013).

In Rwanda, food insecurity also remains an important issue (Republic of Rwanda, 2010a) affecting 19.7 % of households (Republic of Rwanda, 2018a). People around national parks depend on subsistence agriculture with land ownership averaging less than 0.3 hectares (Republic of Rwanda, 2012b). This land scarcity increases has led the local communities dependent on parks' resources for food supplies (Plumptre et al., 2004). Thus, the need to address this issue on biodiversity loss and food security in an integrated way, by assessing the status of food security around Volcanoes National Park in Rwanda (VNP) and its relationship with VNP conservation.

1.2 Problem Statement

The Rwanda food security status report (Republic of Rwanda, 2018a) reveals that Districts around VNP are among the districts with larger proportion of food insecure households and stunt children. For instance, Burera has the greatest number of households that are severely food insecure (6.5%). Nyabihu comes the 6th in food insecurity rate with 25.7% of food insecure households and the 2nd in malnutrition with 53% of stunt children. Also, the percentage of food insecure households in Rubavu District is above the country average (22%) and it is the 3rd district with highest stunting rate of 50%. Musanze District has better food security with a percentage below the country average of food insecurity (11.5%). However, the stunting rate (38%) is above the national average (35%).

The majority of households around the VNP are poor, with many members, with substandard housing, low levels of education, very small landholdings, food shortages with no surplus for market, and limited access to clean water and markets (Plumptre et al., 2004). According to different studies (Guinness, 2014; Munanura, 2013; Bush et al., 2010 and Plumptre et al., 2004), high level of poverty causes local people to become more dependent on VNP resources as a source of their livelihood. However, despite strong law enforcement, the locals community including, men, women and children enter VNP in search of bush meat, bamboo trees, wild honey, fuelwood, water and medicinal plants (Munanura 2013, Republic of Rwanda, 2015). This challenges the view that tourism of mountain gorillas has made a substantial contribution in addressing direct conservation threats to the National park (Munanura 2013 and Bush et al., 2010).

Poaching inside VNP has increased over time from 12 in 2009 to 34 in 2012 and 56 in 2015 (Republic of Rwanda, 2015). Only in 2015, 726 snares were destroyed, 18 bamboo cutters were arrested, and 1 gorilla was found caught in a snare. Participation of local community in park conservation activities is constrained by limited compensation of the damages caused by wildlife (Republic of Rwanda, 2015). The peak of illegal use of the park resources is encountered between May and September, the period that locals do not have enough food because they harvest in June/July and December/January (Bush et al., 2010).

While it is widely recognized that reducing human dependence on parks' resources requires tackling issues of biodiversity conservation and food security as interlinked, related studies are still limited making it difficult for decision-makers and practitioners to clearly define interventions (Glamann et al., 2017). Previous studies at VNP focused on consequences of conflicts between humans and wildlife in the conservation of biodiversity and development (Guinness, 2014); household poverty and forest dependence (Munanura 2013); impacts from community conservation interventions (Bush et al., 2010); the role of ecotourism in conservation (Sabuhoro, 2006); the socio-economic status of communities at VNP (Plumptre et al. 2004) and the socio-ecological issues in conservation of the park (Weber, 1987). Although these studies recommend addressing food insecurity to reduce human pressure on the park

resources, none of them focused on the link between biodiversity conservation in the national park and local community food security. These studies examined the relationship between local people and VNP conservation in the wider perspective of poverty without disaggregating indicators to be used to measure food insecurity. Thus, they do not provide precise recommendations that linking VNP conservation and local community food security. To address this knowledge gap, this study examined the contribution of benefits from VNP to local community food security. Thus, in order to gather evidence to influence policy, the study examined existing policies in relation to biodiversity conservation and local community food security at VNP.

Previous studies revealed that the issues of landlessness and land scarcity are among the barriers to household livelihoods around VNP (Munanura, 2013; Bush et al., 2010; Plumptre et al., 2004). However, none of them studied the effects of land use changes on VNP. The knowledge gap was whether land use changes that occurred between 1930s (when the park was created) and present at VNP reduced the threats to VNP or made the situation worse. To fill this knowledge gap, this study assessed the effects of changes in local land use on VNP conservation. However, it was limited to the period from 2000 to 2019 for the land use changes imagery for easy interpretation.

1.3 Research Questions

The following research questions guided this investigation:

i) How do the existing policies and institutional framework link biodiversity conservation in Volcanoes National Park with local community food security?
ii) How do the land use changes affect Volcanoes National Park?
iii) How do the benefits from Volcanoes National Park contribute to local food security?

1.4 Research objectives

The general objective of this study was to evaluate the implications of biodiversity conservation on food security around Volcanoes National Park in Rwanda. Specific objectives:

1. To examine the policy and institutional framework in relation to biodiversity conservation at Volcanoes National Park and local community food security

2. To assess the effects of land use changes in Volcanoes National Park

3. To evaluate the contribution of Volcanoes National Park to the local community food security

1.5 Hypotheses

i) The current policy and institutional framework of biodiversity conservation at Volcanoes National Park has no significant influence on local community food security;

ii) There is no significant relationship between land use changes and threats on Volcanoes National Park;

iii) The relationship between the status of food security in local communities and their benefits from Volcanoes National Park is not significant.

1.6 Significance of the study

Food insecurity is an important issue that different Rwandan government institutions that is both the central and local governments are well aware of and linking it to other programmes of the country development agenda is of paramount importance. Assessing the relationship between conservation of biodiversity and local community food security, serves as a baseline for long term monitoring at VNP and in the region. This study also provides useful recommendations for the possible review of biodiversity conservation and wildlife policies and institutional frameworks to better capture the linkage between local community food security and land use changes. This ensures sustainable conservation of VNP. This study indeed provides insights to the Rwanda Development Board (RDB), the Ministry of Agriculture and Animal Resources (MINAGRI) and, the Ministry of Environment (MoE) on how they can work to simultaneously conserve biodiversity and improve food security to ensure sustainability of VNP. Furthermore, it provides information for RDB, NGOs, private sector and local government to plan and implement biodiversity conservation and enhancement of local community food security programs in a more integrated way. This is expected to reduce human pressure on the VNP resources and thus improving its conservation.

1.7 Justification of the study

VNP is habitat of mountain gorillas (Gorilla gorilla beringei) that are of high conservation value due to their close genetic relationship with humans and their status as global flagship species for conservation (Plumptre et al., 2006). They are listed as Critically Endangered on IUCN red list (Owiunji et al., 2005). Mountain gorillas are also of high economic value to Rwanda as they cover 80% of the national tourism revenue, which is the country's top income earner with USD 489 million in 2019 (Butera, 2020). Despite this importance, local people remain poor and continue to put pressure on the park resources (Sabuhoro, 2006; RDB, 2015). While VNP is highly protected, protection measures alone cannot guarantee its sustainable conservation given that livelihoods drive conservation rather than simply being compatible (Brown, 2002). It is well documented that food shortages are the driving forces of illegal use of protected areas' resources and therefore hinders the long-term successful conservation (WWF, 2016). Changing this situation demands more than stronger law enforcement. It requires new social, economic, and environmental architecture (WWF, 2016) that takes into account the interdependency of biodiversity conservation and food security (Mandima et al., 2011). However, there is scanty literature about approaches to improve food security around national parks. This study provides a methodology that can be used elsewhere to investigate the interdependency of biodiversity conservation in protected areas and local community food security, increasing knowledge in this area. It provides findings that demonstrate how limited involvement of local people in policy development and related institutional framework reduces their support to policy implementation and exacerbates human-wildlife conflicts. This study also reveals how insufficient collaboration across sectors constrains food security and sustainable biodiversity conservation and how limited linkage of community conservation interventions to direct biodiversity threats undermines conservation efforts. This study delineates the impact of land use changes on VNP and local food security and provides a baseline for monitoring land use changes and food security around VNP and their impact on biodiversity conservation of this park. It demonstrates how successful long-term conservation of VNP depends on how local food security will be improved and the need to integrate

this interdependence in the VNP conservation agenda. This should start with revising regulatory framework to include provisions for food security mainstreaming and raising awareness of decision-makers in park conservation, land use and community development. The understanding of institutional processes can help to identify barriers and gateways that are important for the design of interventions that will result in sustainable livelihood outcomes.

1.8 Conceptual framework depicting integration of conservation of VNP and local food security

The robustness in techniques and methodologies to analyse the link between food security and conservation of biodiversity in protected areas is limited as traditionally, these two issues were studied separately until recent (Glamann et al., 2015). Thus, approaches and frameworks to integrate these two concepts in research and practice remain limited and unclear (Glamann et al., 2015). A recent literature review of 91 papers by Glamann et al. (2015) has shown that there are still gaps in developing a nuanced and holistic approach to address this nexus and recommends integrating biophysical-technical approaches and social-political approaches. This study tries to fill this knowledge gap by combining the Integrated Landscape Framework and the Sustainable Livelihoods Framework to formulate a conceptual framework for studying food security and biodiversity conservation in protected areas such as VNP.

1.8.1 Integrated Landscape Framework

The conservation of tropical forest has historically underwent fortress or fences and fines conservation approaches (Chan et al., 2007; Redford et al., 2006; Siurua, 2006), that were top-down and traditional exclusionary approaches to protected areas management (Brown, 2002). These approaches considered the welfare and development of local communities as conflicting directly with conservation objectives and practice.

The growing human population, especially in the vicinity of national parks (Wittemyer et al., 2008), became a condition that the success of conservation of protected areas had to increasingly be linked to the level of local support it receives and the nature of appropriate benefits it offers communities (Kegamba et al., 2021; Brown, 2002; Emerton, 2001). As a result, in 1980's the world saw a paradigm shift

that originated from the conservation community to promote more holistic approaches and subsequently, the scientific discipline of landscape ecology that integrates national parks into the economic and social context at local, national and regional levels emerged (Reed et al., 2016; Brown, 2002).

In 2000s, the term 'landscape' began to appear in policy decisions (Minang et al., 2015). Since then, this term is used to describe land use mosaics, flora, fauna, people and infrastructure found in defined geographical areas. This concept is important for understanding the co-existence of people, biodiversity, forestry, infrastructure, agriculture and other livelihood systems (Minang et al., 2015).

Since the last two decades, integrated landscape management has been studied and practiced under different names such as whole landscape management, bioregional planning and multi-functional landscapes (Minang et al., 2015), ecosystem approach, integrated conservation and development or integrated natural resources management (Reed et al., 2015). In recent years, these approaches have gained new interest given that the possibility and the need for more collaborative management of multifunctional rural landscapes are increasingly being recognized by scientists, policy makers and local stakeholders (Reed et al., 2016).

The Integrated Landscape Framework (ILF) was defined by Reed et al. (2015) as a framework that integrates policy and practice for competing multiple land uses using integrated and adaptive management systems. ILF is used to deal with the ever-increasingly widespread and complex political, social, economic and environmental issues beyond traditional limits of landscape management (Reed et al., 2015). This framework has a lot of potential in guiding the conservation of biodiversity, sustainably management natural resources, safeguarding forests and alleviating poverty in a more equitable manner whilst mitigating climate change and maintaining food production and if well applied it would ensure equitable and sustainable use of land (Reed et al., 2016).

There are ten principles that guide the ILF approach: continual learning and adaptive management, multi-functionality, multiple scales, multiple stakeholders, common

entry point/common concern, clarification of rights and responsibilities, negotiated transparent change logic, strengthened capacity of stakeholders, resilience and participatory and user-friendly monitoring (Sayer et al., 2013). Practitioners can select among these principles the ones that fit well with their work and adapt them to local landscape conditions and context (Sayer et al., 2013; Tallis et al., 2008).

Minang et al. (2015) has classified ten IL principles in three categories to ensure sustainable development: common concern and entry point as prerequisites or enabling conditions; management, negotiations, skills and participation as actions needed, and that resilience and local community food security are the overall aims of ILF (Figure 1.1).

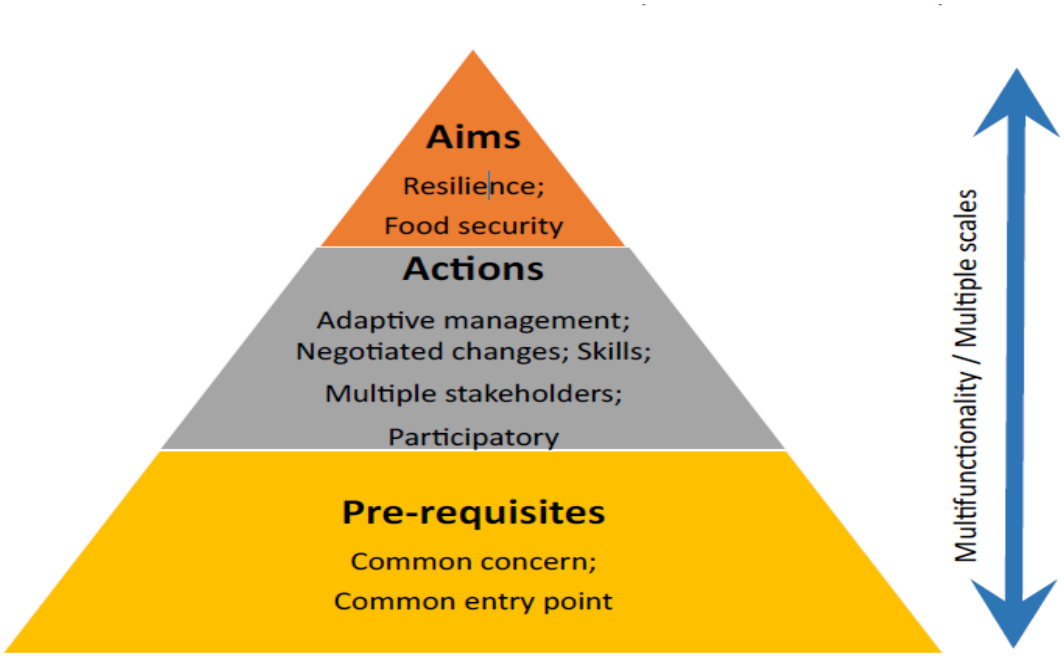

Figure 1.1: Description of the various principles of ILF

Source: Minang et al. (2015).

Reed et al. (2016) describe the ILF as a multi-faceted strategy aimed at bringing multiple stakeholders together from various sectors in order to provide solutions at different scales via adaptive management. Therefore, the landscapes' governance should not be strictly top-down or bottom-up but rather they should have a hybrid, cross-sectoral and multi-level structure (Reed et al., 2016; Kozar et al., 2014).

Inclusive, participatory stakeholder negotiation characteristic of this framework can help to well align global environmental concerns and local socio-cultural challenges. Also, this framework recognizes the intersecting issues of local community food security, climate change and gender inequality that frequently occur in rural landscapes (Reed et al., 2016).

The ILF ensures empowerment of community members as the beneficiaries of planned local interventions. Rather than imposing what people are prepared to accept, this framework gives them an active role in designing and managing the landscape by respecting their expectations and wishes (Costanza, 2003). In addition, inclusive consultations help to align multi-scale objectives of different stakeholders including land users that often conflict. For instance, consensus with the inhabitants of the landscape is important for stakeholders to promote pro-environmental interventions such as biodiversity conservation, large-scale reforestation, agroforestry or climate-smart agriculture that often do not appeal to rural communities. This is achieved through community engagement not only in the form of awareness but also through cooperation, compensation, or co-investment. Identification of the optimal form of engaging different members of the community within a landscape is important to address specific novel or existing landscape challenges. This implies using appropriate landscape principles to build positive synergies and to better account for trade-offs. Effective implementation of the landscape approach requires alignment of investment with local development objectives and existing capacities (Chia & Sufo, 2015). The framework does not help to avoid social conflicts, but it rather helps to identify and manage them (Keough & Blahna, 2006).

For the integrated landscape management to be successful, it requires landscape design and planning processes, supportive incentives and policies, improved investments and sectoral coordination and strengthening institutional and human capacities for negotiations and decision support (Estrada-Carmona et al., 2014).

1.8.2 Community Conservation Approach

This approach is Sustainable Landscape Framework applied around VNP. It is commonly called Community Conservation (Bush et al., 2010) or Community Based

Conservation (Guinness, 2014) and it has been implemented since 1980s (Brooks et al., 2013) around national parks in Africa. This approach encourages trade-offs and complementarities rather than conflicts between development and conservation (Brown, 2002). It recognizes the linkage between development and conservation and stresses the need for involving local communities in conservation activities.

Activities implemented under this approach are generally termed Integrated Conservation and Development Projects (ICDP) (Johannesen & Skonhoft, 2005; Newmark & Hough, 2000). Examples include activities that improve the local community livelihoods, awareness of communities on the importance of protecting biodiversity and local people involvement in the management of national parks. The key element of activities on community conservation is addressing the needs of the local communities whose livelihoods depend on the park resources. It is assumed that these communities will be less involved in illegal or unsustainable use of the park resources only if their development needs are addressed (Bush, 2009).

Despite wide implementation of ICDPs, several scholars have documented their failure to provide either lasting solutions to local poverty or to improve conservation of the national parks (Guinness, 2014; Bush et al., 2010; Sunderland et al., 2009; Adams et al., 2004; McShane & Wells, 2004 ; Brown, 2002). They are judged to poorly define communities, failure to understand their role, the importance and levels of their engagement and the need for their empowerment (Brown, 2002).

1.9.3 Sustainable Livelihoods Framework

Approaches to Sustainable Livelihoods have evolved as a result of three decades of shifting perspectives on poverty and how poor people live and on the importance of institutional and structural challenges (Farrington et al., 1999). The emphasis on livelihoods was made by Chambers (1983) in the 1980s focusing on poverty and rural development, though the concept had been previously used. Chambers and other scholars later on expanded the framework (Ellis, 2000; Scoones, 1998; Chambers, 1995; Chambers & Conway, 1992; Chambers, 1987) and it is currently used by a large number of researchers and has been adopted by a wide range of development

organizations (Ming'ate, 2016; Dawson, 2013; De Haan, 2012; Angelsen et al. 2011; Adato & Meinzen-Dick, 2002; Farrington et al., 1999; DFID, 1997).

The concept "livelihoods" is being increasingly recognized as a way to conceptualize economic activities that poor people engage in as a whole. Whereas job creation in the formal sector is a key strategy to reduce poverty in developed countries, the reality for the poor families in developing countries prosperity and survival depends on how different members of the household simultaneously pursue multiple diverse activities, taking advantage of the various resources and opportunities at different times (Adato & Meinzen-Dick, 2002). Their living is improved and sustained through their livelihoods capabilities and tangible assets such as resources and stores, as well as intangible assets such as access and claims (Chambers, 1987).

Scoones (1998) defines Sustainable Livelihood as a livelihood that includes the capabilities; assets (both material and social resources) and required activities for a means of living. This definition is based on Chambers & Conway (1992) among others. He stresses that a livelihood is sustainable when it can withstand and recover from stresses and shocks, as well as maintain or improve its assets and capabilities, without jeopardizing the natural resource base. His proposed framework is described under figure 1.2 below.

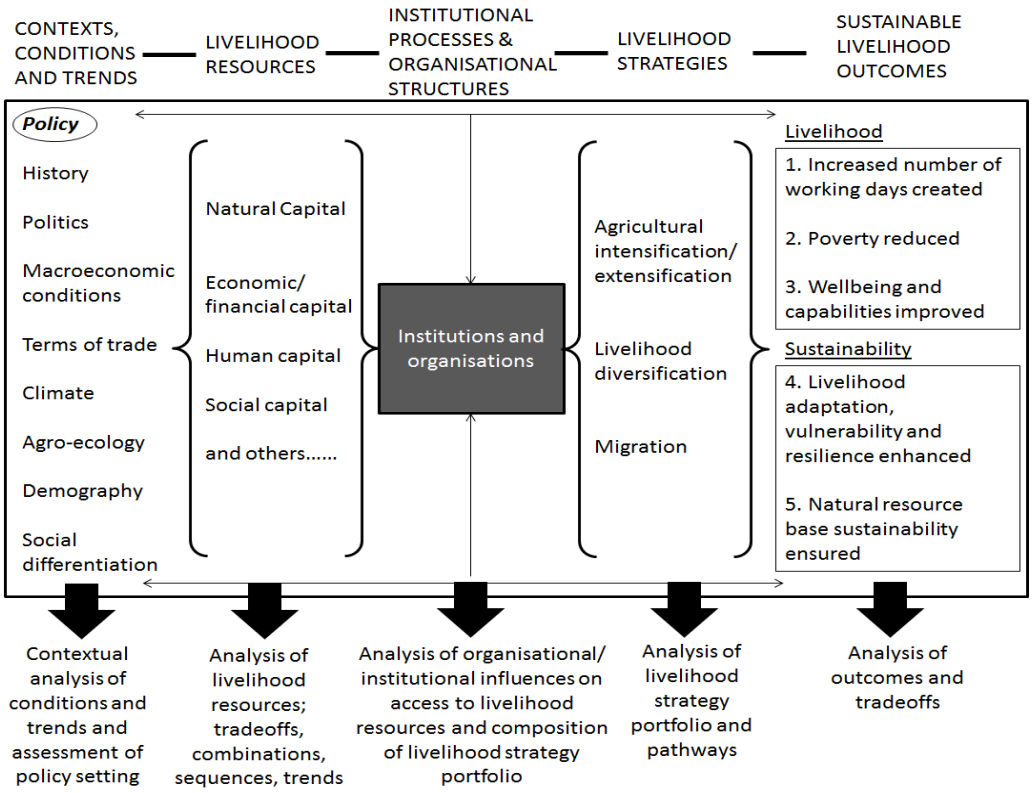

Figure 1.2: Sustainable Livelihoods Framework

Source: Scoones (1998)

Sustainable Livelihoods Framework (SLF) is a synthetic and holistic framework that draws on several theoretical and conceptual approaches to provide a method for considering numerous and interconnected influences on livelihoods. The framework allows researchers to grasp the big picture and therefore narrow the scope of the study to parameters that are most relevant to the important stakeholders or what can have the highest impact. Also, it helps researchers to prioritize factors that are local and less visible (Adato & Meinzen-Dick, 2002). This framework recognizes the livelihood complexities and processes that affect them (Adato & Meinzen-Dick, 2002).

The SLF provides for better analysis of sustainable livelihoods outcomes because it expands the elements used to measure poverty from just looking at income, consumption and adds other elements that provide social well-being and economic security including land access by the household, credit, access to water, access to education, household vulnerability to natural disasters, physical safety, social

relationships and political rights among others (Adato & Meinzen-Dick, 2002). Also, this framework looks beyond who is poor today to who is likely to be poor tomorrow; pays attention to household head counts; takes into account of the effects of social classes, gender, ethnic groups and other local social differentiations and perceptions of local communities on the meaning of poverty and who is poor, taking into consideration on what people themselves value (Adato & Meinzen-Dick, 2002; (Narayan et al., 2000).

The SLF also recognizes multiple scales in space and time and considers that individuals and households can pursue several strategies simultaneously or sequentially. Also, the analysis done by Adato & Meinzen-Dick (2002) emphasizes that applying this framework in research requires a holistic thinking about the types of capital/assets (credit, land, etc.) as well as possible interactions between different types of capital/assets, their sequencing and the complementarities between them. Such understanding would lead to a different intervention strategy. Also, the SLF may guide thoughts around conflicting livelihood objectives such as increasing agricultural production and protection of the natural resource base or human capital development (Adato & Meinzen-Dick, 2002).

The SLF is criticized for overlooking the values in cultural parts of life such as identity, traditions, beliefs, language, sacred sites and festivals that should also be considered as resources beyond assets/capital (Adato & Meinzen-Dick, 2002). Culture may influence some of the elements such as adopting new crop varieties, markets, credits, etc. For example, adoption or rejection of a new crop or new farming practices can be influenced by how these have been used in the past or their relationship with practices and festivals by ancestors (Adato & Meinzen-Dick, 2002). Also, the SLF does not consider historical factors. For instance, where external interventions have caused problems in the past, people will be reluctant to accept new interventions (Adato & Meinzen-Dick, 2002).

1.8.4 Food Security approaches

Over the years, the concept of food security and related approaches have evolved and been modified in response to rapidly evolving global food systems and changing

nature of the food problems (Maxwell & Slater, 2003; Maxwell, 1996). Food security was defined by the 1996 World Food Summit as a situation in which all people have economic, social and physical access to sufficient, nutritious and safe food to meet their dietary needs and food preferences for an active and healthy life at all the times (FAO, 1996). This definition has been confirmed by the 2009 Food Security World Summit that also extended this concept by incorporating the four pillars of food security: availability, access, utilization and stability (FAO, 1996).

According to Reutlinger (1977), over the years, the perspectives in analysing food security have shifted from a food availability approach at macro-level to an income-based approach at micro-level. The debate on food as the most human basic need (Magrabi et al., 1991; Maslow, 1943) and adequate food as a basic human right (Kent, 2005) that started in 1970s, gave birth to the so-called food first approach to measure food security (Maxwell & Slater, 2003; Maxwell, 1996).

In 1980s, the Entitlement Approach by Sen changed the emphasis away from national food availability to food access by the people. In 1990s, approaches of analyzing food security evolved to Sustainable Livelihoods (SL) Approach. According to Chambers & Conway (1992), like the Food First and the Entitlement Approaches, the focus of the SL Approach is gaining ground. Also, similar to the concept of endowments in the Entitlement Approach, it is primarily concerned with household tangible and intangible assets (Chambers & Conway, 1992). Physical capital, natural capital, human capital, social capital and financial capital are five types of assets (Burchi & De Muro, 2012; Scoones, 1998). In addition to assets, the SL approach has other two distinctive features which are of great attention to the context (such as economic, political, physical, cultural and social) and long-term perspective. These 3 analytical features give advantages to the SL approach over the previous approaches by providing a more comprehensive analysis of food security. Their combination brings three interlinked concepts unique to the SL Approach into food security analysis that have been overlooked by previous approaches: i) Explicitly taking shocks, risks, seasonality and negative trends into account leads to the *vulnerability* concept, which Chambers (1995) defines as “exposure and defencelessness”. This concept has a side

of defencelessness (lack of means to cope without causing significant loss) that is internal and an external side of exposure to stress, shocks and risk; ii) The *sustainability* concept in relation to vulnerability and resilience as one of core principles of SL framework; iii) Coping strategies that are a set of activities carried out by a household in a specific order in response to external shocks that cause a decrease in food availability (Davies, 1993). Coping strategies are a subset of *livelihood strategies* that people choose to engage in to achieve their livelihood goals (Burchi & De Muro, 2012). Basing on the SL framework, some institutions such as UNICEF developed frameworks for analyzing food security that are context specific. This study will use the SLF as it cuts across all its three objectives. It will also be complemented by some elements of the Integrated Landscape Framework.

1.8.5 Links between Sustainable Livelihoods Framework and Integrated Landscape Framework

These two frameworks are very well linked. They are both used to solve interconnected challenges and seek to find sustainable solutions to human wellbeing and natural resources management. They both encourage bringing multiple stakeholders together from different levels to come to a common understanding of their expectations, available ecosystem goods and services and how they can sustainably use them. Stakeholder engagement helps to get a compromise over resources use, joint selection of interventions and the roles of different parties to ensure sustainability.

Both the SLF and ILF help to understand the complexities and diversity involved in people's lives, from a local perspective. Also, both SLF and ILF recognize cross-cutting challenges of gender, inclusiveness and climate change. In general, food security, protection of the natural resource base and community resilience form integral parts of both SLF and ILF. Natural, social and human resources and multiple categories of material are common to these two frameworks.

1.8.6 Difference between Sustainable Livelihoods Framework and Integrated Landscape Framework

The ILF focuses on interventions that take place at landscape level with more emphasis on sustainable land use planning while the SLF focuses more on interventions taking place at a household level. Also, the ILF focuses more on the types of people's activities within the landscape while the SLF rather focuses on material gain at household level.

While the SLF is widely used, there are few documented examples of an integrated landscape approach in practice and those examples often lack empirical data evidence to back up the conclusion and necessary details on how this approach has been applied and how progress had been measured (Reed et al., 2016).

Also, the effective implementation of the ILF is more costly and time consuming given that it requires a lot of planning, mapping and intensive coordination at different levels where institutions and individuals may even be unwilling to work outside their normal areas of expertise and operation.

Given that this study is looking at the status of food security around VNP, the factors behind this status and contributions of the benefits from VNP to this status, the SLF and the ILF were combined to guide this study. The SLF mainly guided the analysis of the local food security while ILM guided the analysis of the benefits from the park and the land use changes.

1.8.7 The Importance of the Sustainable Livelihoods Framework and the Integrated Landscape Framework in developing the conceptual framework of this study

Both the SLF and the ILF fit well with the overall objective of this study in evaluating the implications of biodiversity conservation on food security because of their transdisciplinary characteristic. The overall logical thinking about how food security can be integrated in the VNP conservation was guided by the Sustainable Livelihoods Framework (SLF). This framework is widely used in analyzing how communities around national parks can sustain food security; has long-term perspective on

sustainable food security, plays a key role in bringing to attention the food security context around national parks; considers tangible and intangible assets; can be applied at different levels of analysis of the interlinkage between conservation of biodiversity and food security; and objectively describes information with reality through deductive approaches (Scoones,1998; Chambers & Conway,1991). The SLF also fits into this overall study because it shows how the combination and interaction of livelihood assets, policies, institutions and processes shape how households choose livelihood strategies and their outcomes as described by Angelsen et al. (2011) and Adato & Meinzen-Dick (2002). In addition, SLF shows that to achieve sustainable livelihoods; improved food security, vulnerability reduction, households resilience should be enhanced, and the natural resource base sustainability improved and vice versa; which is well in line with the overall objective of this study. (Angelsen et al. 2011). In fact, the framework has elements that underpin the consideration of long-term use of parks' resources and improving local food security by clearly showing that the assets and income of small holder farmers, changes in land holdings, shocks, seasonality, terms of trade, politics, macroeconomic conditions, social differentiation, demography, climate and agro-ecology of the landscape can affect both the natural resources and food security positively or negatively.

With its multidisciplinary characteristic, the SLF has elements that support the consideration of the root causes of food insecurity as well as possible sustainable use of national parks from vulnerability contexts through institutions, policies, processes; livelihoods assets, and livelihood strategies for sustainable livelihoods outcomes. The SLF also clearly shows that to achieve sustainable livelihoods; food security has to be improved. This is the most important element of this study. Furthermore, the SLF places the human being in the centre of any development agenda as does this study.
The sustainable livelihood framework also stresses the understanding of institutional processes that can help identifying barriers and opportunities that are necessary for designing interventions that would improve the sustainable livelihood outcomes. This is in line with the first objective of this study that examines the strengths of biodiversity and food security policies and institutional framework in supporting the integration of VNP conservation and local community food security. The failure of national policies to provide clear framework and guidelines for this integration and

the weaknesses of institutions and organizations to implement their activities at local level in an integrated way may compromise plans and activities to improve local food security and to conserve the VNP for long-term. Also, in this line, the framework stresses that the success of the interventions in supporting the sustainable livelihoods of communities depends on consideration of the complexity of their social relations, power dynamics and institutional forms. This study looked at the role of government institutions, NGOs, private sector institutions and local cooperatives in improving food security and conservation of VNP.

The SLF stresses on the people's ability to pursue various livelihood strategies, is dependent on their tangible, social and intangible assets and their basic material that are considered as capital base for livelihoods such as natural, economic, social and human capitals. The second objective of this study assesses the changes in land use and their impact on local food security. Under this objective, the focus was on land as a natural capital and its contribution to the community's food security, in addition to other income sources (economic capital), education (human capital), gender (social capital) and others.

The third objective of this study explored the contribution of biodiversity conservation in VNP on local food security. It is embedded in two indicators of the sustainable livelihoods framework which are: livelihoods strategies and sustainable livelihoods outcomes. This objective focused on the economic contribution of biodiversity conservation to local food security with emphasis on development projects supported by the Rwanda Development Board (RDB) revenue sharing scheme and partners. It also looked at park related strategies that households use to improve community food security. These include poaching, firewood collection, wild honey harvesting, animal grazing, vegetable and medicinal plants harvesting. It also examines the ability of the combined livelihood strategies to improve local food security for a given period of the year; assets owned; credits and savings; the level of vulnerability, adaptation and resilience measures and actions; and the insurance of natural resource base sustainability.

The ILF is also well linked to the three objectives of this study. The integrated nature of the ILF guided the reasoning around how improved coordination of different actors can help to identify trade-offs and synergies between natural capital management and food security goals as recommended by Sayer et al. (2013). The framework helps to link the sometimes, conflicting objectives of economic development and natural resources management through integrated planning and implementation of interventions. It integrates practice and policy for different conflicting land uses by implementing integrated adaptive management systems that ensure sustainable and equitable use of land (Reed et al., 2016). This framework brings together different stakeholders that operate within the landscape to negotiate and plan to maximise synergies and minimize trade-offs to ensure fewer losers and more winners (Kusters et al., 2017). ILF framework calls for sustainable land use. This study referred to this framework to define the land use changes variables such as trends in forest cover, infrastructure development and crop production, their drivers. The ILF also guided the analysis of how land use policies and institutional framework affect integration of conservation of biodiversity and local food security.

Community Conservation Approach (CCA) that is one of the forms of ILF informed the definition of the third objective of this study that focuses on contribution of VNP conservation on local food security. The CCA tries to integrate national parks into local social and economic context by assuming a linkage between development and conservation and by recognizing the need for engaging local people in conservation efforts (Newmark & Hough, 2000). The conceptual framework of this study assumes that revenue sharing from VNP tourism and community conservation programmes around VNP should help to improve local food security in order to reduce human pressure on VNP resources. Variables includes revenue sharing and alternative resources to what people were getting from the park.

The conceptual framework of this study was formulated basing on SLF and ILF that both value interdependence between conservation of biodiversity and local food security taking into consideration land use changes contribution to this interdependence (Kusters et al., 2017; Reed et al., 2016; Angelsen et al., 2011; Shepherd, 2008; Newmark & Hough, 2000). Interlinkage between independent,

dependent, and intervening variables was then drawn to understand the implications of VNP conservation on local food security. The assumption is that people are food secure if they can meet their dietary needs and food preferences for an active and healthy life by physically, economically and socially accessing enough, safe and nutritious food (FAO, 1996). At VNP, the main sources of food are land owned by households and the park. Thus, the dependent variable in this study conceptual framework is food security. The reasoning is that local food security depends on how land is sustainably used and how biodiversity conservation within VNP benefit local people. Therefore, the independent variables of this study are land use changes and VNP biodiversity conservation. These two variables are also interlinked. Land use changes such as decrease of forest cover, increase in infrastructure development such as buildings and increase in land used for crop production and livestock would negatively affect biodiversity of VNP as land users would encroach VNP, which is the habitat of important wildlife such as mountain gorillas. The long-term food security and biodiversity conservation at VNP will depend on policy commitment, enabling institutional framework and conditions of households' vulnerability that may results from unsustainable land use or lack of benefits from VNP. Food insecure households will tend to destroy the park as they use it as the main to sources of firewood, bushmeat, construction materials, etc. The provisions of policies and the extent to which decision-makers and communities are aware of them may have an influence on how the VNP management and stakeholders in conservation and land use management would consider food security in their interventions.

In general, the conceptual framework of this study assumes that the status of food security of households around VNP depends on how the policies that integrate food security and conservation can be designed, viewed and implemented by institutions and stakeholders, how households are affected by land use changes, the income generated by households, assets owned, harvests, markets, seasonality and how they benefit from the conservation of VNP. Also, it assumes that the sustainable conservation of VNP will depend on how local households are food secure. People illegally use the park resources because they are food insecure. Thus, there is a need

to integrate the VNP conservation and local food security. The relationship between different variables under this framework is shown under figure 1.3 below.

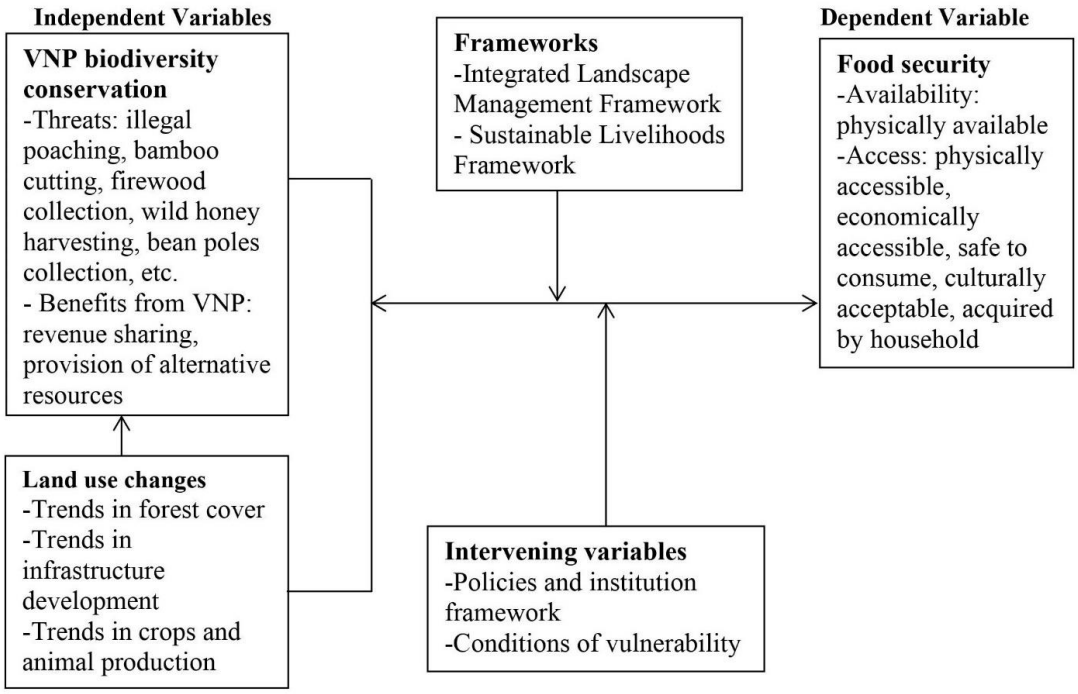

Figure 1.3: Conceptual framework depicting integration of VNP conservation and local food security

Sources: Kusters et al. (2017); Reed et al. (2016); Republic of Rwanda (2015a); Pieters et al. (2013); Angelsen et al. (2011); Shepherd (2008); Mpyisi et al. (2003); Newmark & Hough (2000).

1.9 Chapter outline

This study has five chapters. The first chapter describes the background, problem statement, research questions, study objectives, hypothesis, significance of the study and the conceptual framework for the study, while the second chapter focuses on reviewing the literature on evolution of food security concept, policy and institutional framework in relation to conservation of biodiversity and food security, impact of changes in land use on biodiversity conservation and contribution of national parks to local food security. It also reviews theories that guided the study, summarizes the literature and identify the gaps addressed by this study. The third chapter details the followed methodology including the information on the area of the study, target population, research design and sampling, data analysis procedures and limitations of

the study. The fourth chapter describes the findings of the study per each objective while the fifth chapter provides a summary of the study findings, conclusions and recommendations for further research.

CHAPTER TWO

LITTERATURE REVIEW

2.1 Introduction

This chapter focuses on reviewing the literature on evolution of food security concept, policy and institutional framework in relation to conservation of biodiversity and food security, effects of land use changes on conservation of biodiversity, contribution of benefits from national parks to local food security. It also describes the research gaps that the study addresses.

2.2 Policy and Institutional Frameworks related to biodiversity conservation in national parks and local food security

2.2.1. Evolution of Policy and Institutional Frameworks

The need for policy and institutions emerged when human beings started living together in communities and became no longer self-sufficient (Cloete, 1998). This evolved in public policy to bring social order and respond to the needs, circumstances and living conditions of (Cloete, 1998). The crisis that was left by the Second World War urged for rethinking on how people can act to get out of uncertain circumstances such as the Cold World War. The pioneers of public policy became Daniel Lerner and Harold Lasswell, American political scientists. In 1951, they analyzed American policies and invented what he called policy orientation. They argued that the continued crisis of national security that people were living in during that period called for more efficient use of facilities, resources and manpower of American people (Lerner & Lasswell, 1951). In they exercise to analyze American policies, Lerner and Lasswell developed the first ever policy analysis framework that he called: policy cycle approach. It is argued to be the most enduring conceptual construct in the policy sciences (Howlett et al., 2016). This framework has 7 stages: Policy generation, prescribing what to do, policy innovating, practical application of the policy, policy termination once the problem is solved, and impact appraising (Lerner & Lasswell, 1951). This work of Lerner and Lasswell formed the basis for many later approaches including the multiple streams approach of (Kingdon, 2013) and the

Advocacy Coalition Framework (ACF) approach of (Sabatier & Jenkins-Smith, 1993).

McConnell & Hart (2019) defines policy as governance networks' interactions that are structured and related process of problematizing issues or whatever governments choose to do or not do. Over time, human beings conceived policies and institutions to create order and reduce uncertainty. Institutions, according to North (1990), are society's rules of the game, protocols that shape human interaction or constraints created by humans that shape economic, social and political interactions. Institutions are made up of informal constraints like taboos, traditions, sanctions, codes of conduct, customs as well as formal rules like constitutions, laws and property rights. They enclose social values, norms, regulations and rules that shape people's opportunities for accessing and utilizing resources. According to North (1990), when institutions evolve, they connect the past, the present and the future and therefore shape the economic change towards decline, growth or stagnation.

According to OECD (2008), Institutional Framework is a group of institutions that are in charge of developing and implementing policies. Marcos & Castrillo (2020) define it as a set of several economic, legal, social and cultural variables that make main characteristic of a particular location and influence the actions of people, institutions and businesses in that area. Yamoah et al. (2013) argue that Institutional Framework is the system of regulations, laws, procedures and stakeholders with their norms and roles that shape people's behavior and socioeconomic activity.

Interaction between different actors within the Institutional Framework depends on the level of awareness about the shared policies and benefits envisaged by each group (Warren et al., 2001). At local level, communities are mostly affected by government and partners' ability or inability to implement policies and their participation in policy formulation and implementation is very important for their support and benefits. Communities are composed of people who actively shape, interpret and monitor the world around them as well as form and use different alliances in their struggle for resources. People's location and their economic, environmental, cultural and political institutional frameworks shape or constrain their social behaviour and actions (Warren

et al., 2001; Zimmerer et al., 2003). Thus, the success of institutional frameworks and implementation of policies depends on how multiple interests and associations of actors within communities are taken into account to shape decision making processes (McKeon et al., 2004; Agrawal & Gibson, 2001). For instance, the local elites' control of community members and their development projects may causes failures (Cousins & Kepe, 2004; Platteau & Gaspart, 2003). Also, unequal access to resources, economic inequalities and power differences will only reduce if policies and institutional frameworks ensure equality and consensus among all players (Bizoza, 2011).

2.2.2 Evolution of biodiversity conservation

The English kings made the first conscious effort to protect biodiversity during the Middle Ages. Their desire to create private recreational hunting reserves drove this decision (Great Wild Spaces, 2016). The movement to establish national parks started in 1872 with the creation of Yellowstone National Park in the United States. This was first time the term 'national park' was used (Mulongoy & Chape, 2004; Great Wild Spaces, 2016). In the decades that followed, many other countries started creating protected areas such as El Chico (Mexico), Banff (Canada), Tongariro (New Zealand) and the Swiss National Park. Since then, almost every country in the world has created national parks resulting in displacing local people from their traditional lands in many cases (Mulongoy & Chape, 2004).

In the tropical region, the decision to create new national parks was usually made by colonialists. For instance, the British colonial powers created big game reserves for hunting in Africa. In 1940s, when the British Empire on the continent was ending, they created more wildlife reserves as they were concerned that once the African colonies will be returned to the local people, they will extensively use the land for crop production and hunt wildlife for survival. This was expanded to other places in the world (Great Wild Spaces, 2016) and as a result, International Union for the Conservation of Nature (IUCN) and World Wildlife Fund (currently World Wide Fund for Nature (WWF) were respectively established in 1948 and 1961. The World Conference on National Parks was organized for the first time in 1962, in Seattle, United States. That time, the world had 10,000 protected areas. The number had

increased tenfold to 100,000 in 2003 when the 5th World Parks' Congress was held in South Africa, Durban (Mulongoy & Chape, 2004). The number of Protected Areas has increased to 238,563 covering 14.8% of the world's land surface and 7.27% of the sea in 2018 (United Nations, 2018).

Traditionally, Protected Areas were places set aside as national assets that are owned and financially supported by governments for wilderness, conservation and scenic values. They were mainly managed by scientists who treated them as isolated islands cut off from the rest of the land or sea ignoring the importance of getting opinions from local people. They viewed development of local people as the main cause of biodiversity loss and therefore directly contradicting the goals of biodiversity conservation. With time, this model that excludes local development failed as it was unable to effectively conserve biodiversity but it was rather bringing high livelihoods' costs to local communities (Mulongoy & Chape, 2004). Therefore, in 1980s, a paradigm shift in conservation thinking emerged and policies that once viewed people as a threat started regarding them as potential partners in the strategies for sustainable development (Brown, 2002). The conservation community recognized the need to integrate local development into biodiversity conservation agenda as they slowly understood that sustainability requires considering large scale and long-term decisions that looked beyond the borders of national parks to their wider landscapes or seascapes (Mulongoy & Chape, 2004). Conservation concerns were therefore repackaged under the umbrellas of biological diversity and sustainable development with worldwide interest to link environment and development. Different events were organized on this topic and different reports published. For instance, the Conference of UN on Environment was organized in 1972 in Stockholm, the World Heritage Convention was adopted the same year; the World Conservation Strategy was adopted in 1980 and the Conference of the UN on Development and Environment in 1992 adopted the convention on biological diversity. These new developments helped to initiate linking of conservation concerns and the development agendas. They also helped to review the aims of protected areas to include sustainable use of resources by communities, environmental benefits, cultural values and the local community active participation in decision-making. This new model of conservation is more diverse, it

includes social and cultural considerations and involves more partners and indigenous people. As this new model continues to evolve, local community owned protected areas and private reserves are increasingly being created (Mulongoy & Chape, 2004). However, in many countries especially in Africa, this new model is still in its early development involvement and the benefits of local people from protected areas remain questionable. To ensure success in conservation of national parks, it is important to integrate them in the local, national and regional economic and social contexts. This requires innovative institutions and processes.

2.2.3 Evolution of the Concept of Food Security

The concept of food security has evolved over time in accordance with improved understanding of food problems and global food systems (Maxwell & Slater, 2003; Maxwell, 1996). Food security is a key outcome of sustainable livelihoods and it is currently largely analysed using the Sustainable Livelihoods Framework (SLF). The 1996 World food Summit defined food security is a situation in which all people have social, economic and physical access to sufficient, nutritious and safe food to meet their dietary needs and food preferences for an active and healthy life, at all times (FAO, 1996). The 2009 World Summit on Food Security confirmed this definition and determined the four pillars of food security: availability, access, utilization, and stability (FAO, 2009).

Food security approaches evolved from the Food Availability or Malthusian approach in 1470s to Income-Based Approach to Food First Approach in 1970s to Entitlement Approach in 1980s and to Sustainable Livelihoods (SL) Approach in 1990s (Burchi & De Muro, 2012). UNICEF was the first to develop the food security framework basing on SLF. Its focus is on the causes of malnutrition and death in children and women (UNICEF, 1990). This framework was the basis of other frameworks on food security such as Food Insecurity and Vulnerability Information and Mapping Systems (Burchi & De Muro, 2012). In response to the 2000s global food security crisis, Ecker & Breisinger (2012), introduced a new conceptual framework for food security analysis that views food insecurity as central to overall development and as a cross-sector issue at multiple levels. This new framework extends the UNICEF framework by considering the stresses and external shocks to food security and by emphasizing

that nutrition outcomes are both a cause and a consequence of underdevelopment. It also integrates different disciplines (such as agriculture, macro- and microeconomics, nutrition and health) that in the past have been regarded in isolation of each other. These authors reveal that investments in the key sectors; social and economic policies; and programs that target the vulnerable are important tools for governments to mitigate stresses and external shocks and foster food security. They also stress that for food security analysis to be effective, it must be specific to the situation and context and an integrated and cross-sector approach that combines different intervention options to be undertaken due to the complexity and several food security dimensions and their interaction. The analysis of Pieters et al.(2013) added more policy considerations to the framework of Ecker & Breisinger (2012) and broadly described the determinants of food and nutrition security at macro and micro levels both in the long and short term. The policies added include natural resource, environment and biodiversity conservation among others. This study followed the framework of Pieters et al. (2013) to analyse food security. The main reason for this is that food security was analysed in regard to biodiversity conservation and land use, changes in local context and policy considerations.

2.2.4 Global status of biodiversity conservation

Despite the increasing number of national parks worldwide, animal and plant species continue to become extinct and habitats are being lost at an alarming rate. Also, the viability and integrity of many national parks is threatened by several human interventions (WWF, 2016). Díaz et al. (2019) published a report with alarming findings on the global decline of biodiversity. The report indicates that today, more species are threatened with global extinction than ever before due to that rapid increase of human population and unsustainable production and consumption and this negatively affects ecosystem processes and reduces the contribution of nature to people's livelihoods.

The rate of species extinction at global level is at tens to hundreds of times greater than it has been in the last ten million years (IPBES, 2019). It is projected to continue and even worsen unless action is taken to curb the human population growth and adopt more sustainable consumption and production systems (CBD Secretariat, 2020).

Since 1900s, native species of animals and plants in important terrestrial biomes have shrunk by at least 20% with an estimated 1 million species already on the verge of extinction. Across the tropics that are rich in biodiversity, 32 million hectares of natural forests were cut down between 2010 and 2015 (FAO & UNEP, 2020).

Over the last 10 decades, about 90 % of varieties of crops have disappeared from farmlands. About 8 % of the known 8,000 animal breeds are extinct and 22% are at risk of extinction. About half of the domestic animal breeds have been lost, and the world's 17 main fishing grounds are overexploited. Agrobiodiversity and related local food and traditional knowledge and medicine are disappearing. The loss of diverse diets results into increased diseases such obesity, diabetes and malnutrition (Díaz et al., 2019).

The world is also losing whales, sea turtles, fish, birds and other fresh water and marine biodiversity due to plastic pollution (Ceballos et al., 2015). Estimates show that plastic pollution puts 700 species at the risk of extinction and that at least 267 species have been affected worldwide. This includes 43% of all marine mammals, 84% of all sea turtles and 44% of all sea birds (CBD Secretariat, 2020).

The introduction of new alien invasive species appears to be faster than ever and there is no indication that it will reduce (Brouwer et al., 2023). Since 1980s, alien species have increased by 40% because of increased trade and other human dynamics. Animal and plant invasions threaten about one fifth of the earth surface. This reduces nature's contributions to people's livelihoods, ecosystem functions, indigenous species and human economies and health (Díaz et al., 2019).

Climate change increases biodiversity loss and aggravates food insecurity issues. Many animals, plants and microorganisms fail to adapt themselves to the changing temperatures and moistures and extreme weather events. This results in crop failures and biodiversity extinction (CBD Secretariat, 2020).

The tropical areas that are projected to lose more biodiversity and their habitats have concentrations of poorest communities whose livelihoods depend on natural resources. Consequently, these communities will be heavily affected by these negative changes that will also influence their ability to contribute to biodiversity management and conservation. Co-management of national parks with communities has been proven to be a good tool that can help to solve these challenges (Yang et al., 2021). Global, regional and local initiatives often lack consideration of rights, perspectives and views of local communities; their understanding and knowledge of ecosystems; and their desired development pathways for the future (IPBES, 2019). Transformative changes are needed across social, economic, technological and political perspectives to conserve, restore and sustainably use biodiversity for a better future for people and the planet (Díaz et al., 2019; CBD Secretariat, 2020).

2.2.5 Impact of the governance of national parks on local food security worldwide

The governance of national parks has an important impact on food security and livelihoods of local people. Therefore, the consequences of unequal distribution of benefits from national parks on local food security needs to be better understood (Sunderland et al., 2013). Governance is about relationships, power, accountability, and responsibility. It is defined by some scholars as interactions between structures, traditions and processes that dictate how power is wielded and decisions on public issues are made, and how stakeholders or citizens are involved. Regarding national parks, governance refers to who has responsibility, authority and accountability for the park management based on customary, legitimate or legal rights. Governance is critical in this context for national park management effectiveness and management equity as it determines how benefits and costs are allocated as well as how set objectives can be achieved. Governance is also key to preventing and solving conflicts and helps to get political, financial and community support. The models of national parks' management have often excluded local communities and viewed their concerns as incompatible with biodiversity conservation. Over time, there was a paradigm shift and the world slowly saw new models that value local people involvement in conservation (Mulongoy & Chape, 2004).

The declaration of the 5th World Parks Congress in 2003 put local communities and indigenous people at the heart of conservation emphasizing the need for national parks to address issues of development and poverty, cost and benefits sharing with local communities and community empowerment and governance. Since then, community engagement has become an important element in planning conservation work to reduce negative impacts of wildlife conservation on local communities such as relocation, losing access to natural resources or cultural sites. In many cases, local people have traditional and customary rights to resources and land, and the violation of these rights leads to loss of community support and sometimes to hostility. Also, local people often have traditions, rituals that restrain natural resources use. While this knowledge can help to save biodiversity, it is often ignored by parks management. It is suggested that involving indigenous peoples and local communities in the conceptualization and management of national parks would solve these issues (Mulongoy & Chape, 2004).

Today, some parks are fully managed by governments while others are co-managed with communities. Also, there is an increase in number of community-conserved areas and privately managed protected areas (Mulongoy & Chape, 2004). Community-conserved areas are fully managed by communities or indigenous people. Although the number of these areas is increasing across the globe, the concept is relatively new, and they are still neglected by conservation NGOs and governments. Even if this approach is also new, co-management increases the role of indigenous peoples and local communities in national parks' management. Its advantages include early roles' clarification including traditional or customary rights of local people, creation of institutions such as village conservation committees or joint management boards that represent local communities in decision-making processes, provision of secure tenure to livelihood resources for local communities, open dialogue of different stakeholders to ensure ecologically sensitive livelihoods are opted for, and equitable cost-benefit distribution such as tourism revenue sharing and compensation for human-wildlife conflicts. For them to be successful, initiatives under co-management need good dispute resolution mechanisms, clear legal backing, transparency in information-sharing and capacity building. Also, it should consider traditional

knowledge, be site-specific and sensitive to spiritual and cultural values (Mulongoy & Chape, 2004).

2.2.6 Global policy and institutional framework that links conservation of biodiversity and food security

According to Sunderland et al. (2013), integrating food security and conservation of biodiversity in human- dominated national parks requires a systemic approach. They argue that this integration provides a once-in-lifetime opportunity for national parks' managers and stakeholders to join forces in planning and implementation of programmes to achieve long-term conservation results. They also stress that a clear programme of actions on linking biodiversity and local food security should be placed at the center of national parks' management to ensure sustainability.

IPBES (2019) report indicates that enhanced international cooperation and well linked local measures can reduce direct drivers of biodiversity loss. This would require reviewing and renewing internationally agreed biodiversity conservation-related goals and targets, guided by available scientific knowledge; widely adopting and funding conservation actions, using natural resources in a sustainable manner and restoring degraded ecosystems. This will be quickly achieved by aligning and advancing international, regional and local sustainability measures and mainstreaming sustainability and biodiversity in land use to ensure collective and individual actions result in reversing biodiversity loss at global, regional, national and local levels.

These positive changes will not materialise unless transformative change that addresses both direct and indirect drivers is implemented. This would involve: i) widespread capacity building, eliminating perverse incentives and developing incentives for environmental responsibility; ii) integrating biodiversity conservation in decision-making across sectors and jurisdictions; iii) managing ecological and social systems that are resilient in the face of complexity and uncertainly in order to make robust decisions in a variety of scenarios; iv) taking preventive measures in management and regulatory businesses and institutions in order to mitigate, remedy and avoiding biodiversity loss and monitoring their outcomes; and v) strengthening

the rule of law including environmental policies and laws and their implementation. This would require new resources especially in many developing countries (CBD Secretariat, 2020).

Transformative change towards sustainability is likely to happen if efforts are invested as follows: i) allowing for visions of a good quality of life that do not require ever-increasing consumption of natural resources, ii) reducing waste production and consumption by curbing the curve of per capita consumption and population growth; ii) adopting new social norms for long-term sustainability; iv) addressing gender and income inequalities; v) ensuring inclusive decision-making and equitable distribution of benefits derived from natural resources use; vi) accounting for deterioration of nature as a result of interactions between the environment and socioeconomic activities; vii) ensuring social innovation and environmentally friendly technological development; and viii) promoting knowledge generation and education (Díaz et al., 2019).

Risks related to complexities and uncertainties in transformational change towards sustainability can be reduced through integrative, informative, inclusive, and adaptive governance approaches that consider trade-offs and synergies among societal objectives and alternative paths. These approaches also acknowledge diverse economic conditions, inequity, values plurality, vested interests, and power imbalances in society. They also involve stakeholders including civil society, private sector, communities, academia and other partners in the development and coordination of policies across sectors (Ceballos et al., 2015).

Recognizing the role and value of local communities and ensuring their engagement in the governance of national parks enhance their standard of living and the restoration, sustainable use and conservation of natural resources. A study of Ampaire et al., (2017) on gaps in involving communities in policy formulation found out that central governments do not often involve other stakeholders while local communities are excluded. Also, it indicates that there are issues of political

interference, limited financing and technical capacity, and absence of functional implementation structures at different levels.

Governance that involves local people can ensure sustainable conservation of national parks and their contributions to people's livelihoods. These contributions can be facilitated through access to resource use; recognition of land tenure; free, prior and informed consents for decision-making; equitable sand fair distribution of benefits derived from natural resources use, co-management and improved collaboration (Yang et al., 2021).

2.2.7 Need for integrating conservation of national parks and local food security

Integrated landscape governance necessitates the use of a variety of instruments and policies that address the major drivers of nature deterioration and biodiversity loss by ensuring ecological restoration, nature conservation and sustainability in production, forest management and infrastructure development. Harmonized policy mixed across sectors, jurisdiction and governance can value social and ecological differences beyond and across the landscape, build on existing forms of governance and knowledge and address trade-offs between tangible and non-tangible benefits in an equitable and transparent way (Díaz et al., 2019).

Integration of national parks and local food security can be done better by ensuring multi-use, multifunctional, community-based and multistakeholder approaches. This can combine practices and measures that include: co-management of national parks, community-based conservation; payment for ecosystem services, support of local people in ecological restoration; access to natural resources, participation in park management; provision of alternatives, reducing human-wildlife conflicts and promoting sustainable biodiversity based food systems (CBD Secretariat, 2020). Vedeld et al. (2012) call for more local access and control, rights-based approaches for local use, locally owned parks, and fair compensation as national parks managed by governments have failed to lift local communities out of poverty.

Though it is widely known that addressing the nexus of conservation of biodiversity and food security is important to reduce human dependence on parks resources,

related studies appear to be too broad in scope and tend to loose impact on policy and interventions (Glamann et al., 2015). This research gap was also at VNP where previous studies examined the link between local people and VNP conservation in the wider perspective of poverty, aggregating indicators. As mentioned above, recent studies suggest disaggregating poverty and food security indicators if precise and useful recommendations have to be drawn (Barrett, 2010; Lindenberg, 2002). There are no other known studies that examined the status of food security around VNP, disaggregated from poverty indicators and/or systematically analysing the spatial variations of households' food security.

2.2.8 Status of biodiversity conservation in Rwanda

In Rwanda, most of biodiversity is inside its four national parks (VNP, Nyungwe, Akagera and Gishwati-Mukura). Other protected areas include 1 forest reserve (Iwawa Island in Lake Kivu), 1 forest of cultural importance (Buhanga) and 1 wetland (Rugezi-Bulera-Ruhondo). In Rwanda, national parks are state land reserved for biodiversity conservation (Bizoza & Ndangiza, 2014) with extractive uses prohibited (Republic of Rwanda, 2015a). VNP and Gishwati-Mukura national parks are Man and Biosphere Reserves (MAB) of UNESCO (UNESCO, 2020) while the wetland of Rugezi-Bulera-Ruhondo is a RAMSAR site (UNESCO, 2020). The country has 38 other protected swamps and 106 protected natural forests that have not yet been gazetted as legally protected, but human activity is prohibited within them (Republic of Rwanda, 2015a; Mendelson et al., 2016).

As part of the Albertine Rift, Rwanda shares one of Africa's most important centres of biodiversity and endemism. Among Albertine Rift endemic species, there are 14 birds in Gishwati, 21 mammals in VNP, and 137 endemic plants in Nyungwe National Park. Rwanda has in total 402 mammal species (40% of all mammals in Africa); 1,061 birds, 293 amphibian and reptile species and 5,793 plant species (Mendelson et al., 2016). VNP hosts 30% of the mountain gorillas in the world (Republic of Rwanda, 2010b). The census of mountain gorillas undertaken in 2016 in the Virunga massif revealed that the population in Rwanda, DRC and Uganda was 604 individuals with an increase of 25% since the census of 2010 (Hickey et al., 2018). Rwanda's national parks also provide a habitat for a about 500 chimpanzees

and different species of monkeys including Angolan colobus monkey, L'Hoesti monkey, the silver monkey, golden monkey, vervet monkey, red-tailed monkey, olive baboon and grey-cheeked mangabey (Republic of Rwanda, 2011a).

Despite rich biodiversity and efforts in conservation, Rwanda wildlife has, over the years, been subject to human pressure causing loss within species richness, populations sizes and habitats. Over the past four decades, national parks lost about 60 % of their land area (Republic of Rwanda, 2013). Recent examples of habitat degradation include the conversion of the Karama savanna into animal grazing areas, cropland and other economic activities (Republic of Rwanda, 2011a) and mining in the Mukura Forest Reserve (Republic of Rwanda, 2015a). The current threats to biodiversity within national parks across the country include poaching; boundary encroachment for agriculture; cattle grazing, mining, invasive alien species, climate change, inadequate and inaccurate scientific data and inadequate incentives (Republic of Rwanda, 2013).

2.2.9 Importance of biodiversity conservation to Rwanda's economy

Rwanda's National parks provide numerous opportunities and benefits for improved livelihoods, economic development at national and local levels. Tourism is the country's top income earner with USD 317 million since 2014. Biodiversity directly and substantially contributes to the Rwandan economy through tourism. This is the Rwanda's largest foreign exchange earner that grew at 11% each year between 2008 and 2019 injecting USD 489 million in Rwanda economy in 2019 (Butera, 2020). In 2019, tourism contributed 10% of Rwanda's GDP and employed 8% of the workforce (Cornish, 2020). In this regard, Rwanda recently created a fourth national park (Gishwati-Mukura) that increases the protection of the biological diversity of the country and is expected to contribute to the national tourism revenue.

Also, Rwanda biodiversity habitats play a critical role in ecological functions. The major rivers of the country have sources or flow through National Parks (Republic of Rwanda, 2013). Nyungwe National Park is known as the country water tower (Republic of Rwanda, 2015a). It is the source of more than 70% of water used in Kigali, the capital of Rwanda (Banerjee et al., 2017). Also, the restoration of the

Gishwati forest has reduced floods, erosion, landslides and depletion of water quality downstream (Republic of Rwanda, 2015a). Indeed, conservation of Rwanda's biodiversity significantly contributes to provision of other global services and goods including carbon sequestration and stabilization of the climate (Republic of Rwanda, 2013).

2.2.10 Policies and institutional framework for integrating biodiversity conservation and food security in Rwanda

As any other country in the world, Rwanda governance is based on policies and institutions. However, there are still gaps to be address in terms of policy implementation and institutional architecture (Enabling Agricultural Trade, 2015). The assessment of Rwanda's capacity to develop a policy that is evidence-based, transparent, inclusive and predictable has been undertaken by Africa Leadership Training and Capacity Building Program (2014) which revealed the areas that need improvement in the country in order to sustain policy initiatives on food security. These include clearly defining and improving the role the private sector and the civil society organizations in policy processes related to the development of the agricultural industry; while basing policy planning cycle on economic impact analysis rather than financial analysis, analyse how policies are implemented, and collaborate with research institutions for evidence-based policy design and implementation (Africa Leadership Training and Capacity Building Program, 2014).

The government of Rwanda ratified the Convention on Biological Diversity (CBD) in 1995; elaborated the first ever National Biodiversity Strategy and Action Plan (NBSAP) in 2003 and has so far submitted five National Reports (Republic of Rwanda, 2014). The country submitted the revised NBSAP in 2016 as a guiding document to implement the objectives of the CBD and the Aichi targets. Also, Rwanda adopted the Sustainable Development agenda in 2015 (Republic of Rwanda, 2019). In addition, the country has formulated several good policies and strategies over the years that entail the need for biodiversity conservation including the Wildlife Policy (Republic of Rwanda, 2013) and National Biodiversity Policy (Republic of Rwanda, 2021). The biodiversity policy aims at conserving the biological diversity of Rwanda, to maintain the productivity, health and integrity of the country's ecosystems

while providing long-term socio-economic benefits to the country through efficient and sustainable use of biological resources. The Rwanda wildlife policy provides a framework to conserve the diverse species of wildlife and their habitats for the benefits of Rwandans and the global community.

Existence of policies that consider social, economic and environment elements of sustainable development is a good sign of Rwanda political will to solve the issues of biodiversity loss, food insecurity and health in a more integrated manner. These policies include among others the Rwanda's Vision 2050 to become a high-income, clean, green and climate resilient economy; the National Strategy for Transformation; the Rwanda's strategy for green growth and climate resilience and the Nationally Determined Contributions to the Paris Agreement. Most of Rwanda policy documents emphasize that the country's viability should depends on preservation of its biodiversity and how they contribute to people's livelihoods, the country's economy, food security, health, and cultural diversity.

Rwanda national parks have similar governance structures. Each of them has an onsite management lead by the Chief Park Warden who reports directly to the Head of Tourism in Rwanda Development Board, the national institution in charge of tourism and conservation. Each national park has a management plan that is implemented in partnership with different stakeholders including the NGOs and local government. Private sector agencies are mainly involved in tourism and they are dominated by Tour Operators, Hotels and lodges, NGOs' whose work focuses on research and community conservation projects.

Over the years, the Rwanda environmental sector underwent important institutional transformations in order to address emerging environmental issues, and the country needs and priorities. In 1973, Rwanda created the Office of Tourism and National Parks (ORTPN) with a mandate to manage and conserve national parks, promote tourism and cultural heritage and develop and manage touristic sites and monuments. In 2009, ORTPN lost its autonomous status and was put under the Rwanda Development Board (RDB) and as a department in charge of tourism and

conservation. This department has a mandate to conserve national parks and to develop tourism within them. The institution that provides the overall leadership of the environmental sector is the Ministry of Environment (MoE) with a mandate to sustainably manage natural resources and to ensure their rational use. Under this ministry, there are Rwanda Environment Management Authority (REMA), Rwanda Forestry Authority, Rwanda Land Management and Use Authority and Rwanda Water board. These agencies are interlinked but each has its own mandate. REMA oversees and coordinates the implementation of the environmental policy and related legislations while Rwanda Forestry Authority in collaboration with Districts is in charge of managing forest reserves, other natural forests and plantations. REMA is also in charge of protected swamps. Laws establishing national parks entrust their management and the management of their buffer zones to RDB (Bizoza & Ndangiza, 2014).

In 2009, RDB started entering into agreements with NGOs and Private Sector Companies to jointly manage national parks. Akagera and Nyungwe National Parks have been entrusted to African Parks Network while Gishwati-Mukura National Park has been given to Wilderness Safaris. VNP remains fully managed by RDB.

Despite the country conservation efforts, Rwanda biological diversity remains under human pressure. The main threats are poaching, natural habitat degradation by human resource use, mining, encroachment for agricultural development, climate change, fire outbreaks, invasive alien species and pollution. Incidences of encroachment and illegal use results from local dependence on natural resources for livelihoods. Also, local people lack rights to the parks' resources, and they are not fully engaged in the decision-making on their management. This diminishes their incentives to protect and regenerate them. Although the Rwanda Land Policy delegates the responsibility of improving the management and conservation of protected areas to all Rwandans, ordinary citizens have not been assigned any role in the management of national parks or their buffer zones. Their role is limited to participating in awareness campaigns, provision of labor, monitoring the involvement of their neighbours in illegal activities and chasing away wildlife from crops. The rights of local people to use the buffer zones are limited to few activities such as beekeeping and these have to be approved

and monitored by the park management. RDB fully manages VNP while it has recently signed agreements with companies for co-management of the rest of the national parks. These governance arrangements have limited involvement of local communities, compromising the citizen's ownership as suggested by the Rwanda National Land Policy (Republic of Rwanda, 2004a) and the Environmental Law (Republic of Rwanda, 2005). For conservation of national parks to be successful and sustainable, mechanisms for giving local communities meaningful management rights need to be put in place (Bizoza & Ndangiza, 2014).

Communities surrounding national parks illegally use the park resources because they lack access to affordable and adequate alternatives such as the right to economic benefits from the Tourism Revenue Sharing Programme that was launched by RDB in 2005. Under this programme, about 5% of the revenues is generated by tourism in national parks funds community development projects. However, this percentage is criticized to be small by Bizoza & Ndangiza (2014) who recommend providing a greater share to local communities and to allow them to determine by themselves how these resources are invested in order to address poverty issues in the vicinity of national parks and boost local support to conservation. The authors also recommend that RDB and parks management should employ local people, create new job opportunities and increase their employability and capacity through trainings and educational opportunities. They continued arguing that surrounding communities should be given rights to undertake activities that are consistent with conservation goals in the buffer zones and ensure that these rights alleviate community pressure on parks' resources. They recommend that RDB should work with local communities to devise a regime that grant local people management and user rights in a way that supports both conservation and community livelihood needs (Bizoza & Ndangiza, 2014).

While the tourism revenue sharing program's intention is to encourage robust local community participation, it has been criticized to failure to address pressing livelihood needs of the local communities thus making its participation not evident. Local people do not directly get compensation for the lost benefits from natural resources that they used to get directly from national parks. Instead, the funds are

invested in building infrastructure including roads, health care facilities and schools, which would otherwise be financed by the central government through budgets allocated to Districts. This investment has medium to long-term effects on socio-economic development of people living near national parks but it has no immediate impact on the conservation objectives. Parks management employs some of the individuals reported to undertake illegal activities such as poaching, but this is on a limited basis (Bizoza & Ndangiza, 2014). The report recommends that the support from revenue sharing should be tailored to address specific and immediate needs of selected individuals and households whose actions continue to jeopardize the park's conservation. Another critique is that the 5% allocation of tourism revenue sharing is too low considering the changing needs and rapid population growth. The authors recommend that it is increased to between 7.5 % and 15% and the information related to livelihoods and levels of poverty of people living in the vicinity of national parks updated for optimal allocations to ensure the Revenue Sharing Programme supports livelihoods and decreases local dependence on park resources (Bizoza & Ndangiza, 2014).

In addition to revenue sharing, development partners such as NGOs are working with communities to reduce illegal resource use. They group community members into cooperatives and give them support often in off-farm livelihood activities, such as sheep and goats rearing, bee keeping to replace resources that the people previously used to collect from national parks. They also give them alternative firewood and construction materials by supporting them to plant trees, give them alternative sources of water and health insurance. These partners also build capacity through workshops, trainings and meetings with local authorities and park management authorities (Bizoza & Ndangiza, 2014).

Apart from Akagera National Park that has an electric fence, crop raiding remains an unsolved issue around other national parks in Rwanda. Also, wildlife that gets outside the parks invade houses and cause human injuries in surrounding communities. Local communities complain that the compensation for damages is not forthcoming and the requirements to get compensation are both costly and very demanding for an ordinary citizen (Bizoza & Ndangiza, 2014).

There are also still gaps in terms of integration of biodiversity conservation concerns into national policies and development programmes. Thus, the country should ensure that biodiversity values are reflected in broader policies, incentive structures and pricing benefits associated with biodiversity use. This may be achieved through coordinated efforts by the government of Rwanda and different stakeholders that include government institutions, civil society organizations, the private sector, other development partners and the local communities.

2.3 Effects of land use changes on biodiversity conservation in national parks

2.3.1 Land use change as a driving force of biodiversity loss worldwide

Zhen et al. (2014) define land use as human activities that alter the land bio-geophysical conditions and its environment. Land use is the main element that determines the performance of socioeconomic functions of a landscape such as for crop and animal production, housing and infrastructure. Over the years, changes in land use have increased and it is reported that they have been transformed approximately by one-third of the land surface on the earth surface (Walingo et al., 2009).

The conversion of natural ecosystems to develop and expand agriculture has been the primary mode of land use change worldwide (Paudel et al., 2016) with the most important aim of improving food security. This was quickly followed by further transformations from agriculture to industrial and housing development further diminishing the potential for food security because these conversions sacrifice productive agricultural lands (Agus et al., 2004).

Agriculture, forestry and urbanization are the main drivers of changes in land use. Since 1970s, the primary direct cause of biodiversity loss in terrestrial ecosystems is land use change for agricultural expansion followed by unsustainable logging, hunting and overexploitation of fish stocks. Also, since 1992, urban area has doubled and infrastructure has considerably expanded primarily to the detriment of natural forests, grasslands and wetlands (Díaz et al., 2019). The tropical region alone lost 32 million

hectares of primary and secondary forests between 2010 and 2015 (FAO and UNEP, 2020).

Crops and livestock production use about one-third of the earth's land surface and around three-quarters of freshwater resources. Crop production occupies 12% of the total ice-free land while animal grazing takes 25 % of the total ice-free land and nearly 70 % of the drylands. The world should rethink the appropriate food production systems that will reduce biodiversity loss as intensive agriculture produces more food at the expense of ecosystem services needed to sustain it in the long term. There are emerging positive change in the thoughts of some scholars who have started demonstrating the environmental benefits of small landholdings (less than 2 hectares) in agricultural development. It is reported that they contribute about 30% of crop production and 30% of food calorific supply worldwide by only using approximately a quarter of agricultural land while preserving the rich agrobiodiversity (IPBES, 2019).

Between 1990 and 2015, logging cleared 290 million hectares of natural forests which contributed about 10% to 15% of global timber while only 110 million hectares of forests were planted word wide (FAO and UNEP, 2020) suggesting a global ratio of deforestation-afforestation of 2.6:1. This shows that more efforts must be made to reduce deforestation and increase reforestation of the world to reverse the curve.

The key drivers of unsustainable use of nature are growing human population and related food demand (Brouwer et al., 2023 ; Mandima et al., 2011). The global human population has increased from 3.7 to 7.6 billion since 1970. Per capita consumption also has quickly grown with unequal rate between and within regions. The total GDP of developing countries is four times lower to that of the developed countries. Consequently, food insecurity is also unevenly distributed. Food insecurity affects around 821 million people in Africa and Asia and approximately 40% of the world's population lacks access to safe and clean water (Díaz et al., 2019).

Large world ecosystems are increasingly becoming vulnerable to new threats due to expansions of infrastructure such as roads and cities. For instance, paved roads are expected to increase by 25 million kilometres worldwide by 2050. These expansions come with high social and environmental costs related to deforestation, biodiversity loss, habitat fragmentation, encroachment and local people displacement and related social disruptions. Yet, well planned and efficient infrastructure development can simultaneously generate environmental gains and positive economic effects (Ceballos et al., 2015).

Over the coming decades, the contributions of biodiversity and ecosystems to people's livelihoods are expected to decline further (Mandima et al., 2011) as rural households continue to experience shortage of fertile lands and therefore illegally use nearby protected natural areas to meet their food demands (Mandima et al., 2011). In most cases, to produce food, people around national parks encroach areas that are unsuitable for farming but contain significant biodiversity and provide important ecosystem services. This extensively damages the wildlife and its habitats and, increases local food insecurity experienced by vulnerable people as ecosystem services' base deteriorates. Also, it is well documented that increasing use of land that is unsuitable for agriculture and overexploitation of lands that results in degradation of ecosystem services, including loss of soil fertility, is not a long-term solution to food insecurity. For this, people around national parks who mainly depend on small scale agriculture and collection of natural resources from parks are unlikely to accumulate capital and therefore remain in a poverty trap with resources that help them to survive but without being able to improve the quality of their life and therefore continue to be vulnerable to shocks (Mandima et al., 2011). Therefore, understanding the trade-offs and synergies between food security and conservation is necessary for National Parks sustainability.

Increasing productivity of land and labor may help to create new livelihood options that benefit both biodiversity and people. This may include providing improved seeds and other crop production inputs, introducing improved livestock and technology that reduces agricultural expansion at the expense of biodiversity. The pressure to expand

subsistence agriculture into national parks to satisfy immediate food needs can be reduced by increasing farm yields under agriculture intensification and local labour productivity in zoned areas through land use planning that is led by communities and supported by adequate strategies, policies, market and management interventions. Increased agricultural production alone cannot result in new opportunities for biodiversity conservation or more secure livelihoods for the rural poor around national parks. There is also a need to ascertain that local people get benefits from national parks, receive incentives, get involved in parks' governance, have rights to land tenure (Fischer et al., 2017; Speelman et al., 2014) and get compensation of damages made by the wildlife (Mandima et al., 2011). The combination of all these factors is likely to improve local food security and thus it would not be necessary for local people to encroach national parks for subsistence cultivation, poaching, cutting down trees for firewood, timber or charcoal making in order to meet their basic needs. As a result, biodiversity inside national parks will grow and destruction of its habitat reduce. Achieving food security will also create favourable conditions for local people to opt for new options of land use that necessitate sustainable management strategies that provide higher potential for producing resources that offer a way out of poverty (Mandima et al., 2011).

All these issues concerning land degradation, the unsustainable use of natural resources and food insecurity are well felt in the Zambezi Heartland as it has been revealed by a study of Mandima et al. (2011). The Zambezi Heart land uses a rapid and important agricultural expansion scheme for maize production in areas where soils and climate are not suitable. Therefore, overtime yields reduced due to inefficient agricultural practices that wash soil nutrients. Consequently, more land is cleared with cultivation shifting. Poor farming practices have resulted in land degradation and rivers and streams' sedimentation, lowering water quality and depleting aquatic biodiversity. Also, local communities in the Zambezi Heartland depend on traditional subsistence agriculture and, subsistence fishing is the main livelihoods' option along the rivers. There is no formal participation of local communities in economic activities that use other natural resources such as wildlife, tourism or trade of non-timber forestry products such as fruits and honey. In addition,

wildlife conservation is not welcome, because most of local people do not get direct tangible benefits from tourism and face the challenge of wild animals that destroy their crops and causes injuries or loss of human lives and livestock. The conflict expands as people occupy new areas for cultivation, thus reducing and fragmenting biodiversity habitats while not necessarily increasing crop production or related gains (Mandima et al., 2011). Guinness (2014) recommends revising regional and national policies to resolve the persisting conflicts between subsistence communities around national parks and the protected biodiversity.

Existing approaches to understand the interconnected processes that result in food security and biodiversity conservation outcomes frequently do not consider temporal and spatial scales, and the interactions between them (Wittman et al., 2016). This may lead to over-simplification of communities' role in national parks' governance and related policy considerations (Lang et al., 2001) and missing them as important actors in the food systems (Ericksen, 2007). Understanding the effects of agricultural development on biodiversity is critical to ensure that long term food production is supported by the natural resource base. However, the current approaches neglect some necessary elements that also affect conservation of biodiversity and food security such as resources use rights (Conway & Schipper, 2011) and lack of equity and social justice in sharing benefits from biodiversity conservation (Lambin et al., 2001). Integrating food security and biodiversity conservation requires a more integrated approach for socio-ecological systems due to the complexity of agricultural landscapes and management of national parks that is in most cases government-owned (Mandima et al., 2011).

2.3.2 Land use changes in Rwanda

Data about land use changes in Rwanda before 1990s is limited if not non-existing. According to Mpyisi et al. (2003), Rwanda underwent significant changes in land use patterns between 1990 and 2002. The area of cultivated land increased from 64% to 74% (from 782,500 hectares to 899,133 hectares) at the expense of forests management, fallow, and pastureland. From 1990 to 2002, the area covered by forests decreased from 11% to 7% and pastureland and land under fallow reduced from 22% to 14%. These authors explain that these trends of rapidly increasing cultivated land

was observed from the mid-eighties, implying that since then, land has been farmed more intensively without enough fallow to allow the soil to rejuvenate. Deforestation for agricultural expansion had significant implications on the environment.

The rural population in Rwanda whose livelihoods depend on land has increased by 27 % from 1984 through 2002 (Mpyisi et al., 2003). These trends remain the same and, today land is intensively cultivated without fallowing (Republic of Rwanda, 2009a). The rapid population growth and land parcelling is caused very rapid reduction in household's land holdings: which was 2 hectares in 1960s, but reduced to 1.2 hectares in 1980s and to 0.5 hectares in 1990s (Clay & Lewis, 1996) and to 0.3 hectares in 2012 (Republic of Rwanda, 2012b). Such land scarcity and the fact that subsistence agriculture employs more than 90% of the population (Rurangwa, 2013; Musahara et al., 2014), justifies the persistent food insecurity and human pressure on national parks in Rwanda.

Rwanda population was estimated to be 1,595,400 in 1934, had risen to 7,700,000 by 1997 (Republic of Rwanda, 2011a) and to slightly above 11.5 million in 2013 (Musahara et al., 2014). The country is the most densely populated in the great lakes region with a average population density of 415 inhabitants per km^2 (Republic of Rwanda, 2012b). The density was only 183 persons per sq. km in 1978, and 321 in 2002. In Rwanda, land is the most valuable asset both for survival and production and it will continue to be the foundation of the country's agriculture-based economy for may years to come. Agriculture contributes about 40% of GDP and employs more than 90 % of the Rwandans population (Rurangwa, 2013; Musahara et al., 2014), with average land holding less than 0.3 hectares per household (Republic of Rwanda, 2012b). Traditionally, Rwandans are very attached to land. Consequently, competition for land access is increasing due to rapid population growth and lack of off-farm jobs. Almost 78% of the country is used to crops and livestock farming and exotic tree plantations. Around 21% of the country is under natural cover, mainly wetlands, lakes and open water, and natural forest. Urban areas account for about 1% of Rwanda's area (Mendelson et al., 2016) which is 26,338 km^2.

Most of the land under agriculture is cultivated under very small landholdings (less than 0.2 hectares), primarily for household subsistence (Musahara et al., 2014, Republic of Rwanda, 2012b). In Rwanda, subsistence agriculture involves a wide variety of crops grown throughout the country including food staples such as beans, bananas, sweet potatoes, Irish potatoes, maize, cassava and sorghum. Banana is the most widely planted staple crop in Rwanda, occupying 348,717 ha of the harvested land area; the second being beans with 336,577 ha, followed by cassava with 163,099 ha, sweet potatoes with 149,724 ha and Irish potatoes occupying 127,226 ha. Cash crops grown in Rwanda are mainly coffee and tea that take up less than 3% of the land area (Rurangwa, 2013). Over the years, Rwanda underwent significant changes in crop distribution by the agricultural land area they occupied. From 1990 to 2002, there have been no significant changes in the area occupied by cereals and legumes. However, the area covered by tubes increased from 25% in 1990 to 33% in 2000 while the area occupied by banana decreased from 26% to 23%. Also, the area covered by vegetables reduced from 3% to 1% and the area occupied by coffee, tea and other cash crops dropped from 8% to 5% (Mpyisi et al., 2003).

A recent mapping of Republic of Rwanda (2019) on Rwanda forest cover revealed that between 2009 and 2019, Rwanda's forests occupied approximately 724,695 ha (30.4%) of the total country land. Of this forest land, 387,425 ha (53.5%) were plantations, 161,843 ha (22.3%) were wooded savannah,130,850 ha (18.1%) were natural mountain rain forests and 43, 963 hectares (6.1%) were shrubs. Bamboo occupied 613 ha. Southern and Western Provinces contain 50% of the total forests of which 174,199 hectares are in the Western Province and 177,537 hectares are in the Southern Province. The Eastern Province takes up to 38% of the total forestland (274,630 hectares). Northern Province contains only 85,688 hectares and Kigali City remains only with 12,641 hectares. The same report indicates that countrywide, about 105,713 hectares (15.7%) of forest and woodlots area have been deforested while new 139,674 hectares have been planted (20.7% increase of forest cover from 2009 to 2019). This means that the net balance is about 5% afforestation rate over 10 years (on average, 0.5% of forest area is added each year).

2.3.3 Effects of changes in land use on food security in Rwanda

Land is an essential resource for food security in many societies that depend on agriculture. The livelihoods of more than 90% of Rwandans are dependent on subsistence agriculture. However, the rising population density leads to its over cultivation and increased environmental stress. There has been massive environmental degradation in the past four decades and it is recorded to increase over time (Wiesmann et al., 2015). In 1990s, land holdings had shrunk and had become extremely fragmented, and agriculture was expanded to marginal and fragile lands. Also, fallow periods had been shortened or were non-existent and more farmers were renting plots for farming (Clay & Lewis, 1996). This exacerbated soil erosion that the country was already facing due its relief of steep slopes. Erosion affects 50% of all farms in Rwanda, resulting in the fall of agricultural productivity (Musahara et al., 2014). The annual loss of humus per hectare per year in Rwanda is estimated to 10MT (Wiesmann et al., 2015).

Since decades, food insecurity has been more pronounced in Rwanda's rural areas where land remains the population's most valuable asset (Musahara et al., 2014). Over the centuries, landholdings in Rwanda have been regulated by customary law and land control was inherited from father to son. Land fragmentation and land renting started in 1950s, resulting from human pressure on land due to rapid population growth. A lot of migrations to areas with virgin lands in other parts of the country and to neighbouring countries such as Democratic Republic of Congo, Uganda and Tanzania followed (Musahara et al., 2014). In 1990s, the average landholding per household reduced to 0.5 hectares from 1.2 hectares in 1980s (Clay & Lewis, 1996). It is this time that the government realized the urgent need for paradigm shift in land use and management. The problems facing land use included growing human pressure on natural forests and wetlands, declining agricultural production, growing conflicts between agriculture, livestock and natural reserves and increasing number of landless households. Thus, several studies on agricultural productivity, crop intensification and land use in the country started pointing out the pressing need for land reform that could reduce land fragmentation (Clay & Lewis, 1996; Kelly & Murekezi, 2000; Musahara et al., 2014). At the same time, reforestation programs were initiated across the country (Musahara et al., 2014).

According to Austin et al. (2012), land fragmentation occurs when a household uses non-connected plots at the same time, either owned or rented. Some scholars describe land fragmentation as an issue related to farm management and regard it as a characteristic of less developed systems of agriculture (Van Hung et al., 2007) that can be an impediment to agricultural development because it hampers mechanization of agriculture, causes production inefficiencies and entails enormous costs to mitigate its impact (Najafi, 2003). Bizimana et al. (2004) argue that land fragmentation makes agricultural production and supervision of farming difficult and costly due to long walking distances to small distant farms that cause loss of working hours and make it difficult to transport agricultural inputs and products. In light of these views, the government of Rwanda adopted land use consolidation in 2008 to increase agricultural production while protecting the environment (Musahara et al., 2014; Musahara & Huggins, 2005).

Land use consolidation was preceded by several reforms in land use. The first was the formulation of Rwanda Vison 2020 that was launched in 2002, focusing on sustainable land use and agricultural production to transform the country into a middle-income economy by 2020. Consequently, in 2004, the Rwandan government adopted a National Human Settlement Policy (updated in 2009) that stresses that rural dwellers should move into villages (Republic of Rwanda, 2009b) not only to avail the agricultural land for land use consolidation but also to create more urban areas that could yield off-farm employment in order to reduce the number of people that depend on agriculture. Under this settlement policy, households that gave away their land for grouped settlements were compensated by the households that occupied their land. In the same year (2004), the country adopted the first ever national land policy (updated in 2014) that was followed by the 2005 organic law determining the management and use of land in the country (updated in 2013). The aim of this law was to improve security of tenure through land registration and rights of all citizens to get land titles that are supported by official certificates as full evidence of ownership of land right. All rural land previously under customary tenure were since then granted an Emphyteutic Lease of 99 years (Rurangwa, 2013). Both the land policy and organic

law on land consider land as an important asset for political and socio-economic transformation. Land rights and their transfers and penalties on misuse of land are authorized by the law (Rurangwa, 2013). The land policy and land law made it clear that crop intensification, villagization (grouped settlements) and other land uses should be linked (USAID, 2013). Thus, the Crop Intensification Program was launched in 2007 and Land Use Consolidation started in 2008 as an important pillar meant to resolve land use changes effects. Also, the Crop Intensification Programme is anchored in the agricultural policy reform that aims at increasing the agricultural productivity of high potential food crops that may increase the country's self-sufficiency and improved food security. The Land Use Consolidation Program aims to combine small agricultural plots into one unit in order to achieve economies of scale in acquiring agricultural inputs, harvest processing and marketing, and to ensure efficiency in access to extension services with the end result being enhanced productivity and increased crop yields (Musahara et al., 2014). In 2012, Rwanda embarked on development and land use master plan that is translated into Districts' plans to guide zoning of land uses including agriculture, resettlement, urbanization, public infrastructures, and biodiversity conservation (Rurangwa, 2013).

The studies of Kathiresan (2012) and Musahara et al. (2014) show that land use consolidation has helped to increase productivity and yields in the country priority food crops including beans, wheat, maize, soybeans, Irish potatoes, cassava and rice. Yet, these authors accept that there are still gaps in understanding on to what extent the improvement in food security in Rwanda could be attributed to land use consolidation program. Since the launch of the land use consolidation program, important changes occurred at macro level including the increase in the area of land consolidated and in yields but these records require more empirical evidence given that these statements are too general and cannot fully support the food security concept (Musahara et al., 2014). The findings of the assessment of Musahara et al. (2014) show that 67.3% of respondents under land use consolidation program had insufficient food for their households while 49.7% said that they consumed cheaper and less preferred food during the 7 days prior to the interview. In addition, 45.7% of

respondents said that they reduced the number of eaten meals and 47.1% reported that they limited the sizes of their meals (Musahara et al., 2014).

As opposed to the perspectives of the Rwandan government and the scholars above who are against land fragmentation, other scholars argue that land fragmentation was more favourable for Rwandan farmers. They stress that some of its advantages are the fact that each plot has its specific fertility characteristics, accessibility, retention of water, altitude and, tenancy form that allow for crop diversification and risk management (USAID, 2013). According to USAID (2013) the disadvantages of land fragmentation including long distance from the homestead may be offset by these benefits and better labour spacing across the year given that various crops are planted in different soils and microclimates and thus require different labour demands. Also, they stress that land fragmentation results from the fact that households view land as an asset. They sell some of their plots during hard times and purchase new ones as soon as financial means become available. The view of some scholars is that the private benefits of land fragmentation might be as large as the private costs (Blarel et al., 1992).

The sustainability of the land use consolidation programme in Rwanda remains unknown (Musahara et al., 2014). This is based on a similar system that was tried in Malawi in 1940s and early 1950s to transform the country agriculture (Muhinda & Dusengemungu, 2011) and collapsed in 1960s after consolidating 81,000 ha in 30 areas across the country primarily due to inability to persuade local chiefs to adopt this programme. Each household in those areas ended up with a consolidated land parcel equal to the same size of the fragments that they had previously owned but there was dissatisfaction because the government insisted on fixed rotations, extension officers' request for intensive labour and in some areas no a satisfactory crop could be grown. Despite these challenges, Land Use Consolidation Programme helped to build the capacity of farmers to meet food security through improved productivity (Holden & Lunduka, 2010).

Rurangwa (2013) reveals that the type of land consolidation practiced in Rwanda is rather crop consolidation as farmers continue to grow the subsistence or cash crop on their individual plots that are less than 1ha, which is the minimum surface area that is economically profitable under land use consolidation as provided by the Land Policy. The author continues to argue that this means that land use consolidation does not help much at the household level. Each household continues to own fragmented plots and ensures that they grow the crop designated for the area where it is located. This means that households may end up planting only one crop throughout the year. The shortcomings include unbalanced diet, hunger when this crop fails, time to buy the crop that was not planted in some cases more expensive than the sold crop. With climate change, intercropping should help better than monoculture (Dawson, 2013).

2.3.4 Effects of land scarcity on national parks in Rwanda

Over the past 40 years, Rwanda national parks lost more than 60% of their land area mainly due to agriculture development (Republic of Rwanda, 2013). The size of the Nyungwe natural forest reduced from 114,125 ha to 97,138 ha between 1958 and 1978 due to forest clearing for agriculture development. This huge forest was already being destroyed by commercial timber production and poaching of mammals including elephants, buffaloes, duikers, etc. Currently, the Nyungwe natural forest remains with about 90,000 ha and it had become a national park in 2005.

The Gishwati natural forest was gazetted as a forest reserve in 1930s and that time its size was 21,000ha. 5,000 ha of this area were converted into grazing land by a World Bank financed project in 1981 (Republic of Rwanda, 2014). After the genocide against the Tutsi, between 1994 and 2005, 95% of Gishwati forest has been redistributed to some of the former 1959 refugees who returned to the country. Today, the remaining forested area is only 600 ha of secondary forest and 900 hectares under restoration that were reclaimed in 2010 from local people (Mendelson et al., 2016).

The government of Rwanda created the Akagera National Park in 1956 with an area of 331,000 ha. This size decreased to 255,000 ha in 1992 and to 90,000 ha in 1997 as the government gave the remaining area to old refugees returning from exile in 1997 for the resettlement pursuant to the Arusha Peace Accords. The Akagera region

experiences prolonged droughts that have negative effects on mammals in the park and on the cattle around the park. For instance, 22 hippopotamus died in 2000 due to lack of water and about 30,000 cows died in 1997 due to lack of fodder and water (Republic of Rwanda, 2014).

The volcano forest area was 35,000 ha in 1958 but in 1973, it had lost 49% of its surface area due to land settlements and introduction of pyrethrum in the region. Currently, this forest remains with 15,000 ha (Republic of Rwanda, 2014).

2.4 Benefits from National Parks to local food security

2.4.1 Contribution of benefits from national parks to local food security

. Bush meat and wild vegetables, honey, mushrooms, fruits, seeds and tubers from natural forests provide diet rich nutrients for households around national parks (IPBES, 2019.; FAO, 2014; Mulongoy & Chape, 2004). Also, local communities have been harvesting for thousands of years other commodities from natural forests such as bamboo, animal skins, firewood, construction materials, medicinal plants and timber (Díaz et al., 2019; Mulongoy & Chape, 2004). Other benefits include revenue from tourism, and ecological services at local level including soil regeneration, nutrient cycling, pollination, recreation and potable water (IPBES, 2019; Mulongoy & Chape, 2004). Also, most of modern varieties of crops and livestock are derived from their wild relatives (Díaz et al., 2019).

Fuelwood and water are essential resources for food systems but they are often overlooked (Kuhnlein, 2009). In sub-Saharan Africa, about 95% households rely on firewood and charcoal as their source of energy for cooking (Shakya et al., 2021). Household's access to fuelwood contributes to its food and nutrition security. However, fuelwood has been scarce in many areas over the last years due to deforestation (Knight & Rosa, 2012; Arnold & Persson, 2003) that imposes travelling long distances for access or more spending. Firewood collection is becoming more and more time-demanding for poor families especially women and children. The time they spent collecting fuelwood exacerbates their poverty as women should use this time to work in agricultural farms, cook and take care of their children or perform other income generating activities. Also, it is well documented that children drop out

of school or miss some classes due to travelling for long distance for firewood collection (Wan et al., 2011).

Natural forests play a safety-net function to local communities especially during cyclical or seasonal food gaps, periods of low agricultural production and times of climate induced vulnerability such as drought or during periods of food insecurity. Also, households turn to natural forests in the situation of exhaustion or diminution of other sources of income or need of cash to solve issues such as medical or educational needs (Sunderland, 2011).

When national parks were being created, local communities were banned the user rights. They exhibited fortress conservation approaches or fences and fines approaches (Chan et al., 2007; Redford, Robinson & Adams, 2006; Siurua, 2006); that were traditional, top-down exclusionary approaches to management of national parks (Brown, 2002). Between 1970s to the 1990s, a strong consensus was developed that the conservation of national parks has to go beyond conservation and contribute to poverty reduction (Mulongoy & Chape, 2004). The growing global human population, particularly in the vicinity of national parks (Wittemyer et al., 2008), became a condition that the success of conservation had to increasingly be linked to the level of local support it receives and the nature of appropriate benefits it offers to communities (Brown, 2002). However, still a lot has to be done to ensure that local people get fair benefits from national parks (Díaz et al., 2019). Mulongoy & Chape, (2004) indicate that if local communities have to get sustainable benefits from national parks, institutions have to solve related issues involving proper scales and proper roles. They suggest that local communities if empowered with proper tenure may handle threats to biodiversity loss than public institutions, and that if governments have resources and the political will can deal with strategic issues better than local people. These authors also argue that national parks should be integrated in the whole national system of land use when they are conceived. They indicate that some sites can be designed to primarily respond to local people's needs such as (provisioning of food, job creation and recreation) and others can be created to focus

on biodiversity conservation, while others can be established to mainly generate national benefits such as international tourism and watershed protection.

Other scholars proposed a Community Conservation or Community Based Conservation approach in the mid-1960s that became progressively adopted by several countries (McShane & Wells, 2004). This approach recognizes the need to involve local communities in conservation efforts and assumes a linkage between development and conservation (Brown, 2002). Activities implemented under this approach are generally termed Integrated Conservation and Development Projects (ICDP) (Newmark & Hough, 2000). Despite wide implementation of ICDPs, several scholars documented their failure to provide either long term benefits to local livelihoods or conservation of the natural resources (Guinness, 2014; Bush et al., 2010; Adams et al., 2004; McShane & Wells, 2004; Brown, 2002). Ferraro & Kiss (2002) advocate for a new approach named "Payment for Ecosystem Services (PES)" for linking conservation and local livelihoods by directly paying households as a way of encouraging them to adopt desirable social and environmental behaviour. The approach is gaining momentum and it is widely used in Latin America and growing in other parts of the globe.

In Rwanda, each national park has a Community Conservation Program through which local people get involved in the park management, about 10% of tourism revenue is shared with local communities and national and international NGOs support for local livelihoods with the aim of providing alternatives to park resources. However, this program seems not to address the real needs. For instance at VNP, although gorilla tourism injects a considerable amount of money in the country's revenue and there are several ICDPs implemented around the park, their impact on conservation and local community livelihoods remain unclear (Bush et al., 2010; Sabuhoro, 2006). Previous studies undertaken by Guinness (2014); Munanura (2013); Bush et al. (2010); Sabuhoro (2006) and Plumptre et al. (2004) indicate that a large number of households around VNP are poor and this is justified by food insecurity, low income, water shortage, poor housing, low education level and poor health services. Average annual income has been estimated to be less than USD 540 per household, a figure below the poverty line (Bush et al., 2010). This study provides an

empirical justification for food security importance in the debate around involvement of local people in conservation of VNP biodiversity, a factor that has not been previously given due attention.

2.4.2 Food Security in Rwanda

Rwanda has made commendable overall development progress since 1994 genocide against the Tutsi. Yet the country still faces developmental challenges including rapid population growth, poverty, food insecurity and chronic malnutrition (Republic of Rwanda, 2012b). Research on food security in Rwanda is mainly undertaken by National Institute of Statistics (NISR) supported by the World Food Programme (WFP). The findings of the 2018 report on comprehensive food security and vulnerability analysis (CFSVA) and nutrition reveals that 19% of Rwandan households are food insecure moving from 21% in 2012. This analysis shows that food insecure households are those who are typically poor living in small and crowded houses in rural and remote areas far from main roads, markets and hospitals or other public infrastructure; depending on own low-income agriculture, agricultural daily labour, external livelihoods support, unskilled daily labour; and in many cases headed by a lowly educated, elderly person, single or a person with disability (Republic of Rwanda, 2018a). In most cases, few members of these households are active (ranging between 18 and 60 years of age), have small land holdings or are landless. Thus, they grow few crops, unlikely plant vegetables or own livestock and they unlikely practice land conservation (Republic of Rwanda, 2018a).

Across Rwanda, families that are involved in off-farm employment have better livelihoods than those that are involved in agriculture and they represents only 15% of the entire population because 85% of households in Rwanda are small scale farmers whose livelihoods depend on cultivating land and raising livestock (Republic of Rwanda, 2012b). About 60% of farmers own land that is less than 0.5 ha and 26% of them own land that is less than 0.2 ha. This land is often located on steep slopes with poor soil fertility thus chronic food insecurity (Republic of Rwanda, 2012b).

Another important constraint for households to access food in Rwanda is high seasonal variation of the prices of staple crops. The most vulnerable to high food

prices are the poor households, especially during the lean season when they have finished their food stocks and they have no monetary buffer to protect their families from the shocks' shortcomings like flooding, drought, sickness, and crop failure due to diseases. The most recent food security status report of Republic of Rwanda (2018a) reveals that 67% of interviewed households reported that they experienced some type of difficulty to access food in the 12 months that preceded the survey compared to about 51% in 2012. About 40% had seasonal food access problems compared to about 20% in 2012, about 22% experienced acute food access problems compared to about 17% in 2012 while about 5% encountered chronic food access problems compared to about 14% in 2012. These trends show that households' resilience to shocks is reducing over time. Household reliance on markets was found to be increasing and constitutes the main source of food for Rwandans who, on average, spend almost half of their expenses on food. The figure 2.1 below shows the status of food insecurity per district.

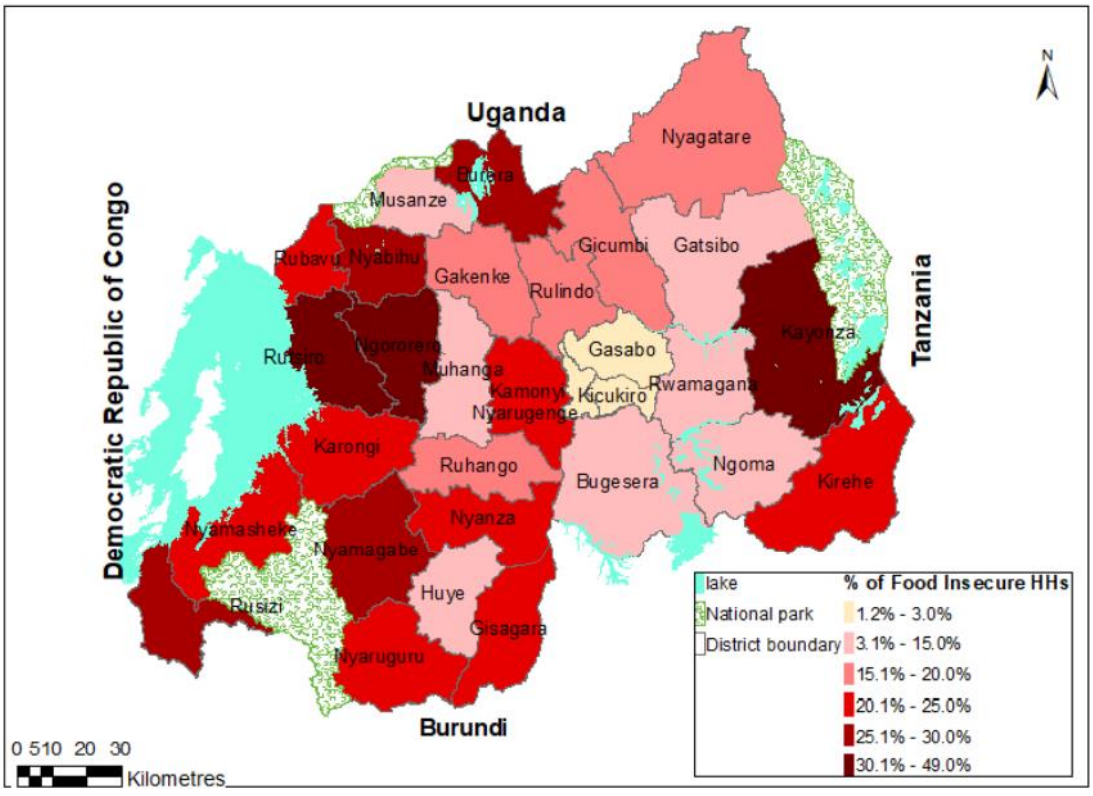

Figure 2.1: Districts' percentages of food insecure households in Rwanda (2018)

Source: Republic of Rwanda (2018a)

The Republic of Rwanda (2018a) report recommends improving and diversify agricultural production, mitigating risks and improve household resilience to shocks, facilitating access to structured markets, improving food consumption through behaviour change, targeting and timely assisting the most vulnerable households through integrated safety nets and to undertake deeper food security monitoring and analysis in order to improve food security across the country. This NISR study used the Sustainable Livelihood Framework as this study did.

The review of the existing policy documents by Africa Leadership Training and Capacity Building Program (2014), revealed that policies, institution frameworks and action programmes have been put in place to improve food security, reduce poverty and eradicate hunger in Rwanda but the involvement of civil society organizations, private sector and research institutions is very limited. Authors recommend defining clearly and improving these stakeholders' roles in policy process. The findings of this study also reveals that the policy cycle is planned based on the analysis of the financial output rather than the analysis of the economic impact that should be the appropriate framework for designing, implementing and evaluating policy options. The authors furthermore indicate that food security priorities are not well reflected in development policies and therefore lack of coordination between ministries. The authors recommend capacity building that is multisectoral to ensure integrated planning and that right institutional arrangements are put in place for effective policy design and implementation (Africa Leadership Training and Capacity Building Program, 2014).

2.5 Research gaps

The reviewed literature on research gaps (Guinness, 2014; Munanura, 2013; Mandima et al., 2011; Bush et al., 2010; Sabuhoro, 2006; Weber, 1987) shows information gaps on integrating biodiversity conservation and food security. Rwanda Biodiversity Policy and Wildlife Policy promote conservation of wildlife in protected areas and call for community conservation and improvement of local community livelihoods. However, the extent to which these policies consider food security improvement around protected areas still remains unknown. Some studies attempted to link threats to national parks in Rwanda with rapid human population

growth (Munanura, 2013; Bush et al., 2010; Plumptre et al., 2004) but they did not analyze the role of land use changes on food security to enable for planning of effective measures that can reduce human pressure on National parks such as VNP. Also, the role of conservation benefits in improving local food security remains poorly delineated. Studies that link food security and wildlife conservation are still limited in the existing literature (Glamann *et al.*, 2015). Most of the existing scanty literature globally and in Rwanda have broadly looked at the impact of conservation of national parks on local community's livelihoods without disaggregating indicators to show food security status and spatial variation of the food security magnitude in order to allow for targeted and effective interventions. Most of their analysis is limited to broader poverty indicators (Barrett, 2010; Lindenberg, 2002). Thus, the link between conservation of national parks such as VNP and local community's food security has not been comprehensively analysed in literature. This forms the basis for this study.

CHAPTER THREE

STUDY AREA AND METHODOLOGY

3.1 Location and extent of the study area

This study was carried out around VNP within a boundary radius of 10 km from the park edge as shown in figure 3.1 below. The VNP is a mountain natural forest of about 160 km^2 located in North-West of Rwanda. This national park was established in 1925 with the purpose of protecting mountain gorillas (Republic of Rwanda, 2004b). This park, together with Mgahinga Gorilla National Park on the Ugandan side and Virunga National Park on the side of the Democratic Republic of Congo form the Virunga massif. VNP ranges in altitude from 2300 meters to 4500 meters and lies in the Albertine Rift (1°21'–1°35'S and 29°22'–29°44'E), that separates the Nile and Congo River basins (Weber, 1987).

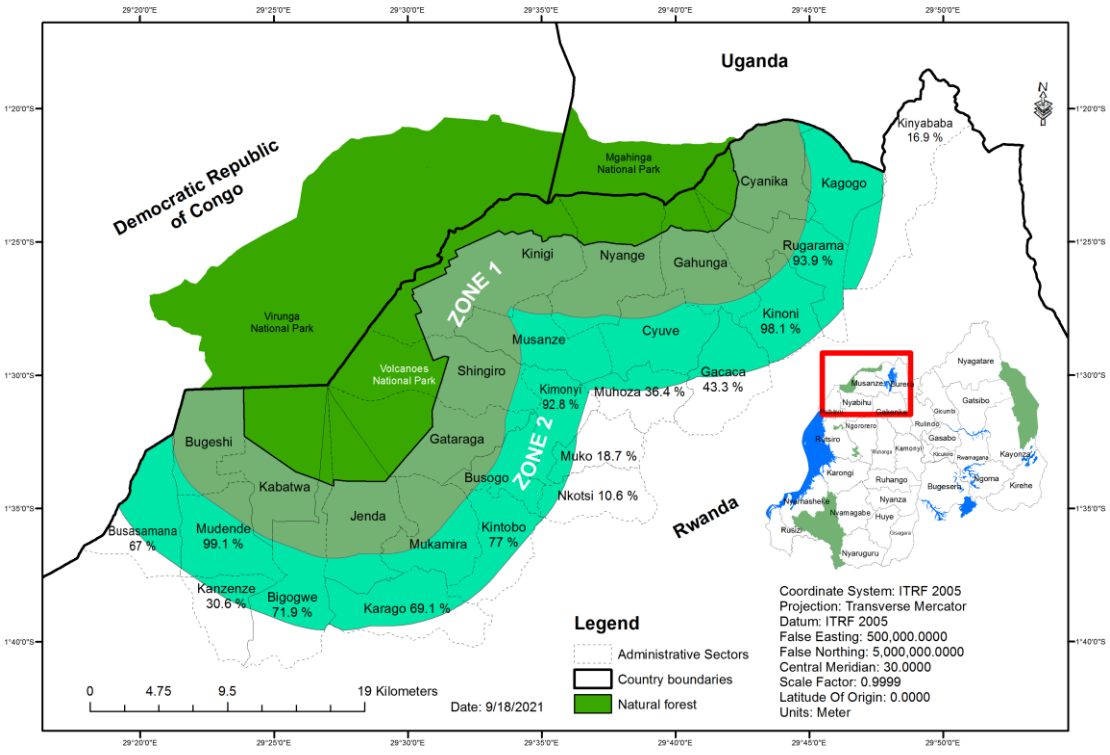

Figure 3.1: Location of the study area

Source: GIS data, 2017; Republic of Rwanda (2012b).

3.2. Climate, topography, drainage, vegetation, geology and soil

Besides the VNP, the environment in the study area is highly anthropogenic due to permanent human occupation since several decades. The study area has two different landscapes: the mountain range with altitude that ranges from 1,900 m to 2,000 m and the volcanic plains with 1,860 of average altitude. The mountain range has the highest picks of the country which are volcanoes. These include Kalisimbi of 4,507m; Muhabura with 4,127 m; Bisoke of 3,711 m; Sabyinyo that has 3,574 m and Gahinga of 3,474 m. The area of this study has a tropical-high altitude climate characterized by average temperatures ranging from 9^0C to 29^0C (Republic of Rwanda, 2012a) and abundant rains that range from 1,400 mm to 1,800 mm per year. The region has 2 rainy seasons and 2 dry seasons with the big dry season starting on June and ending in mid-September. This is followed by the short rainy season that ends in December. The short rainy season ranges between January and March followed by the big rainy season that ends in May (Republic of Rwanda, 2012a).

The hydraulic network in the study area comprises permanent waterbodies and temporary torrents caused by water running downhills from the volcanoes. During strong storms, these water overflows create heavy sedimentation, floods and erosion and destroy crops. Permanent waterbodies around the VNP include rivers, springs and lakes of Burela, Ruhondo, Mukamira and Nyirakigugu, all in the Nile basin. Their water flows into Mukungwa river that discharges into river Nyabarongo, which in turn flows into river Akagera that ends up in lake Victoria (Republic of Rwanda, 2012a).

Geologically, the volcanic region is covered by lava sediments that result from volcanic eruptions that occurred at different instances several years ago. Cenozoics and proterozoic rocks such as granites, metaquartzites, orthoquartzites, phyllites and pegmatites are found in the area (Uwiduhaye et al., 2018). Volcanic rocks are potassic and alkaline with the abundance of K-benmoreites ,K-basanites, Kmugearites, K-hawaiites and leucitites (Uwiduhaye et al., 2018). About 70% of the soils in the study area are volcanic. Others are clay, sandy and lateritic especially in Shingiro and

Gataraga sectors where crop production is low compared to the areas with volcanic soils (Republic of Rwanda, 2012a).

Inside VNP, the vegetation is natural while on agricultural land the dominant tree species is eucalyptus followed by agro-forestry species such as grevilleas and alinus. The majority of agricultural land surface in the area of the study is covered with crops (Republic of Rwanda, 2012a).

3.3 Biodiversity Status in the VNP

Despite its size, VNP is home to a significant biodiversity including mountain gorillas *(Gorilla Beringei beringei)* that are listed as critically endangered by IUCN that only live in Virunga Massif and Bwindi Impenetrable Forest, golden monkey (*Cercopithecus mitis kandti*), an endangered sub-species of the blue monkey are only found in central Africa, African buffalo (*Syncerus caffer*), African elephant (*Loxodonta africana*), black-fronted duiker (*Cephalophus nigrifrons*), bushbuck (*Tragelaphus scritpus*), serval (*Leptailurus serval*), African golden cat (*Carcal aurata*), servaline genet (*Genetta servalina*), side-striped jackal (*Canis adustus*) and eastern tree hyrax (*Dendrohyrax arboreus*) (Nyiratuza, 2016; Pavageau, Tiani & Butterfield, 2013; Owiunji et al., 2005; Plumptre et al., 2006). Additionally, VNP shelters several bird species, including some on Albertine Rift endemics list and others on IUCN Red list. It is also a habitat of several species of amphibians, reptiles and insects (Plumptre et al., 2006). VNP supports 624 plant species (Owiunji et al., 2005) including Albertine rift endemics and threatened species listed by IUCN. Spatial distribution of these species is highly heterogeneous due to the significant altitudinal variation of the volcanoes landscape (Gray et al., 2010) zoned from open montane forest to sub-alpine vegetation, afro-alpine vegetation and bamboo (Republic of Rwanda, 2004b). Exotic species such as black wattle (*Acacia mearnsii*), eucalyptus (*Eucalyptus spp.*), cypress (*Cupressus spp.*) and pine (*Pinus spp.*) are also found at the park edge (Owiunji et al., 2005; Ruzigandekwe, 2009).

According to Republic of Rwanda (2015b), the number of poachers encountered inside VNP increased over time (from 12 in 2009 to 34 in 2012 and 56 in 2015). Also, night bamboo cutting is increasing. Only in 2015, 726 snares were destroyed, 18

bamboo cutters were arrested, and 1 gorilla was found coughed in a snare. Furthermore, crop raiding by wild animals was reported to be a big issue. Indeed, this report reveals that local people are resisting to get involved in park conservation if not paid. Finally, the report shows that most of illegal activities take place during May and September. This may be the evidence that the pressure on the park is due to food insecurity because these are the months that local people have no enough food because they harvest in June/July and December/January. Hickey et al. (2018) recommend enforcing protective measures and addressing emerging threats to ensure longer term increase of the mountain gorilla population in the Virunga massif. These authors warm that the increasing proximity between humans and gorillas causes a high threat of disease outbreaks that soon may rapidly reverse the gains made during the last three decades. They recommend to effectively enforce and implement all IUCN best practices and guidelines for great ape conservation throughout the Mountain Gorilla habitat as the survival of this species will continue to depend on conservation for the foreseeable future.

3.4. Land use and socio-economic characteristics of the area of the study

The VNP region is the most populated in rural Rwanda (outside the City of Kigali) with the average population density of 703 inhabitants per km^2 (Republic of Rwanda, 2012b). The four Districts that surround the VNP are among the five Districts of the highest population density of rural Rwanda. Rubavu District encounters the highest population density of 1039 people per km^2, Musanze is the second with 694 inhabitants per km^2, Nyabihu the fourth with 555 inhabitants per km^2 and Burera is the fifth with 522 inhabitants per km^2. The third is Huye with 565 inhabitants per km^2 but it is not adjacent to VNP (Republic of Rwanda, 2012b). This high population density in the VNP region is a consequence of the large migration of the population from other regions of the country since the 1960's in search of agricultural land. People were mainly attracted by the volcanic fertile soils and favourable weather that allows for three agricultural seasons. Thus, people quickly settled on the foothills of the volcanoes. Such a spontaneous occupation has had a considerable impact on PNV natural resources (Plumptre et al., 2004).

The main economic activity around VNP is subsistence agriculture in addition to a limited number of livestock under zero-grazing conditions. However, food production is constrained by parcelling out land resulting from inheritances from fathers to sons due the rapid growing population. Also, fallow is rare due to the scarcity of arable lands, thus, soil-infertility and the resulting insufficiency of food produced. Periods of significant food shortages are October to November and April to May of each year (Weber, 1987). As consequence, local residents highly depend on VNP resources for subsistence needs.

Other consequences of insufficient food production include food insecurity, malnutrition, poverty and low income among the local people. The average annual income has been estimated to less than USD 540 per household (Bush et al., 2010), while linkages to markets and alternative incomes is thought to be limited (Plumptre et al., 2004). Crops that local farmers plant in the vicinity of the park are often destroyed by wild animals. This reduces agricultural production and contributes to local food insecurity. This encourages local people to resort to exploiting the natural resources of VNP to compensate for their losses (Plumptre et al., 2004). Land use consolidation is at varying stages along the boundary of VNP. In addition, extensive regions of VNP-adjacent land are under the control of an agro-industry cash crop scheme. Land-use agreements state that 40% of original long-term land parcel leases by the Rwandan government must be used to cultivate pyrethrum for pyrethrin oils export to pharmaceutical industries (Guinness, 2014).

A recent mapping of Republic of Rwanda (2019) on Rwanda forest cover revealed that the afforestation rate around VNP remains low at 8.3% in Sectors bordering the park compared to the overall rate of the districts they are located in (31.1%) as shows the table 3.1 below.

Table 3.1: Rate of afforestation in the vicinity of VNP between 2000 and 2019

District bordering with VNP	**Afforestation rate (%)**	**Sectors adjacent to the park per district**	**Afforestation rate (%)**
Musanze	17.3	Shingiro	8.9
		Gataraga	6.3
		Kinigi	7.8
		Nyange	8.6
Burera	46.7	Cyanika	11.8
		Gahunga	8.8
Nyabihu	29.3	Jenda	12.5
		Kabatwa	1.7
Overall average rate	**31.1**		**8.3**

Source: Republic of Rwanda (2019)

3.5 Relationship between local people and Volcanoes National Park

Although before COVID-19 pandemic the gorilla tourism in VNP park was injecting a considerable amount of money in the country revenue and there are several Integrated Conservation and Development Projects implemented around the park, their impact on conservation and local livelihoods is challenged. A large number of households around VNP live in poverty, characterised by many members; poor quality of housing; low education level; very small landholdings; shortage of food products with no surplus for sale; and inaccessibility to basic infrastructures including schools, health-centres, hospitals, water and markets (Plumptre et al., 2004). Several studies reveal that this high level of poverty leads to increased dependency of the local people on VNP resources for their subsistence needs (Guinness, 2014; Munanura, 2013; Bush et al., 2010). \ There is also inadequate tourism revenue sharing and limited opportunities for employment (Guinness, 2014; Munanura, 2013; Sabuhoro, 2006; Plumptre et al., 2004). Despite an acknowledgement that tourism provides national benefits, local benefits are rarely recognised. Support amongst local farmers for both conservation and tourism initiatives is also reported to be low and to be undermined further by human-wildlife conflicts (Guinness, 2014; Plumptre et al.,

2004). Also, the impact of community development projects on VNP wildlife conservation is reported to be unclear (Bush et al., 2010; Sabuhoro, 2006). The RDB report of 2015 on ranger based monitoring in VNP shows that changes in encounters of illegal activities such as poaching and bamboo harvesting are not significant over the years despite a reported corresponding increase in community development support and collaboration (Republic of Rwanda, 2015b; Sabuhoro, 2006). A lot of the poorest households live near the park while wealthier families are found in or near the village centers (Munanura, 2013; Sabuhoro, 2006; Plumptre et al., 2004). Although small about (5%), most of assistance from revenue sharing goes to social development including water infrastructure, schools and health centres that are mainly placed in village centres because of logistical reasons. Thus, such services are not likely to reach the poor who should be the target (Guinness, 2014; Sabuhoro, 2006; Plumptre et al., 2004) if their impact on the park resources has to be reduced (Bush et al., 2010). This study will provide empirical support to justify the importance of food security in the debate around the link between VNP biodiversity conservation and local people, a factor that has not been previously given due attention.

3.7 Food Security status around Volcanoes National Park

The food security status report of Republic of Rwanda (2018a) reveals that Districts around VNP are among the districts with larger proportion of food insecure households and stunt children. Burera has the greatest number of severely food insecure households (6.5%) and it is the 5th district with food insecure households (29.7%) and 4nd district with highest chronic malnutrition rate countrywide. Nyabihu comes the 6th in food insecurity rate with 25.7% of food insecure households and the 2nd in malnutrition with 53% of stunt children. Also, the percentage of food insecure households in Rubavu District is above the country average (22%) and it is the 3rd district with highest stunting rate of 50%. Musanze District has better food security with a percentage below the country average of food insecurity (11.5%). However, the stunting rate (38%) is above the national average (35%).

The study of Plumptre et al. (2004) suggested several policy recommendations to ensure that VNP conservation is linked to local food security. Those include improve coordination between conservation and development projects, supply water to

communities around VNP, promote family-planning in the region, improve access to micro-credits, combine law enforcement with community development support, improve relationship between park rangers and local people. This study analysed policies and institutional framework in relation to biodiversity conservation and local food security at VNP to better understand where the gaps are and what should be done to ensure sustainable conservation of this park.

3.8 Research design

A literature review of previous studies on biodiversity conservation, food security, land use, biodiversity conservation and livelihoods, and integration of food security and biodiversity conservation was undertaken before deciding on data collection and data analysis methods. This was followed by an assessment of methodological approaches that were adopted and the kind of data that were collected. This advised the design of research methods and tools used in this study.

Mixed methods research design has been chosen for this study in order to expand the research breadth and to compensate for the weaknesses of either approach used alone (Gretchen & Bruce, 1991). The data collected under this study requires internal validity and external validity given the types of the research questions. Like in any other research on livelihoods of people around protected areas, internal validity of food security status had to be obtained by directly sampling targeted households. Thus, quantitative research methods. The same applies to land use cover/change analysis using biophysical data that would not necessarily require external validity for its accuracy. However, the analysis of impact of benefits from the park on the local community food security and the analysis of the gaps in policy and institutional framework for integration of VNP biodiversity conservation and local food security required external validity by policy-makers, park management, cooperatives of beneficiaries, stakeholders in VNP conservation such as NGOs and the Private sector to ensure conclusions made are credible and well within the context. Thus, the choice of qualitative research methods including focus groups discussions and Key Informant interviews to collect and analyze related data (Driscoll et al. (2007). The mixed methods research design helped to predict the relationships between different variables and to explain how and why these predicted relationships happen. This kind

of analysis cannot be provided by only in quantitative or qualitative research methods (Tashakkori & Teddie, 2009).

Mixed methods have been used by researchers for several decades under different terms including hybrid, multi-method, combined or integrated (Creswell & Clark, 2007). Johnson & Onwuegbuzie (2004) recommend developing mixed methods design that answers research questions of each researcher within the boundaries and constraints of their own study context since there is no exhaustive list of mixed methods design options. These authors recommend to call this research design that integrates both qualitative and quantitative methods "mixed model" in order to differentiate it from the designs that simply use both types of data such as the transformative design that convert one type of data into another, in several cases qualitative data into quantitative data with a simple purpose of merging collected data (Driscoll et al., 2007).

Questions asked in the quantitative research are confirmatory in the sense that they aim to test theoretical hypotheses whereas the questions asked in the qualitative research are exploratory as their purpose is to generate information of unknown features of a phenomenon. Mixing these two methods instead of using a single approach design helped to simultaneously ask confirmatory and exploratory questions during the household survey of this study and therefore helped to verify and confirm responses and to get a good mixture of divergent views from the household and key informants interviews and the focus groups discussions and, to therefore draw rich evidence-based conclusions (Tashakkori & Teddie, 2009).

In mixed methods, quantitative methods help to gather, analyze, interprete, and present numerical information while qualitative methods help to gather, analyze, interprete, and present narrative information. The analysis of quantitative data uses techniques that delineate relationships or differences between variables or that describe the phenomenon of interest. On the other hand, qualitative data analysis uses a variety of iterative and inductive techniques that include: i) categorical strategy that disintegrates narrative data and reorganize them to generate categories that enable

comparisons and understanding the phenomenon being studied and ii) contextualizing strategy that interprets the narrative data as a whole in a coherent way including interconnections between their different elements and helps to group these data in different themes (Tashakkori & Teddie, 2009).

During this study, the collection of qualitative and quantitative data was iterative, with the data collected in one phase contributing to the ones collected in the next as recommended by Driscoll et al. (2007). Biophysical quantitative data were collected from existing google datasets of remotely sensed images, a close-ended questionnaire was used to collect quantitative data from households and open-ended questionnaires were used to collect qualitative data from key informants and focus groups. Qualitative data helped to get more details on the quantitative data (Driscoll et al., 2007). Selected questions from the household survey questionnaire were asked to key informants and during focus groups' discussions to ascertain to which extent were the research findings reliable, valid or contradictory. The reliability was ascertained by looking at the extent to which the findings from similar questions yielded similar responses and the validity of the study was ascertained by triangulating the research findings to understand the extent to which responses from both household survey, key informant and focus groups appear to get at the same underlying issues in a way that allows for general agreement in their responses (Hesse-Biber, 2010). A total of 400 household interviews, 10 focus group' discussions, and 21 key informants' interviews were undertaken for collecting data on policy action gaps and institutional challenges to integrate food security and conservation, land use changes and food security status and benefits from the park. Major data on land use changes were obtained from existing google datasets of remotely sensed images. A GPS unit was used to map the villages and households that participated in the survey.

Following the recommendation of Morgan (1995), this study used content analysis to analyze qualitative data from key informants' interviews and focus groups' discussions that were afterwards converted into quantative data through a "three-element coding framework" as described by Charmaz (2006). This framework included three steps: two steps of data coding that generated quantitative results and

ethnographic analysis that yielded qualitative results. At the first step of data coding, emerging ideas were coded, diagrams of relationships between variables drawn, and important themes that reflect the keywords that the respondents used while answering to the questions were identified. This step generated numerous category codes (Charmaz, 2006). The second step of data coding namely "focused data coding" eliminated unnecessary codes identified in the first step by combining similar codes and subdividing wider codes into categories. Attention was paid on wider themes and recurring ideas, connecting the codes as recommended by Charmaz (2006). This process yielded quantitative results that drew dynamics within groups and comparisons between focus groups, participating individuals and statements from participants (Morgan,1995). The ethnographic analysis focused on direct quotes from key informants and focus group discussions and was strictly qualitative not systematic (Hesse-Biber, 2010). These quotes were labelled into themes to document how many focus groups and key informants made similar statements.

3.9 Target Population

For household survey, this study targeted households located in 28 Sectors around VNP, within 10km from the boundary; and 36 km along the boundary. The 10km boundary was subdivided into two belts 0km-5km and 5.1km-10km to better analyze the variation of findings between the area in the vicinity of the park and the area far away. 21 key informants randomly sampled from a list of 42 resource people on VNP conservation and local food security included staff of the Volcanoes National Park Management, Agronomists of the 12 sectors in which cooperatives that benefit from revenue sharing and community conservation are located, representatives of NGOs supporting community conservation and local development, representatives of the private sector companies involved in tourism and the nutritionist of Musanze hospital. 10 focus groups were formed basing on the location of cooperatives that benefit from revenue sharing and community conservation.

3.10 Sampling procedure and sample size

The size of the household survey sample was calculated using secondary data from the population and household census of 2012 (Republic of Rwanda, 2012). This sample size was randomly determined from the population of 28 Sectors in which the

10 km boundary falls from the VNP edge (Table 3.2). Fractions were used to determine the number of households per Sector with boundaries going outside the 10km belt.

Table 3.2: Households located in the 10 km buffer of Volcanoes National Park

District (Administrative Unit)	**Sector (Administrative Unit)**	**Number of Households**
Musanze 12 Sectors)	Gataraga	4,949
	Shingiro	4,794
	Kinigi	6,311
	Nyange	6,354
	Cyuve	8,962
	Musanze	7,371
	Kimonyi	3,644x92.8% = 3,382
	Busogo	4,771
	Nkotsi	3,292x10.6% = 349
	Muko	4,561x18.7% = 853
	Muhoza	12,091x36.4% = 4,402
	Gacaca	5,379x43.3% = 2,330
Rubavu (4 Sectors)	Bugeshi	6,261
	Busasamana	6,954x37% = 2,573
	Mudende	5,664x99.1% = 5,613
	Kanzenze	4,073x30.6% = 1,247
Nyabihu (6 Sectors)	Bigogwe	6,439x71.9% = 4,630
	Kabatwa	4,201
	Jenda	7,748
	Mukamira	6,224
	Kintobo	3,377X77% = 2,600
	Karago	5,735x69.1% =3,963
Burera (6 sectors)	Gahunga	5,635
	Cyanika	8,007
	Rugarama	5,095x93.9% = 4,785
	Kinoni	3,790x98.1% = 3,718
	Kinyababa	4,269x16.9% = 722
	Kagogo	4,249
Total households' number		**127, 004**

Source: Republic of Rwanda (2012b)

To calculate the sample size for the household survey, the following formula was used as recommended by Singh & Masuku (2014) and described by Yamane (1967):

$$n = \frac{N}{1+N\,(e)^2}$$

Where *n* = sample size, N= population size, e= level of precision which is 5% that equals to 0.05 with confidence level of 95%. Since the 28 Sectors have 127,004 households in total, then the formula will be applied as follows:

$$n = \frac{127004}{1+127004\,(0.05)^2}$$

This gives 399 respondents as the sample size. In total 400 respondents were sampled to get 200 respondents in 0km-5km belt and 200 respondents in 5km-10 km belt. In total 450 interviews well administered and 400 of them with full responses were selected for data analysis.

The area of the study was demarcated using ArcGIS and shapefiles of the boundaries for the VNP and Rwanda administrative units were used to define its spatial extent. The study area is comprised of two zones: One from the VNP boundary to 5km (0km-5km belt) and another one from 5km to 10km (5km-10km belt). Then, in order to systematically document the variations in attributes from the forest edge to 10km away, the area was divided into 1km; 2km; 3km; 4km; 5km; 6km; 7km; 8km; 9km and 10 km. The area of the study was divided into 10 belts of 1km each and 45 random points were generated in each belt as shows the map below using NOAA's Biogeographic Branch's sampling Design for ArcGIS. This tool uses simple random sampling to generate points that are distributed across the study area and can help to sample any kind of population defined in space, be it a corn field or coral reefs (Buja & Menza, 2013). Random points are commonly used to sample a population defined by an area on a map such as a national park or other protected areas, a given habitat or political jurisdiction. Buja & Menza (2013) stress that an unbiased survey of the population can be undertaken by taking measurements at points distributed randomly throughout the population. NOAA's Biogeography Branch's Sampling procedure is area-based sampling and is supported by data in GIS. This Sampling Design Tool can do three types of points sampling: stratified random, multi-stage random and simple random. Since the sample size for each belt was already defined, simple random was chosen to define points shown in the figure 3.2 below that were based on to select the 45 households to interview during the household survey. The Simple Random

sampling produces randomly placed points within a population that is defined by a polygon dataset, which is 1km belt in this study.

After generating 45 random points for each belt, ArcGIS' Spatial Join tool was used to expand the attributes of the points' layer to include details such as their locations in terms of administrative units including district, sector, cell, village. The sampled points were then extracted from the sampling frame (the 10km boundary) to make sampled points' shapefile and loaded into a GPS receiver to locate them for interviews in the field. One household nearest to the point was visited for interview, giving 45 households per belt. In case no elder person was found at the visited household, the next closest household was surveyed. Below is the map describing the sampling method:

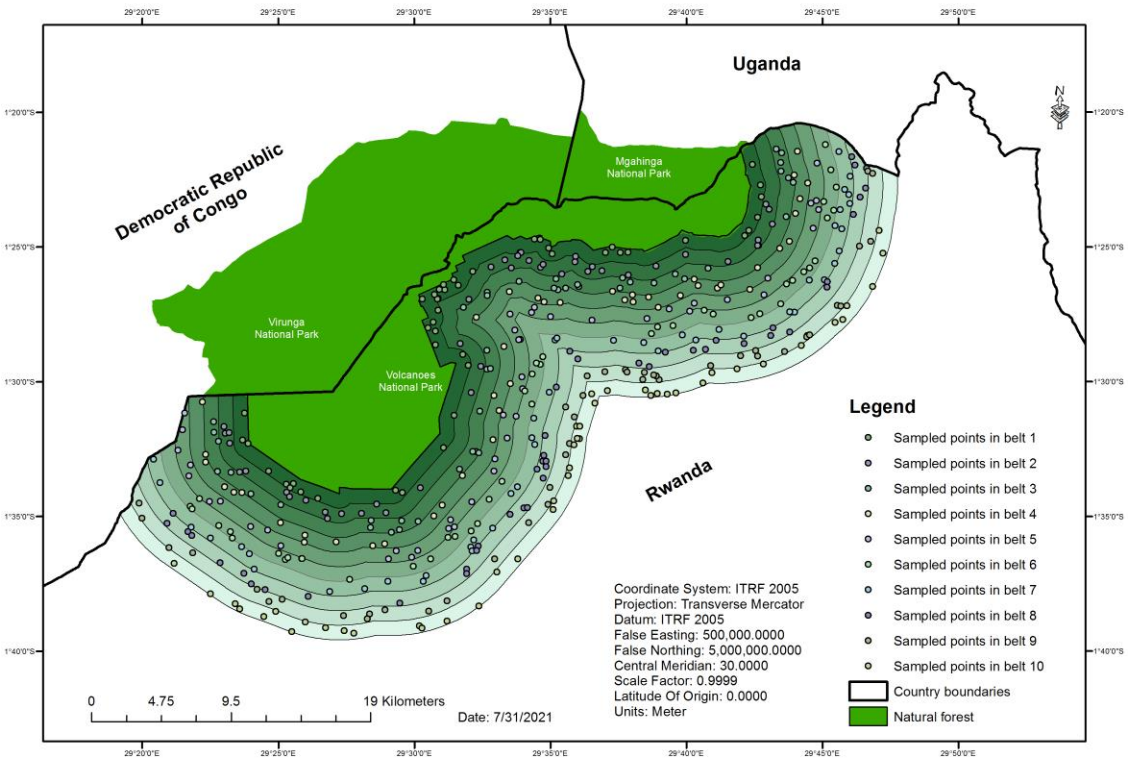

Figure 3.2: Sampled random points

Source: GIS data, 2017; Republic of Rwanda (2012b).

21 key informants were sampled using random sampling which involves selecting a small number of units at random from a large target population. Random sampling is recommended for focus groups discussions and key informants data collection as it contributes to the credibility of the findings of a larger study (Tashakkori & Teddie, 2009). A list of VNP management staff and their responsibilities, the list of community conservation stakeholders, the Private Sector actors around the park and the list of agronomists of sectors were shared by VNP management. Each list contained the names of individuals, and their cell phone numbers. The selection of key informants was based on their role in community conservation, food security promotion and participation in the revenue sharing. One VNP community conservation warden, the RDB head of community conservation, all agronomists of the 12 sectors, four representatives of conservation NGOs (KRC, IGCP, MGVP, Conservation Turambe), two representatives of private sector actors (Iby'Iwacu Cultural Village and SACOLA) and one nutritionist for the local hospital were selected for interviews.

Focus groups were organized to get details about the relationship between the benefits from the park and the status of local community food security. Focus group discussions were created using purposive random sampling. A list of 34 cooperatives supported by community conservation and revenue sharing was shared by VNP management. These cooperatives were distributed in 12 sectors around the park. The cooperatives were then grouped in one focus group per Sector (administrative unit) and each cooperative was represented by two members. Women were encouraged to participate by selecting one man and one woman per cooperative. However, some women could not attend and were replaced by men in the end. In total 68 people (34 men and 34 women) were sampled to participate in 10 focus groups' discussion. Jenda and Mukamira had only one cooperative each and Bigogwe had two cooperatives. All of them were put in one focus group that had 8 members. According to the nature of their profit-based activity, 5 cooperatives multiply Irish potato seeds and sell them locally, 9 plant improved Irish potatoes, 3 do beekeeping, 2 produce and sell agroforestry trees, 3 multiply bamboo, 2 rear sheep and pigs, 2 rear

sheep, 2 are porters of tourists luggages, 3 make handcrafts and sell them, 2 plant and sell vegetables.

3.11 Data collection procedures

A household questionnaire was used to collect data from the sampled 450 households. The household head was interviewed and where the head of the household was the husband, the wife was also requested to complement especially on the questions related to food security and crop raiding considering that women are the ones who spend much time in the field and they are more involved in preparing food and harvesting, selling and buying agricultural products. The household survey was used to assess local food security status, effects of changes in land use on VNP and benefits from the park at the household level. Data were collected using interviews guided by questionnaires. Three enumerators were hired and trained for data collection. They asked questions that were translated in Kinyarwanda to the head of the household. The household survey used quantitative close-ended questions to facilitate statistical data analysis. Before administrating the questionnaire to the households, it was tested on 10 households randomly selected in the village not included in the survey (Angelsen et al., 2011). Visited households were georeferenced using GPS units. The information provided by the respondents was verified during field visits, visual inspection and triangulation by using additional data collection techniques for deeper understanding of results and relationship between variables. These techniques include key informants' interviews, focus group discussions, remote sensing for land use analysis and desk review of policy documents.

A semi structured questionnaire was used to collect data from focus groups' discussions and key informants. Key informants were contacted via e-mails and phone calls and after fixing appointments for interviews, they were visited at their workplace and interviewed. 21 key informants were interviewed as sampled, and interviews lasted for 30 to 40 minutes. Key informants' interviews were undertaken between October 2018 and May 2019. Those interviews generated more specific and individual experiences of the issues surrounding the research topic. This helped to obtain general information about local food security status, historical changes in land use within the study area as well as the benefits of local people from the park.

Respondents provided information on (i) their experience with the processes of formulation of policies and their implementation, (ii) involved actors at different scales and stages, (iii) encountered challenges in policy implementation; (iv) food security interventions they promote and (v) criteria for choosing the beneficiaries of revenue sharing and Community Conservation Projects. The in-depth household survey also contained questions related to policy action gaps and institutional challenges including inclusion in policy formulation and implementation processes and gaps and strengths in policy implementation.

Each of the 10 focus groups was met at Sector offices. Executive Secretaries of the Sectors assisted to invite the members of focus groups and a follow up was made with the chairpersons of each cooperative through phone calls to ensure that required members attend. Focus groups were created based on the existing cooperatives benefiting from revenue sharing schemes and community conservation programmes where cooperatives under each Sector were represented by 2 members each in one focus group. Focus group discussions lasted for 1 to 1.5 hours. Although women were encouraged to participate by selecting one man and one woman per cooperative, some of women were not able to attend and were replaced by men in the end making the figures 43 males and 25 females. Focus groups' discussions lasted for 1 to 1.5 hours and were guided by pre-developed questionnaire with open-end questions.

This study also used Landsat Images to examine changes' trends in land use and cover. Images from four time series covering the study area and VNP were analysed to find out changes in land use and land cover from 2000 to 2019 (2000, 2010, 2015 and 2019). No map for 2005 was produced because the landscape was covered by clouds. Semi-structured interviews were also conducted to supplement remote sensing data.

Policy analysis data were gathered from existing policy and strategic documents and these were complemented by data gathered from the household survey and key informants' interviews and the focus groups' discussions. Policy documents were reviewed to shade light on policy provisions, opportunities, gaps and counterincentives which can shape food security considerations in the tourism revenue sharing programme and community conservation projects around VNP. The

selection of policy documents for review was done through google search of enacted and published policies, laws, ministerial orders, management plans, reports and action plans. Most of the reviewed documents were downloaded from the official websites of government institutions. In all, six official policy documents published between 2011 and 2019 were selected based on their direct relevance to VNP conservation.

3.12 Data analysis procedure

All data from the household survey were entered into version 25 of the SPSS software and analysed using the version 16 of the Stata software. Univariates, bivariate and multivariate methods were used to analyse those data. Simple graphical methods including frequency and percentage histograms were used to investigate how value of different variables were distributed across the sample. This Study used Chi-Square to test the relationship between households' food security status and the benefits they get from the park. It also used the Consolidates Approach for Reporting Food Security Indicators (CARI) to analyze the status of food security around VNP, a tool developed by the World Food Programme (WFP) in 2015 and recommended for food security analysis with the unit of analysis being the household (WFP, 2015). The CARI approach groups households into 4 categories: food secure, marginally food secure, food insecure and severely food insecure by systematically combining food security indicators. The WFP designed this methodology for use to assess food security status with the aim to estimating the number of food insecure households within a target population. This methodology is a good fit for assessments conducted at regional or national levels or at specific locations for instance refugee camps. In this study, three food security indicators were used in order to generate the overall Food Security Index for the households around VNP. Food Consumption Score indicates that food secure households are those that consumed adequate food items in the week prior to being surveyed. The respondents were asked to tell the number of days in the previous 7 days that their household ate food items in 9 groups that were used to measure food security and what was the source. These groups are: i) grains, cereals, tubers and roots, ii) legumes and nuts, iii) milk and other diary products, iv) fish and eggs, v) vegetables and leaves, vi) fruits, vii) oil, fat, butter, viii) sugar and sweets, ix) condiments and spices. This revealed usual household diet with details on diversity and frequency of consumed food groups. During the analysis, every food group was

weighted based on its nutritional value. Groups that contain dense foods for instance those of animal origin were weighted greater than groups with foods that have low nutritional densities like tubers. Food weighting of CARI is as follows: meat/fish weigh 4, milk 4, pulses (legumes and nuts) 3, main staples (cereals, grains, roots and tubers) 2, vegetables 1, fruits 1, oil 0.5 and sugar 0.5. A household that consumed food items with big weight has big food consumption score and it is food secure, while the household that consumed food items with less weight has less food consumption core and thus food insecure.

Under the economic vulnerability indicator, food secure households are those that used less than 50% of their income on food (i.e food expenditure share that is below 50%). Households that are more economically vulnerable are those that spend more on food compared to other consumed items/services (WFP, 2015). The households under marginally food secure category are those that used 50-65% of their income on food items during the 7 days that preceded the interview. Households that are moderately food insecure are those that spent 65-75% of their income on food items. Severely food insecure households are those that spent more than 75% of their income on food items.

Under the asset depletion indicator, food secure households are those that did not need any strategy to cope with livelihood shocks/vulnerability. This means that these households have adequate coping capacity or resilience to potential shocks as they did not experience any stress to their livelihoods or depletion of their assets in the 30 days that preceded the survey and have enough reserve for future productivity. The households under marginally food secure category are those that employed stress livelihood coping strategies such as spending savings or borrowing money. These strategies indicate the reduction of the household ability to cope with future shocks because of reduced resources or increased debts.

Moderately food insecure households are those that employ crisis livelihood coping strategies such as selling assets that were productive and therefore directly reduce the productivity of the household in the future including formation of human capital. Severely food insecure households are those that employed emergency livelihood coping strategies that affect their future productivity but are more dramatic in nature

or difficult to reverse such as selling owned land. Four images covering the study area were analysed to produce maps and data that described the changes that occurred in land use and cover from 2000 to 2019 (2000, 2010, 2015, and 2019). In order to create the land use/cover maps, each image was categorized into five classes using supervised classification approach: 1) forest and woodlots, 2) agriculture and grassland, 3) water bodies, 4) built-up and 5) Bare land. Images were analysed using visual interpretation that was supported by a combination of feature extraction and image classification tools in Exelis ENVI software. ESRI ArcMap was used to digitalize built-up and agriculture and grassland polygons. Outputs included four detailed land use maps and additional continuous maps indicating variability in vegetation cover in the study area from 2000 to 2019.

The policy action gaps and the institutional challenges to link food security and conservation of VNP were analyzed using desk review that was complemented with SWOT analysis and data from household and key informants' interviews and focus groups' discussions were used for triangulation. The desk review used the content analysis that is a technique of research used to produce replicable and valid conclusions by coding and interpreting textual material such as documents, hypertext, audio text, graphics or oral communication (Weber, 1987). The reviewed policy documents included the Rwanda constitution, the biodiversity policy, the law governing biodiversity in Rwanda, the national biodiversity strategy and action plan, the wildlife policy, the protected areas' concessions management policy, the law on compensation for damage caused by wild animals and related ministerial orders, the tourism policy and volcanoes national park management plan (2012-2021) (table 3.3). In addition, relevant peer-reviewed articles and grey documents were reviewed to get more information on policy formulation and implementation at global, regional, national and local levels. To narrow down to content analysis, key search terms which capture food security, specifically "food security" were searched, and examples identified (supply of livestock, seeds; roads, water provision, vegetable gardens, school food provision programs, etc.). Also, the words 'poverty reduction" and "livelihoods" were included in the key terms as food and nutrition security can be understood under them. The denotative occurrence of these key words was looked at as standalone terms or in conjunction with other concepts or other related information

provided in the policy documents. This methodology is supported by Bauler & Pipart (2013) who argue that empirical verification of the adoption of a concept at the first stage lies in finding out the number of times this concept has been referred to in policy documents and Mascarenhas et al. (2015) who suggested that verifying how many times the key word is referred to in the reviewed policy documents helps to eliminate subjective interpretations. In cases where there was no mention of food security indicators, poverty reduction or livelihoods, proxy examples of food security were identified through the direct content analysis that involved reading the whole policy documents to identify proxy content as recommended by Geneletti & Zardo (2016). The emphasis on reference of the food security concept in the policy documents reflects whether this concept was given due attention in developing these documents, which words or terms were specifically used to mean food security, and at which scale (national or local). The desk review was conducted from April through August 2019. The desk review examined food security, wildlife and biodiversity policies and related laws, and VNP strategic and management plans. It also analysed the roles and mandates of implementing institutions such as RDB and NGOs working on conservation of VNP.

Table 3.3: Documents used in desk review

Conservation policies/laws+A1:C8	Enactment year	Policy focus
1.Rwanda constitution	2003 with amendments through 2015	Fundamental principles according to which Rwanda as a sovereign state is governed
2.Protected areas concessions management policy	2013	Leasing the development and management of tourism facilities, infrastructures and services within protected areas to private sector companies.
3.Rwanda biodiversity policy, law governing biodiversity in Rwanda and national biodiversity strategy and action plan	Policy in 2011, law in 2013, strategy in 2016	Providing a framework for conserving, access and sustainable use of biodiversity and equitable and fair sharing of the benefits arising from these resources.
4.Wildlife Policy	2013	Providing a framework for long-term conservation of Rwanda wildlife, diverse species and their habitats and other ecosystems for the benefits of Rwandans and the global community.
5.Law on compensating people for damages caused by wild animals and related ministerial orders	Law in 2011, ministerial orders in 2012	Types of damages that are compensated, source of wild animals that is either national parks or other protected areas, the modalities of compensation and the competent authorities to evaluate damages and provide compensations.
6.Tourism policy	2009	Increasing tourism revenue for long-term development and re-investments and conservation and job creation.
7. VNP Management Plan	2012-2021	VNP Ecological Management & Monitoring; Tourism Management and Development; Community Partnership and Park Operations

Source: Desk review, October 201

After thorough analysis of the policies, registrations and plans, SWOT analysis was conducted to bring out their strengths, weaknesses, opportunities and threats. According to Bull et al. (2016), This analysis helps to highlight how internal and external features of a system interact and how this interaction affects the success of this system to inform the development and implementation of future strategies. These authors developed the SWOT approach for analyzing food security that is primarily based on primary data. This study adopted how Bull et al. (2016) conceptualized strengths, weaknesses, threats and opportunities to analyze the policy documents (secondary data). In this study strengths are looked at as internal features of the analyzed policy documents that provide strategic information for increasing awareness on food security and the contribution of this awareness to achieving VNP conservation goals. Internal features of policy documents that can hinder the achievement of mainstreaming local food security in VNP conservation are considered as weaknesses. Political, technical, economic factors that are external to the policy documents are considered as opportunities and as actions that provide enabling environment for achieving local food security mainstreaming into VNP conservation. Then, opportunities are regarded as a means for increasing strengths and overcoming weaknesses. Finally, threats are viewed as external features that may jeopardize achieving the mainstreaming of local community food security in VNP conservation.

Additional data collected during the household and key informants' interviews and focus groups' discussions were analyzed using situational analysis for triangulation. In-depth HH interviews contained specific questions on types of benefits of local people from the park; source of support in food provision and nutrition (education, awareness, kitchen garden, etc.) while focus groups' discussions and key informants' interviews focused on questions related to the processes of the formulation and implementation of policies, different actors that are involved in these processes and their roles and responsibilities. Questions were formulated in a way that they were linked to the constraints related to policy implementation identified at household level during the household survey and corroborate key findings from the desk review.

3.13 Ethical requirements

Research permit attached in the appendix was obtained from Rwanda Development Board. Interviewees were given an opportunity to read and ask questions about the consent form that they signed before responding to the questions. This was for them to confirm that they have read and understood the information in the form and they understood that their participation was voluntary and that they were free to withdraw at any time, without giving a reason.

3.14 Limitation of the study

This study used Landsat Images from four time series of 2000, 2010, 2015 and 2019 to examine changes' trends in land use and cover. No map for 2005 was produced because the landscape was covered by clouds. This limitation did not affect the overall results.

CHAPTER FOUR

RESULTS AND DISCUSSION

The study findings and their discussion are presented per research objectives in this chapter. The policy and legislative analysis and institutional challenges in relation to biodiversity conservation at Volcanoes National Park (VNP) and local food security are under section 4.1 while the results and discussion on the effects of changes in land use on VNP are under section 4.2 and section 4.3 presents results and discussion on the contribution of the benefits from Volcanoes National Park to local food security.

4.1 Policy and institutional framework for the integration of biodiversity conservation and local food security at VNP

The first objective of this thesis focused on examining policy and institutional framework and how they relate to biodiversity conservation and local food security at Volcanoes National Park. This section focuses on analyzing how food security is taken into account in VNP conservation in Rwanda by analyzing the provisions of the Rwanda constitution, in this regard, the conservation policy documents in Rwanda and the extent to which they have been implemented by different institutions and organizations around VNP and thereafter recommend strategies that can be used to mainstream food security in the conservation of this park.

4.1.1 Analysis of policy provisions for integration of biodiversity conservation at VNP and local food security at VNP

During this study, the desk review of policy documents revealed that while food insecurity is an important issue that is well recognized by different Rwandan government institutions, its application in VNP conservation is minimal. The analysis of the Rwanda constitution, the biodiversity policy, the law governing biodiversity conservation in Rwanda, the national biodiversity strategy and action plan, the wildlife policy, and protected areas' concessions management policy, the law on compensating people for damages caused by wild animals and related ministerial orders, the tourism policy and VNP Management Plan and other relevant grey and peer-reviewed literature showed that the conservation policy documents focus more

on planning for the work to take place inside protected areas and less on people living around them. This corroborates the findings of Bizoza & Ndangiza (2014) that in Rwanda the governance of the national parks is significantly done by the government, with limited involvement of local communities and that laws establishing national parks entrust their management and the management of their buffer zones entirely to the government, diluting the citizen ownership provided by the national land policy and environmental law. These authors recommend putting in place mechanisms for engaging local people in national parks' management and providing communities with meaningful management rights if they are to feel fully engaged in their conservation.

In the reviewed policy documents, the appearance of the key term "food security" was rare and where it was found, it was mostly used superficially and not in direct connection with the conservation of national parks in Rwanda. Related terminologies considered in this study are food, food production, food supply and food sovereignty. In most of the cases, the conservation benefits of protected areas to local people were mentioned using the terms "livelihood" and "poverty reduction" or poverty alleviation". Thus, this study also looked at how many times the policy documents mentioned these terms because food security can be as a result of improved livelihoods or poverty reduction/alleviation interventions. The context in which each term (food security, livelihood, and poverty reduction/alleviation) was used was analysed to determine how this term or key word reflects food security in relation to national parks' conservation in Rwanda. This study reveals that food security or related terms including food, food production, food supply and food sovereignty, livelihood, poverty reduction or poverty alleviation are rarely mentioned in the 6 reviewed policy documents.

i) **The Rwanda Constitution**

Although it did not use the term food security, related terminologies, livelihoods or poverty reduction/alleviation, the Rwanda Constitution recognizes the importance of environment protection under its different articles and has provisions on gender equality; homegrown solutions; rights to education, good health, participation in

government and public services and equal protection of the law. It also states that the Government has the duty to put in place development strategies for its citizens. These are foundations for ensuring that policies, strategies, and plans take into consideration the mainstreaming biodiversity conservation into the agenda of biodiversity conservation in national parks.

ii) The Law Governing Compensation for Damages Caused by Wild Animals and related ministerial orders

The developers of this law did not use the term food security, related terminologies, livelihoods or poverty reduction/alleviation. However, its article number 6 stresses that "any person whose property will be damaged by wild animals should get compensation following real cost valuation" as provided by in the regulation on calculating the amount for compensation. Articles 24, 24, and 25 focus on compensation modalities. For them to get compensation, the persons whose properties have been damaged by wild animals have to submit a report from an expert that describes the damages made and their values and includes related pictures and testimonies of witnesses interrogated by the Cell leaders. It is unfortunate that very few people get fair and timely compensation as this would reduce the effects of these damages caused by wildlife on local food security.

iii) Protected Areas Concessions Management Policy

This policy did not mention the word food security or any of the related terminologies nor the word "livelihoods". It only mentioned the term "poverty reduction/alleviation" 3 times of which only once was referring to food security in relation to conservation of national parks and other protected areas where it states that *"Sustainable use of protected areas can make contributions to poverty reduction, community development and biodiversity conservation to meet the needs of future generations. Utilization of the protected areas can contribute to reduced poverty, community development and conservation of these ecological areas to meet the needs of future generations"*.

iv) Tourism Policy

This policy did not mention the term food security or any related terminologies. However, it mentioned the word "Livelihood" once and the term "poverty reduction/alleviation" two times, all the three reflecting food security in relation to PAs conservation. Here are the three statements: *"It is preferable to grant tourism concessions to investors that present sound economic, social and environmental integration that enhances conservation of biodiversity and benefits local community livelihoods"; "Identification and support to community based tourism initiatives that are commercially viable and contribute to conservation and poverty alleviation"; "Develop concessions strategy to stimulate and guide creation of public-private partnerships including guidance on revenue sharing; processes of tenders; contracts management and exit strategy; rights, responsibilities and accountability of stakeholders; sustainable investments that reduce poverty, protect environment and strengthen society and local community culture".*

v) Wildlife Policy

This policy mentions the word "food" once in relation to conservation of national parks where it states that *"wildlife contributes to the livelihoods of people in the form of food, energy, medicine, shelter and other social values".* Also, this policy mentions the word "livelihood" 4 times reflecting food security in relation to national parks' conservation. Example: *"Revenues from tourism in national parks have considerably increased and significantly contributed to the national economy and the local livelihoods of communities near the parks".* It has only one mention of "poverty reduction/alleviation" and its context does not reflect food security in relation to the PAs conservation. This is the related statement: *"This wildlife policy provides for capacity building, incentives and knowledge required to get the public support necessary for conservation of wildlife resources to ensure they contribute to poverty reduction".*

v) The Rwanda Biodiversity Policy, Law Governing Biodiversity in Rwanda and the National Biodiversity Strategy and Action Plan

These documents show food security or related terminology (food, food production, food supply and food sovereignty) in relation to PAs conservation 4 times out of 15

mentions, the word “livelihood” as food security in relation to Pas is mentioned 15 times out of 19 mentions and, poverty reduction/alleviation 4 times out of 16 mentions. Here is one example from the biodiversity policy that reflects food security in relation to PAs conservation: *“A large number of Rwandans directly depend on biodiversity for subsistence purposes that include poaching and harvesting plants for food, fuel, medicine, construction materials and trade”*. The table 4.1 below shows the encounters of the key word food security, related terminologies, the word livelihood and the term poverty reduction/alleviation in the reviewed policy documents.

Table 4.1: Encounters of mentions of food security and related terminologies

Policy/Act/Regulation	Mention of food security		Mention of livelihood		Mention of poverty reduction/alleviation		Guidelines for integration of food security in conservation planning
	In relation to PAs Conservation	Not in relation to PAs Conservation	In relation to PAs Conservation	Not in relation to PAS Conservation	In relation to PAs Conservation	Not in relation to PAs Conservation	
1.Rwanda constitution	0	0	0	0	0	0	No
2. Protected Areas Concessions Management Policy	0	0	0	0	1	2	No
3. Rwanda Biodiversity Policy, Law Governing Biodiversity in Rwanda, and National Biodiversity Strategy and Action Plan (NBSAP)	4	11	14	15	4	12	No
4. Wildlife Policy	1	0	4	0	0	1	No
5. Law on compensating people for damages caused by wild animals and related ministerial orders	0	0	0	0	0	0	No
6. Tourism Policy	0	0	1	0	2	0	No
Subtotal	**5**	**11**	**19**	**15**	**7**	**15**	**NO**
Total	**16**		**34**		**22**		

Source: Desk Review, October 2018

Out of the 6 policy documents reviewed, only 2 mentioned food security or other related terminologies such as food, food production, food supply or food sovereignty. Rather, most of them used the terms livelihoods and poverty reduction/alleviation to reflect the link between the conservation of protected areas and local benefits. However, these terms are too broad to target people who are in needy and to link interventions to the direct causes of human pressure on the Protected Areas' resources (Glamann et al., 2015; Barrett, 2010; Lindenberg, 2002).

Acknowledging food security in community conservation planning is a necessary step to ensure that the program is pro-poor and addresses the needs that are associated directly with illegal park resources' use (Glamann et al., 2015). Since the rise of community conservation programs around protected areas across Africa, success stories in reducing the illegal use of the PAs resources remain few. Several studies indicate that conservationists look at community issues with a broad lens, poorly plan for interventions and provide insufficient support to the communities (Mandima et al., 2011; Glamann et al., 2015). Several studies suggest the need for a linking between local community food security and conservation of PAs to ensure sustainability (Barrett, 2010; Lindenberg, 2002; Glamann et al., 2015).

Strengths of the reviewed policy documents: The way different terminologies have been used, across the policy documents reviewed to give recognition to the food security concept was analysed. The wildlife and biodiversity policies recognize the contribution of natural resources from national parks and other PAs to food security and the need for alternatives to reduce the illegal use of these resources. They both mention PAs resources use that includes hunting animals and collecting plants, medicine, firewood and building materials. All documents reviewed except the Rwanda constitution and the law on compensating people for damages caused by wild animals and related ministerial orders recognize that Rwanda's viability depends on preserving the country biodiversity and extent to which it contributes to the country sovereignty on food. Some directly used this concept while others used words like livelihoods and poverty reduction/alleviation or explained the need for pro-poor programs to reduce illegal use of PAs resources. This awareness that these policy documents creates through the reference to food security allows for the recognition of

the concept and its benefits to conservation. Also, this awareness provides a strong foundation for the concept of food security contribution to improving decision-making in conservation. In addition, the campaign across the country on nutrition suggests that eradicating malnutrition is everyone's business in Rwanda and coordination among all government institutions is key (ReliefWeb, 2018).

The reviewed policy documents also recognize that biodiversity conservation issues are cross-sectoral, and therefore should be tackled in a collective way by diverse institutions such as forestry, agriculture, wildlife, water, trade and investment. They also encourage the provision of incentives that are directly linked to the nature of biodiversity threat to address poverty of communities living around national parks. This corroborates the recommendation of Vedeld et al. (2012) that there is a need for cross-sectoral policies that address poverty around national parks in a more comprehensive way.

Weaknesses of the reviewed policy documents: Whereas community conservation programs around national parks in Rwanda and across Africa are criticized for failing to address local needs and reach out to the poor (Guinness, 2014; Bush et al., 2010; Adams et al., 2004; McShane & Wells, 2004; Brown, 2002), most of the reviewed policy documents do not directly use the concept of food security. Two of the documents do not use the term food security nor any related terminology such as food, food production, food supply and food sovereignty, livelihood, poverty reduction or poverty alleviation while only two use the term food security with only 5 instances among 19 instances pointing out food security in relation to PAs conservation. They also lack clarity on where and whom to focus on because they provide vague recommendations and commitments about community conservation actions without showing the intervention gaps. Other 11 instances are used to mean food security in relation to improving agricultural production across the country. The rest of the documents use broad and vague terms such as "supporting livelihoods", "reducing poverty" or "alleviating poverty". It is difficult for an intervention to have an impact, if it is not well defined and target beneficiaries are not clear in the plans. None of the reviewed policy documents includes a framework for mainstreaming food security.

Neither the law on compensating people for damages caused by wildlife and related ministerial orders nor any other policy document reviewed clearly shows how the damages caused by wildlife should be fairly evaluated. This corroborates the findings of Bizoza & Ndangiza (2014) that apart from around Akagera National Park that has an electric fence, crop raiding remains an unsolved issue around other national parks in Rwanda as the requirements for compensation claims are both demanding and costly for an ordinary citizen.

Opportunities: Several entry points exist to mainstream food security in VNP conservation. Different reports recommend increasing the share of revenue sharing that goes to local people and ensuring fair compensation for crop damages caused by wildlife. Revising the revenue sharing scheme and compensation policy should be an entry point to mainstream food security and conservation. Also, RDB should make sure that food security is integrated in the VNP Management plan when it is updated. The Vision 2050, the NST1 and the strategy for climate resilience and green growth clearly show how the country green growth is important and how environment and development should be intertwined to ensure sustainability. Taking this linkage at the VNP scale it can guide in mainstreaming food security in the conservation of the park. This study also elaborates the methodology that can be adopted to update the status of food security around VNP. In addition, with the current government commitment to eradicate malnutrition in Rwanda and the call for collective efforts, it is anticipated that decision-makers are becoming more aware of the importance of mainstreaming food security in their plans.

Threats: the limited interest of policymakers and RDB is a key threat to potential food security integration in conservation. The success of passed laws and policies relies on how decision-makers are engaged and committed to implementing them. Without political interest, drafting, enacting and enforcing policies that mainstream food security concept in conservation of national parks will be compromised. Increasing the tourism revenue sharing percentage that goes to community conservation programmes and the areas of its focus rests on RDB commitment to ensure local people fairly benefits from the tourism revenue and conservation of national parks. Details on SWOT analysis are provided under Table 4.2. Republic of

Rwanda (2018b) indicates that limited funding is one of the key impediments to the implementation of food security interventions in Rwanda. Thus, the need for the tourism and conservation sector to provide support. Also, the agriculture sector should be a key player to reduce food insecurity around VNP. However, this sector is criticized to have huge gaps in terms of policy implementation and institutional architecture (Enabling Agricultural Trade, 2015). The assessment on policy design and implementation in Rwanda conducted by the Africa Leadership Training and Capacity Building Program (2014) revealed that to sustain the country initiatives on food security, there is a need to fully engage Civil Society Organizations and Private Sector, base policy planning cycle on economic impact analysis rather than financial analysis, analyse how policies are implemented, and collaborate with academia to meet the country capacity needs especially those related to evidence-based policy planning and implementation processes.

Policies that mainstream food security in biodiversity conservation at national parks can be achieved if the outlined threats can be eliminated and the relevance of this concept can be given due attention at all levels of planning. The initial conceivable idea is for the government to consider food security mainstreaming in conservation policies, strategies and management plans as a strategy that may reduce illegal use of national park resources and therefore lead to their long-term conservation.

Table 4.2: SWOT Analysis Matrix

Policy	Strengths	Weaknesses	Opportunities	Threats
1.Rwanda constitution	It recognizes the importance of environment protection under its articles 22, 53 and 169. It also promotes gender equality (article 10), homegrown solutions (article 11), right to education (article 20), right to good health (article 21), right to participate in government and public services (article 27) and equal protection of the law (article 15). It also states that all Rwandans have the right to participate in the development of the country and that the State has the duty to put in place development strategies for its citizens.	It does not mention food security, livelihoods or poverty reduction in relation to biodiversity conservation.	Policy reviews are key entry points to mainstream food security in VNP conservation. The Vision 2050, the NST1 and the strategy for climate resilience and green growth clearly show how the country green growth is important and how environment and development should be intertwined to ensure sustainability. Taking this linkage at the VNP scale can guide mainstream food security in this park conservation. This study also elaborates a methodology that can be adopted to update the status of food security around VNP. In addition, with the current government commitment to eradicate malnutrition in Rwanda and the call for collective	ii) Limited participation of local communities in policy development and implementation: this study revealed that 90% of the households around VNP are not aware of the policy documents related to biodiversity and food and security including the VNP Management

			efforts, it is anticipated that decision-makers are becoming more aware of the importance of mainstreaming food security in their plans.	
2.Protected Areas Concessions Management Policy	It recognizes that sustainable use of PAs can make contributions to poverty reduction and community development to meet the needs of future generations.	It does not mention food security or livelihoods and it does not show how poverty reduction and community development considerations can be included in protected areas' management agenda.	Private Sector engagement in tourism management started recently in Rwanda. The growing awareness of corporate social responsibility among Private companies and the need to address direct threats to biodiversity in protected areas presents opportunities for ensuring action plans to increase tourism revenue will be well linked to better conservation of biodiversity, which is well linked to local livelihoods and development.	Insufficient enabling environment to ensure private sector actors mainstream local food security in tourism development plans.
3. Rwanda Biodiversity Policy, Law Governing Biodiversity in	This policy recognizes the contribution of natural resources from national parks and other PAs to food security and the need for alternatives to	i) Although it mentions food security in relation to PAs conservation, it provides vague recommendations on community conservation	This policy is linked to important international commitments under the CBD and NBSAP is updated on a regular basis.	Limited interest of policy maker to address this issue due to limited budget or engagement of other sectors

Rwanda, and National Biodiversity Strategy and Action Plan (NBSAP)	reduce the illegal use of these resources.	actions without showing the intervention gaps and clarifying where and whom to focus on; ii) This policy does not provide guidelines for integration of food security in conservation planning and how alternatives can be provided to reduce the illegal use of natural resources.	The policy document and NBSAP mention food security in relation to food security. Also, the implementation of this policy is guided by the Ministry of Environment and Rwanda Environment Management Authority with the mandate to ensure biodiversity conservation is improved. These are important entry points that would ensure food security is integrated in plans for biodiversity conservation for sustainability.	
	It recognizes that a large number of Rwandans directly depend on biodiversity for subsistence purposes that include poaching and harvesting plants for food, fuel, medicine, construction materials and trade.			
	It recognizes that Rwanda viability depends on preserving the country biodiversity and to what extent it contributes to the country sovereignty on food.			
	It mentions terms “food security, food, food production, food supply, food sovereignty, livelihood and poverty reduction/alleviation” in relation to PAs conservation.			
4.Wildlife Policy	It recognizes the contribution of natural resources from national parks and other PAs to food security and the need for alternatives to reduce the illegal	i) This policy does not provide guidelines for integration of food security in conservation planning, how alternatives can be provided to reduce the	The policy review to merge this policy with biodiversity policy has been proposed by different stakeholders in different fora. Food security	Limited interest of policy makers to mainstream food security in the new policy due to limited

	use of these resources.	illegal use of natural resources and who should be the main beneficiaries; ii) It indicates that revenues from tourism have significantly contributed to the national economy and local livelihoods of communities near the parks but with no evidence to support the last statement.	should be mainstreamed during this review process.	engagement of stakeholders that can advise on this integration
	Mention PAs resources use that includes hunting animals and collecting plants, medicine, firewood and building materials.			
	It recognizes that wildlife contributes to the livelihoods of people in the form of food, energy, medicine, shelter and other social values".			
	It recognizes the need for conservation of wildlife resources' contribution to poverty reduction.			
	It mentions the terms "food security, livelihood and poverty reduction" in relation to PAs conservation.			

5. Law on compensating people for damages caused by wild animals and related ministerial orders	It provides for compensation for those whose property is damaged by wildlife and details the modalities for awarding compensation including the requirements for the farmers to get compensation. In 2012, the government of Rwanda established the special guarantee fund with a mandate of compensating for the damages caused by wild animals among others.	i)The compensation scheme is centralized, and this makes it difficult for farmers to get timely and fair compensation: 9 focus groups suggested that the compensation fund should be decentralized to Sector level and 5 mentioned that RDB should provide the real value of the damage in order to solve the issues related to a lot of waiting for compensation, expenses related to travels to Kigali and timely evaluation of the damages; ii) All 21 key informants and 10 focus groups emphasized that the valuation of damages made by wildlife is complicated: 2 focus groups indicated that while they are the most expanded, no compensation is made for the damages made by monkeys, duikers, bushbucks and porcupines; iii) This policy does not mention food security, poverty reduction/alleviation or livelihoods.	There are several reports that show how crop raiding remains an issue around Volcanoes National Park including unfair compensation. Their recommendations should be used by Policymakers and the park management to solve this issue.	Limited interest of policy makers, RDB and Rwanda Guarantee Fund to include all damages in the compensation scheme, decentralize the compensation services and increase the amount of money paid to ensure farmers get the real value of the losses.

6.Tourism Policy	It recognizes that investments in tourism should benefit local livelihoods, reduce poverty, protect the environment and strengthen society and local culture. It mentions the words "Livelihood" and "poverty reduction" reflecting food security in relation to PAs conservation.	i) Although this policy recognizes the importance of ensuring tourism interventions address poverty and support local livelihoods, it does not provide recommendations on how this should be done; ii) This policy does not mention food security.	Limited amounts that go to addressing the direct biodiversity threats and unfair tourism revenue sharing are well documented in different reports. Also, this has been discussed in different fora including conservation forums. RDB should use recommendations from the studies and forums to increase the tourism revenue that goes to improving local food security. Also, local food security should be mainstreamed in the policy during its review.	Limited interest of RDB and policy makers to use the biggest share of revenue sharing to improve local food security rather than supporting public infrastructure development.

4.1.2 Analysis of the institutional framework for integrating conservation of biodiversity in national parks and local food security

Undertaken policy review has shown that none of the 6 policy documents analyzed provides guidelines for integrating food security considerations in biodiversity conservation planning and implementation. This is a big issue because there is no framework for policy makers to guide the implementation of this integration and no basis and policy requirement encouraging conservationists, local government, park management and their stakeholders to plan related activities.

i) The VNP Management Plan

This plan does not mention food security or any related terminology. However, it used the word "livelihood" 24 times all reflecting food security in relation to conservation of national parks although 17 times were a repetition of the previous ones under subtitles. Here is an example: *"Human impacts on VNP will be reduced by developing livelihoods that are compatible with conservation and providing alternatives to the park resources and strengthening human-wildlife conflict mitigation measures".* Also, the VNP Management Plan used the term "poverty reduction/alleviation" three times all reflecting on food security in relation to national parks' conservation. Example: *"VNP conservation Livelihood impacts: Poverty reduction, compensating for losses (crop raiding), and providing alternatives for park resources".*

ii) Local awareness of the integration of VNP conservation and local food security

The VNP Management Plan stresses that community conservation and awareness activities remain a priority in Sectors around the park and its structure includes two Community Based Conservation Wardens who are functional. One of their responsibilities is to raise local awareness about conservation and new laws and regulations. However, 90% of the households interviewed around VNP stressed during the survey for this study that they were not aware of the policy documents related to biodiversity and food and security including the VNP management plan (Figure 4.1). This corroborates the findings of Ampaire et al. (2017) that policies are primarily designed by the central government bodies with exclusion of local communities and limited involvement of other stakeholders.

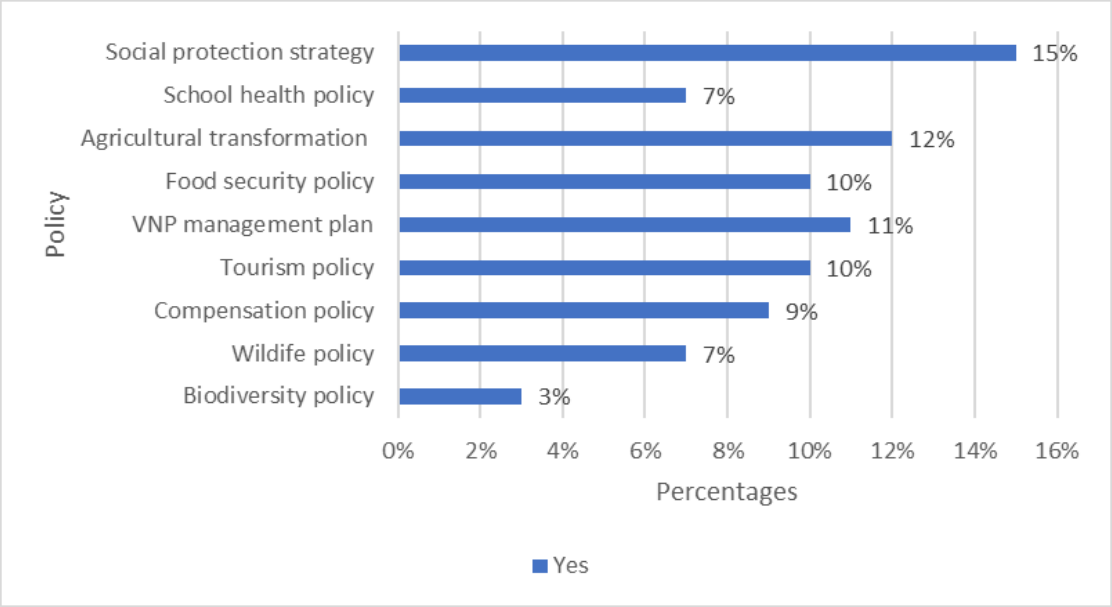

Figure 4.1: Level of awareness about conservation and food security policy documents

Source: GIS data, 2019

iii) Crop raiding as an institutional issue

About 30% of respondents from the household survey reported that wild animals damaged their crops. Only 40 households (10%) around VNP reported that they claimed compensation for damage caused by wildlife and only one person among them said that he was compensated for the damage. The 39 households that did not receive compensation mentioned that the reason was that documents, statements and approvals requested for justification of the damage were difficult to get and that the process is complicated, and people do not get fair compensation. The information was confirmed by 7 out of the 10 focus groups that reported that wild animals damaged their crops, but they did not claim compensation because the cost related to it is greater than the benefit they get from compensation. Also, all 21 key informants emphasized that the valuation of damages is complicated due to the long process involving travel, phone calls and underestimation of the damages. 5 of the 10 focus groups indicated that only damages made by buffaloes and gorillas are compensated because they are easy to identify and 2 of them continued arguing that while they are the most expanded, no compensation is made for the damages made by monkeys,

duikers, bushbucks and porcupines because those ones are not covered by the compensation law the reason being the fact that it is not easy to differentiate them from the damages made by goats and sheep. These findings confirm the report of Bizoza & Ndangiza (2014) that there are still complaints by members of communities around National Parks across the country that compensation for wildlife damages is not forthcoming.

Around 90% of interviewees from the household survey reported that they prefer not to claim compensation and accept the loss. Out of the 40 respondents who reported that their crops were damaged by wild animals during the household survey, 24 (60%) said that what is difficult/complicated with the process is the modality for calculating and awarding compensation; 12 (30%) said that it takes too much time to get the compensation while 4 (10%) said that the process is expensive. Usually, the damage is assessed on the plot where animals destroyed crops and compensation value in Rwandan francs is calculated there by park officials and local government representatives in the presence of the farmer. These respondents from the household survey said that the authorities underestimate the damage and therefore do not get fair compensation. Other issues mentioned by two focus groups on crop raiding were that it is difficult for locals to plant crops that are not palatable to wild animals because their crops are for subsistence, and they own very small land. Suggestions from the household survey, focus groups and key informants to solve this issue are described below under 4.3.2. Guinness (2014) recommended revising the national compensation policy for damages made by wild animals in order to fairly resolve existing conflicts between protected wildlife and subsistence communities along the margins of national parks. In Rwanda the law on compensation of people for damages caused by wildlife and related ministerial orders provide for the compensation of those whose property are damaged by wildlife and detail the modalities for awarding compensation including the requirements for the farmers to get compensation. Also, in 2012, the government of Rwanda established the special guarantee fund with a mandate of compensating for the damages caused by wild animals among others (Republic of Rwanda, 2018c). Therefore, more work has to be done by RDB, VNP management, Musanze, Nyabihu, Rubavu and Burera Districts, leaders of Sectors, Cells and Villages adjacent to the VNP as well as Development Partners such as NGOs

operating in community conservation in the area to ensure local people get fair and timely compensation for the damages made by wildlife.

iv) Revenue Sharing as an institutional challenge

Limited participation of local communities in policy development has implications on the benefits they get from the park given that they cannot organize themselves to claim their rights if they are not aware of them. Although the VNP Management Plan emphasizes linking VNP conservation with improving local livelihoods to reduce human pressure on the park resources, it does not show clearly on how this should be done and nothing about improving local food security is mentioned. Consequently, local people do not benefit from VNP conservation as revealed by the findings from the household interviews. Among the 400 interviewed households only 152 (38%) indicated that they have benefited from the park. It is positive that VNP supported some of the members of the local community to group themselves into cooperatives that benefit from Revenue Sharing Proramme to reduce local pressure on the park resources. Revenue sharing data of 2005 to 2019 show that 72.71% of the revenue sharing amount (5% of total revenue) went to infrastructure development including construction of schools, health centers and markets; and the other 5.47% went to the construction of the wall that prevents buffalos from getting outside the park. These data were confirmed by the findings of the household survey and focus groups' discussions as detailed below under 4.3.2. This corroborates the findings of Bizoza & Ndangiza (2014), Guinness (2014), Bush et al. (2010), Sabuhoro (2006) and Plumptre et al. (2004) that in several cases projects financed by revenue sharing do not address the pressing needs of poor livelihoods in the local communities in addition to the lack of direct compensation for benefits they used to get by using natural resources from national parks. Rather most of the revenue sharing resources are used to develop public infrastructure like health facilities, roads and schools which could be financed from other sources of funds such as annual budget allocated to districts by the central government (Bizoza & Ndangiza, 2014). These public infrastructures are mainly placed in village centres for logistical reasons and as such, these services are not likely to reach the poor who should be the target if their impact on park resources has to be reduced (Bush et al., 2010). In addition to the 5% of revenue, local conservation partners such as SACCOLA, DFGFI/KRC, IGCP and MGVP also have some

community engagement programmes that support local development. However, their contribution to food security is still very small looking at the number of households that are food insecure (71%).Furthermore, cooperatives that benefit from Revenue Sharing Programme sign performance contracts with the VNP management to ensure they support to repair the stone wall and dig trenches to prevent animals from getting out of the park; raise local awareness; report poachers and other illegal users; take animals back to the park (mainly monkeys during the day), provide 5 people who guard the crops in their respective sectors every day, burry dead animals, support poor cooperative members and poor community members to pay health insurance, etc. Members of cooperatives consider performing these activities as paying back to the park and indicated that they do not benefit from Revenue Sharing Programme. Also, another challenge is that most handcraft cooperatives that benefit from community conservation and Revenue Sharing Programme are run by people from Musanze town because they are more open to quickly grab opportunities than local people who have a direct relationship with the park.

Also, although it seems that the park and partners are addressing the issue of water scarcity by providing rainwater harvesting tanks to households in the vicinity of the park to reduce their entrance to the VNP in search of water, local access to clean water is still small: Although 16% of respondents have access to rainwater harvesting systems and during focus group discussions, local people mentioned the need for expanding this support and supplementing it by connecting villages to piped clean water systems. During household interviews, 10 respondents mentioned that local people still go to fetch water inside the park while only one respondent mentioned that local people enter the park for other uses such as hunting and collecting bamboo, bean poles, honey, handicraft-making materials, fodder and animal grazing. This shows that water scarcity is a big issue in the vicinity of VNP.

The successful long-term conservation of VNP depends on how local food security will be improved and for it to be improved, it must be integrated into the VNP conservation agenda. This should start with revising regulatory framework to include provisions for food security interventions and raising awareness of decision-makers in

park conservation, land use and community development. Their understanding of institutional processes can help to identify barriers and gateways that are important for the design of interventions that will result in sustainable livelihood outcomes. Also, there is a need for improved coordination of different actors to identify trade-offs and synergies between natural capital management and food security goals. Importantly, placing local people livelihoods at the centre of conservation interventions is important to find sustainable solutions to biodiversity conservation. Policies, institutions and related processes influence people's choice of livelihood strategies (Angelsen et al. 2011; Adato & Meinzen-Dick, 2002). Thus, without clear policies and institutional framework that support improvement of local food security, people around VNP will continue to illegally use the park resources to get food.

4.2 Effects of land use changes on Volcanoes National Park

The second objective of this thesis was to examine the effects on changes in land use on Volcanoes National Park (VNP). This section focuses on analyzing how land use changed between 2000 and 2019 in the study area of 10 km belt around VNP and the impact that the changes caused on VNP biodiversity. This study used Landsat images of four time series covering the study area from 2000 to 2019 (2000, 2010, 2015 and 2019) and field data to analyze the changes in land use and land cover around VNP. It was not possible to produce maps for 2005 due to heavy clouds that were covering the area at the time satellite images were taken. To understand whether changes occurred more prevalently along the park or further away from it, changes in land use and cover that took place between 2000 and 2019 were analyzed and compared between two belts, one from the park edge to 5km and another from 5.1km to10km.

4.2.1 Assessment of classification accuracy

The assessment of the accuracy for the area of this study (10km belt around VNP) reveals that in 2000 the overall accuracy and kappa were 88.67% and 86.8% respectively. In 2010, overall accuracy was 87.42%, Kappa was 85.17% while year 2015 had the overall accuracy of 88.33% and Kappa of 86.28%. In 2019, the overall accuracy was 87.00% while Kappa was 65.48%. Although the results of this assessment show a slight variation of Kappa and accuracy from 2000 to 2019, these two metrics are statistically significant: above 85% that is the minimum required for

the accuracy according to Anderson et al. (1976) or above 80% according to Carletta (1996).

For the assessment of the accuracy of the map of the area inside VNP, the results show that in 2000, overall accuracy was 85.21% and Kappa equals 83.12%. For 2019, overall accuracy was 86.35% and Kappa equal 84.82% (table 4.3).

Table 4.3: Classification accuracy of the maps of the study area

LULC category	**2000 (%)**		**2010 (%)**		**2015 (%)**		**2019 (%)**	
Class name	Producer's	User's	Producer's	User's	Producer's	User's	Producer's	User's
Water body	81.25	92.86	55.56	83.33	64.29	90.00	81.25	86.67
Forest and woodlot	96.4	89.17	73.68	80.00	91.30	91.30	95.31	87.14
Agriculture and grassland	76.92	76.92	91.25	82.02	96.05	87.95	71.43	83.33
Built-up area	30	100	55.56	83.33	42.86	75.00	50.00	100.00

Source: Field Survey, December 2018

4.2.2 Changes in land use and land cover around VNP between 2000 and 2019

Four classes were identified during image classification, where clear blue colour represents the area occupied by agriculture and grasses, dark green forests and woodlots, dark red colour the built-up distributed in the study area, dark blue colour represents the area covered by water and grey colour represents bare land area.

The LULC map from 2000 shows that the 0km-5km belt around VNP was dominated with agriculture and grassland (86%), followed by built-up (9.25%), then forest and woodlots (4.63%) followed by bare lands (0.11%) and lastly water bodies (0.01%). Agriculture and grassland area increased from 80.13% to 95.55% between 2000 and 2010 but reduced overtime since then to 93.89% in 2015 to 86% in 2019. The forest

and woodlots land considerably reduced from 19.25% in 2000 to 3.83% in 2010 and slightly increased since then to 4.4% in 2015 to 4.63% in 2019. The built-up area did not change between 2000 and 2010 (0.58%). It increased to 1.7% in 2015 and to 9.25 in 2019 (more than five-fold increase only in 4 years). Also, the bare land area remained unchanged between 2000 and 2010 (0.04%), reduced to 0.01% in 2015 and increased to 0.11% in 2019. There were no water bodies in this belt between 2000 and 2015. In 2019, water bodies covered 0.01%. Ground truth data have shown that there are no water bodies in the 0km-5km belt, only few small water sources in Kinigi area (Table 4.4). Most of the area of 2.97 ha shown on the map was covered by temporary water that was running from Volcanoes to Mukungwa river after rain when the satellite image was taken (Figures 4.2-4.5).

Table 4.4: Land cover changes in the 0km-5km belt around the park between 2000 and 2019

Class name	2000		2010		2015		2019	
	Area (ha)	**Area (%)**	**Area (ha)**	**Area (%)**	**Area (ha)**	**Area (%)**	**Area (ha)**	**Area (%)**
Built-up	197.1	0.58	197.01	0.58	575.46	1.7	3,120.21	9.25
Agriculture & grass	27,032.40	80.13	32,236.56	95.55	31,670.50	93.89	29,015.10	86
Forest & woodlots	6,494.49	19.25	1,290.78	3.83	1,485.95	4.4	1,562.49	4.63
Water bodies	0.27	0	0.18	0	0.45	0	2.97	0.01
Bare land	12.51	0.04	12.24	0.04	4.41	0.01	36	0.11
Total	**33,736.77**	**100**	**33,736.77**	**100**	**33,736.77**	**100**	**33,736.77**	**100**

Source: Field Survey, February 2019

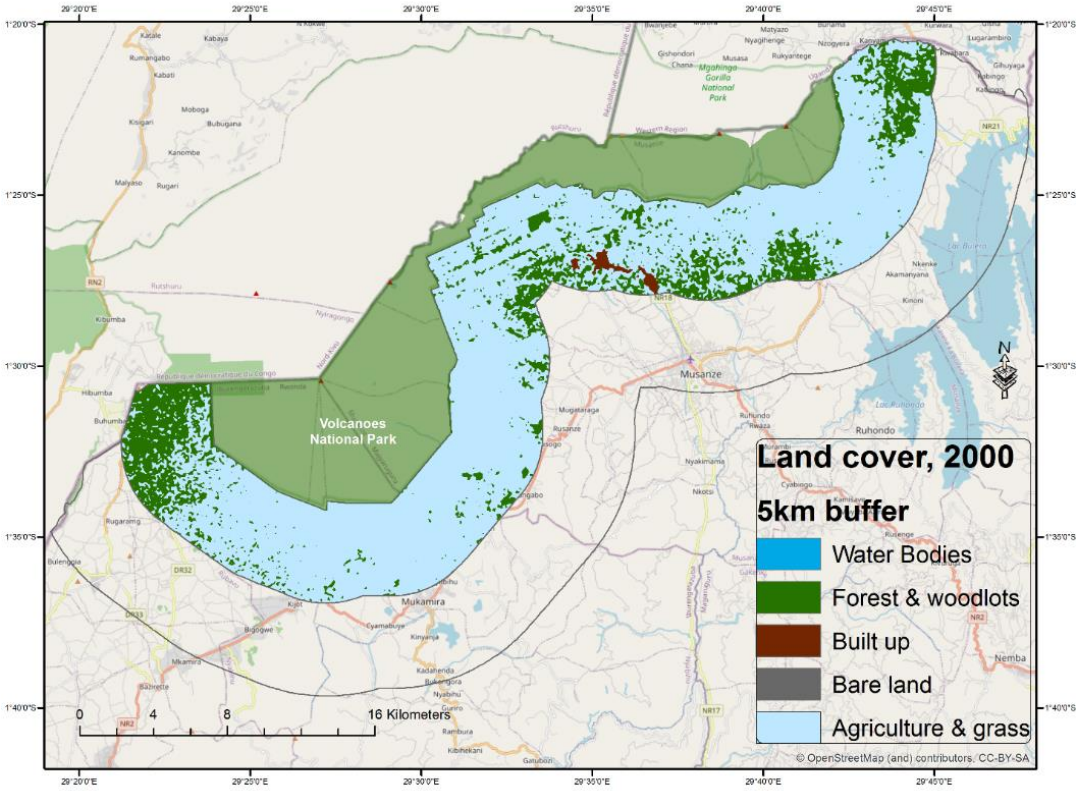

Figure 4.2: Land use and land cover in the 0km-5km belt around VNP in 2000

Source: GIS data, 2019

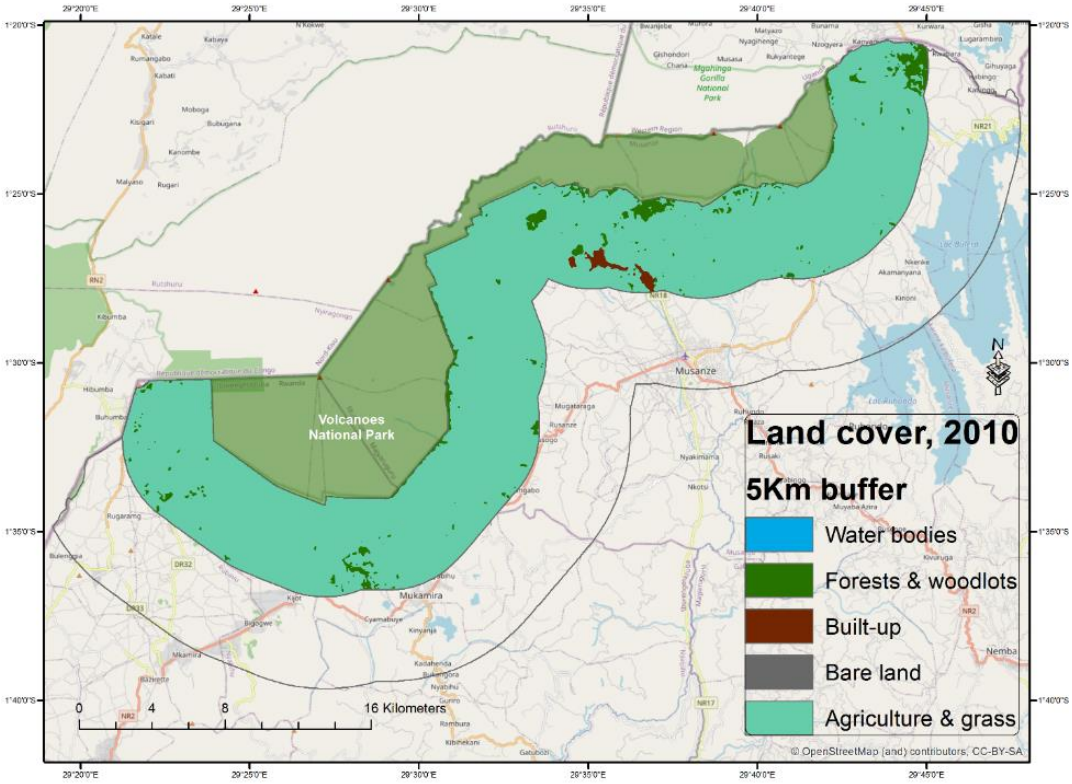

Figure 4.3: Land use and land cover in the 0km-5km belt around VNP in 2010

Source: GIS data, 2019

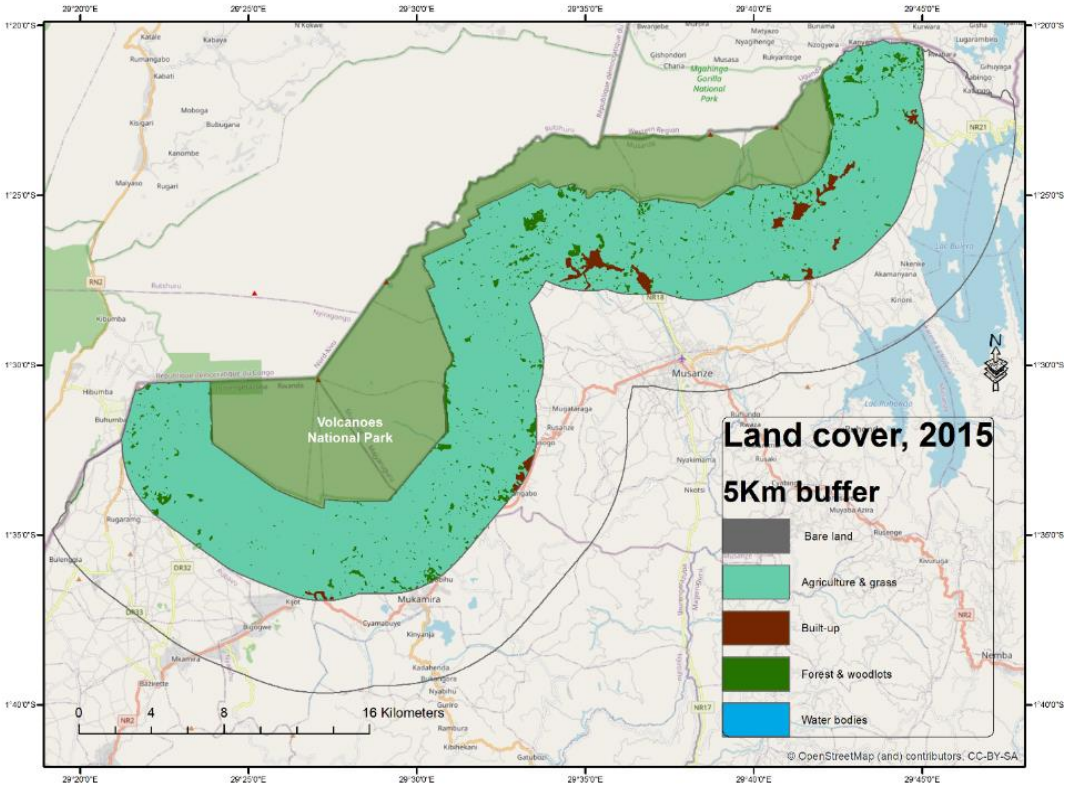

Figure 4.4: Land use and land cover in the 0km-5km belt around VNP in 2015

Source: GIS data, 2019

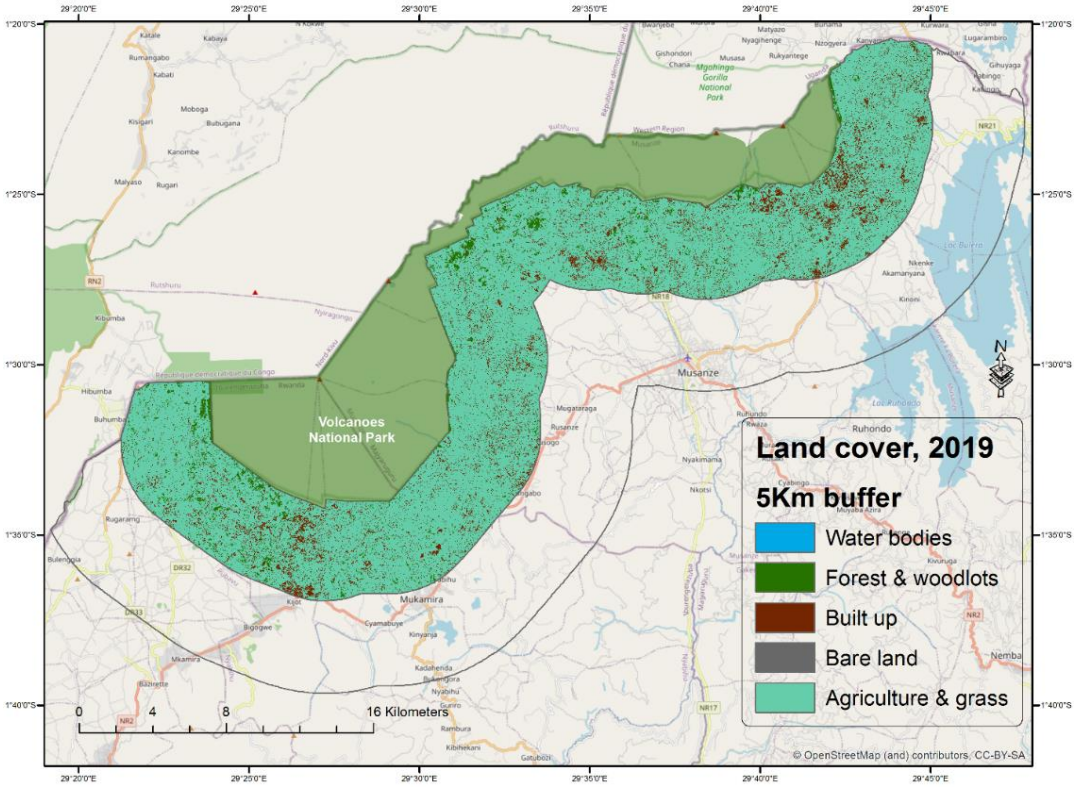

Figure 4.5: Land use and land cover in the 0km-5km belt around VNP in 2019

Source: GIS data, 2019

The LULC map from 2000 shows that the 5.1km-10km belt around VNP was also dominated with agriculture and grassland (77.66%), followed by built-up (9.28%) then water bodies (7.49%), followed by forest and woodlots (5.52%), and lastly bare land (0.05%). Agriculture and grassland area increased over time from 54.47% to 75.7% in 2010 to 77.22% in 2015 and to 77.66% in 2019. The forest and woodlots land considerably decreased over time from 35.31% in 2000 to 13.47% in 2010 then to 9.58% in 2015 and to 5.52% in 2019. The built-up area considerably increased over time from 1.6% in 2000 to 2.11% in 2010, then to 4.58% in 2015 and to 9.28% in 2019. The bare land area did not change between 2000 and 2010 and started reducing since then to 0.17% in 2015 to 0.05% in 2019. Water bodies area slightly increased from 8.43% in 2000 to 8.53% in 2010, slightly decreased to 8.45% in 2015 and again slightly increased to 8.49% in 2019 Table 4.5; Figures 4.6-4.9).

Table 4.5: Land cover changes in the 5.1km-10km belt around the park between 2000 and 2019

Class name	2000		2010		2015		2019	
	Area (ha)	**Area (%)**	**Area (ha)**	**Area (%)**	**Area (ha)**	**Area (%)**	**Area (ha)**	**Area (%)**
Built-up	584.91	1.6	771.75	2.11	1,673.10	4.58	3,395.07	9.28
Agriculture & grass	19,924.20	54.47	27,689.64	75.7	28,248.47	77.22	28,405.89	77.66
Forest & woodlots	12,915.36	35.31	4,928.16	13.47	3,503.17	9.58	2,017.62	5.52
Water bodies	3,084.30	8.43	3,119.67	8.53	3,091.50	8.45	2,740.23	7.49
Bare land	70.02	0.19	69.57	0.19	62.55	0.17	19.98	0.05
Total	**36,578.79**	**100**	**36,578.79**	**100**	**36,578.79**	**100**	**36,578.79**	**100**

Source: Field Survey, 2019

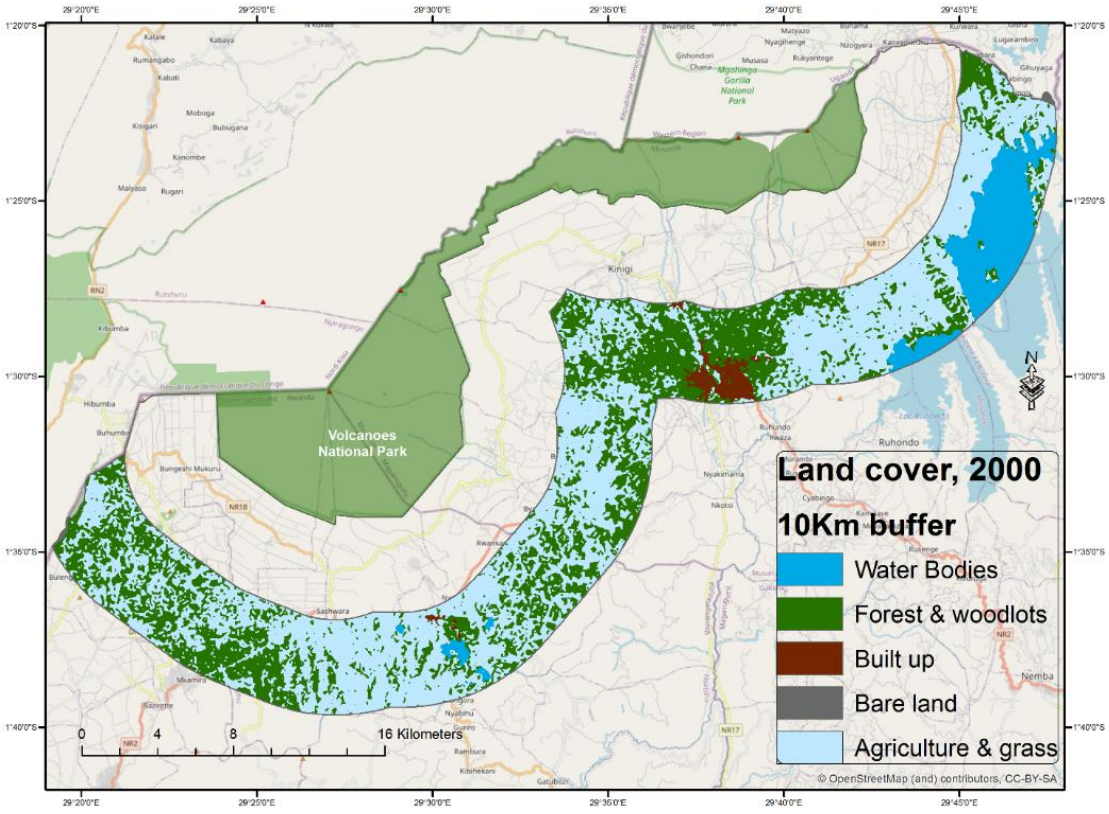

Figure 4.6: Land use and land cover in the 5.1km-10km belt around VNP in 2000

Source: GIS data, 2019

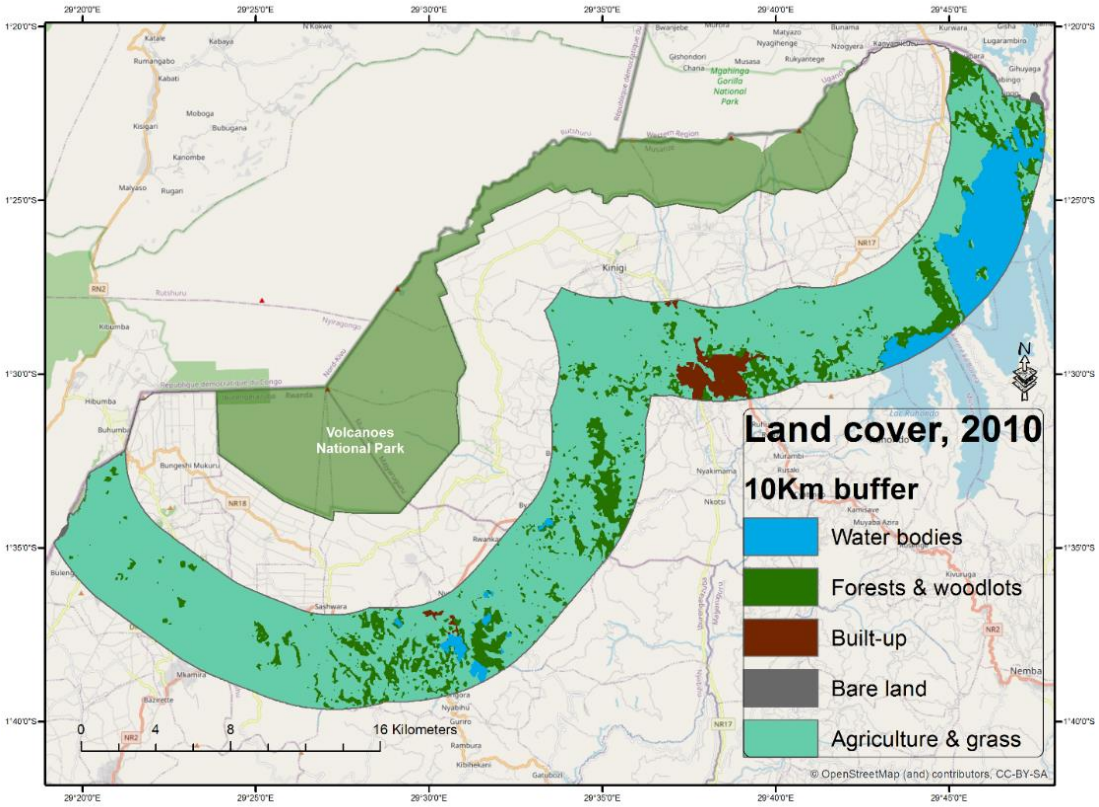

Figure 4.7: Land use and land cover in the 5.1km-10km belt around VNP in 2010

Source: GIS data, 2019

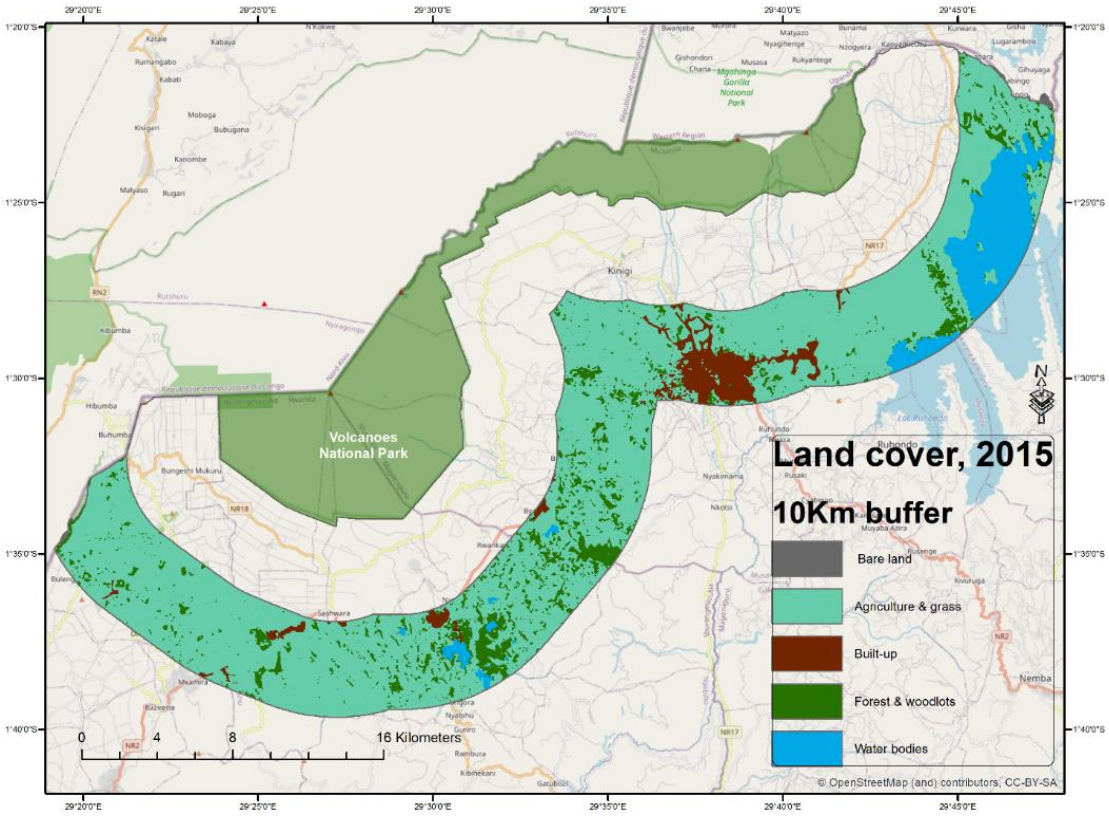

Figure 4.8: Land use and land cover in the 5.1km-10km belt around VNP in 2015

Source: GIS data, 2019

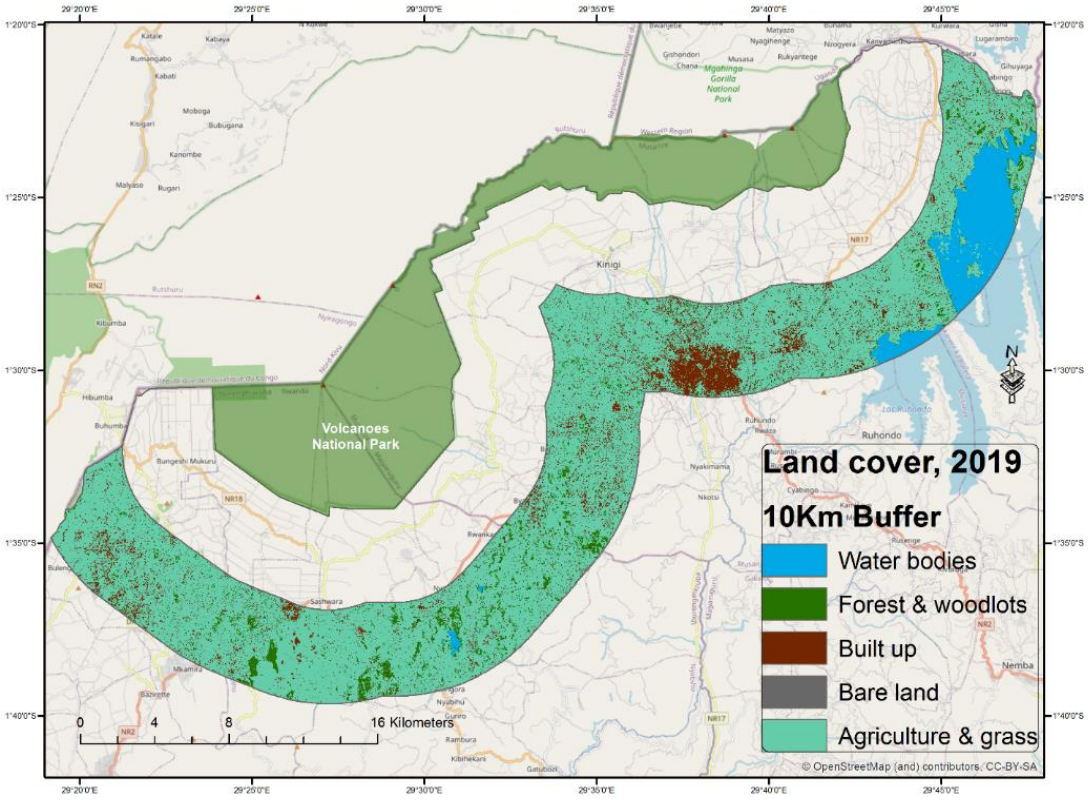

Figure 4.9: Land use and land cover in the 5.1km-10km belt around VNP in 2019

Source: GIS data, 2019

Although, agriculture and grassland was the land use cover that was dominant in the two belts in 2000, there was a higher percentage in the 0km-5km belt than in the 5.1km-10km belt (86% and 77.66% respectively). The second dominant land use in both belts was built-up with almost the same percentages (9.25% in 0km-5km belt and 9.28%). The third percentage in 0km-5km belt was forest and woodlots with a slightly less percentage than in belt 5.1km-10km (4.63% and 5.52% respectively). The 0km-5km belt had no water bodies (0.01%) while this land cover occupied the third percentage in 5.1km-10km belt (7.49%). Bare land was not significant in the two belts (0.01% in 0km-5km belt and 0.05% in 5.1km-10km belt). While agriculture and grassland area in the 0km-5km belt increased between 2000 and 2010 and decreased since then, in the 5.1km-10km belt it kept increasing over time. However, in 2019, the agriculture and grassland area in the 0km-5km belt was still bigger than in the 5.1km-10km belt (86% and 77.66% respectively). In both belts, the forest and woodlots land considerably reduced between 2000 and 2019 (from 19.25% to 4.63% in 0km-5km

and from 35.31% to 5.52% in 5.1km-10km). In the 0km-5km belt, the reduction took place between 2000 and 2010 and started to slightly increase overtime since then while in the 5.1km-10km belt, the reduction continued over time.

The built-up area considerably increased and almost at the same overall rate in the two belts between 2000 and 2019 (from 1.7% to 9.25% in the 0km-5km belt and from 1.6% to 9.28% in the 5.1km-10km belt). The area increased over time in the 5.1km-10km belt while in the 0km-5km belt the area only increased between 2010 and 2019. The bare land area in the two belts was not significant. It increased from 0.04% to 0.11% in 0km-5km and decreased from 0.19% to 0.05% in the 5.1km-10km belt. There were no water bodies in the 0km-5km belt between 2000 and 2019, only a few small sources of water in the Kinigi area. However, the 5.1km-10km belt has several lakes and rivers including the Mukungwa river and Burera, Nyirakigugu and Karago lakes. The area of these water bodies almost remained the same between 2000 and 2019 (8.43% and 8.49% respectively). The area slightly decreased between 2010 and 2015 and slightly increased between 2000 and 2010; and between 2015 and 2019.

4.2.3 The dynamics of land use and land cover in the 0km-5km belt around VNP

Several gains and losses occurred in land use between 2000 and 2019 in the 0km-5km belt around VNP, which this study determined as the direct influence zone on the conservation of this park. In 2000, the area had an estimated agriculture and grassland land area of about 27,032.40 ha, representing approximately 80.13% of the coverage. In 2019, the unchanged agriculture and grassland area was 23,289.12 ha (86.15%). The area gained 5,725.98 ha (about 21.18 %). These are 5,589.18 ha from forest and woodlots, 124.74 ha from built-up area ha from the area that was occupied by the built-up, 11.79 ha from bare land area and 0.27 ha from water bodies. However, the agriculture and grassland also lost 3,743.28 ha (approximately 13.85%). 2,638.71 ha were transformed into built-up area, 1,075.5 ha to forest and woodlots; 27.09 ha were degraded to bare land and 1.98 ha were occupied by water bodies. This means that the overall gain in agriculture and grassland between 2000 and 2019 was 7.33% (1,982.70 ha) and was mainly from deforestation.

In 2000, the built-up area in the 0km-5km belt was 197.10 (0.58%). In 2019, the unchanged built-up area was 71.10 ha (36.07%). The area gained 3,049.11 ha

(1,546.99%). The land occupied by the buildings includes 2,638.71 ha from agriculture and grassland, 409.95 ha from forest and woodlots and 0.45 ha of bare land. The built-up are also lost 126 ha (63.93%). The buildings were mainly replaced by agriculture and grassland that took 124.74 ha, forest and woodlots (1.08 ha) and water bodies (1.08 ha). Most of the houses that were in the 5km belt in 2000 were demolished between 2005 and 2010 when the government relocated people from dispersed settlements in the vicinity of the park to grouped settlements. The overall increase in the area of built-up in the 0km-5km belt between 2000 and 2019 was 2,923.11 ha (1483.06%). This high increase in the built-up area is caused by the rapid population growth in the vicinity of the park as people migrate to the area because of fertile volcanic soils. Also, a lot of people from across the country move to this area because there is a lot of job opportunities due to quick gorilla tourism development that attracts a lot of Private Sector investment and the growing number of NGOs in the area for gorilla conservation work.

In 2000, the forest and woodlots land in the 0km-5km belt was 6,494.49 ha (19.25%). In 2019, the unchanged forest and woodlots land was 485.64 ha (7.48%). The area gained 1,076.85 ha (16.58%). This gain is made up of 1,075.5 ha from agriculture and grassland, 1.08 ha from built-up land and 0.27 ha from bare land. Between 2000 and 2019, the forest and woodlots land lost 6,008.85 (92.52%). Forests and woodlots were mainly cut down for pasture and agriculture development, which took away 5,589.18 ha (93.01%). This was followed by the buildings that also increased over time occupying 6.77% (409.95 ha) while 0.14 % (8.91 ha) of this area was degraded into bare land and 0.01% (0.81 ha) occupied by water bodies. The overall forest and woodlots loss in the 0km-5km belt between 2000 and 2019 was 75.94% (4,932ha). These data indicate that around VNP, deforestation is occurring at an alarmingly high rate. Also, considering that between 2000 and 2019, the forest and woodlots area lost 6,008.85 ha and only gained 1,076.85 ha, this study reveals that the deforestation and afforestation ration is 6:1. This means that in the vicinity of VNP, of 6 hectares of trees cut down only 1 hectare is afforested. These figures are very far high compared to overall country deforestation and afforestation rate. This high deforestation rate poses a big threat to the VNP as it is likely the only sources of firewood, construction

materials and bean poles for local households especially those that cannot afford to buy them from other sources.

In 2000, water bodies in the 0km-5km belt occupied 0.27 ha (0.00%). This is because there are very few and small water sources in the vicinity of the park as the area is a volcanic plain. In 2019 this area gained 2.97 ha (1,100%). These include 1.98 ha from agriculture and grass land, 0.81 ha from forest and woodlots and 0.18ha from built-up. Considering that this increase in not significant, there are no lakes in the 5km belt and that during the field visit there was no sign of new sources of water in the area, this increase might be because the 2019 satellite image used in this study was taken after a heavy rain. This is also justified by the fact that the 0.27 hectares of water bodies in 2000 was totally changed to agriculture and grassland in 2019. There are temporary big water ways in both 5km belt and 10 km belt that takes a lot of water from heavy rains that fall in the volcanoes almost every day away to the Mukungwa river. These ways are called “imyuzi” meaning temporary rivers. During the rainy season, they frequently create floods that kill people, destroy houses and wash away crops in the study area and beyond.

In 2000, the bare land in the 0km-5km belt occupied 12.51 ha (0.04%). In 2019, the totality of this land was transformed into agriculture and grassland (11.79 ha), built-up (0.45ha) and forest and woodlots (0.27 ha). In 2019, the area gained 36 ha (287.77%). This includes 27.09 ha degraded from agriculture and grassland and 8.91 ha from forest and woodlots. This means that the overall increase in bare land between 2000 and 2019 is 23.49 ha (187.77%). Based on the ground truth data, the bare land in the 5km belt does not results from the long-term land degradation. It is rather from short term cultivation of the land and the harvest of woodlots.

Table 4.6: Gain, loss and no change in the 0km-5km belt between 2000 and 2019

Class name	2000 to 2019											
	Gain (ha)	Gain (%)	Loss (ha)	Loss (%)	Unchanged (ha)	Unchanged (%)	Total 2000 (ha)	Total 2000 (%)	Total 2019 (ha)	Total 2019 (%)	Overall gain/loss in 2019	Overall gains/loss in 2019 (%)
Agriculture & grass	5725.98	21.18	3,743.28	13.85	23,289.12	86.15	27,032.40	80.13	29,015.10	86	1,982.70	7.33
Bare land	36	287.77	12.51	100	-	-	12.51	0.04	36	0.11	23.49	187.77
Built-up	3,049.11	1,546.99	126	63.93	71.1	36.07	197.1	0.58	3,120.21	9.25	2,923.11	1483.06
Forest & woodlots	1,076.85	16.58	6,008.85	92.52	485.64	7.48	6,494.49	19.25	1,562.49	4.63	-4,932.00	-75.94
Water bodies	2.97	1,100.00	0.27	100	-	-	0.27	0	2.97	0.01	2.7	1000
Total							**33,736.77**		**33,736.77**			

Source: Field Survey, February 2019

4.2.4 The dynamics of land use and land cover in the 5.1km-10km belt around VNP

The 5.1km-10km belt also underwent several land use and cover changes between 2000 and 2019. In 2000, this belt had an estimated agriculture and grassland land area of about 19,924.20 ha (54.47%). In 2019, the unchanged agriculture and grassland land was 17,194.23 ha (86.30%). The area gained 11,211.66 ha (56.27%). These are 10,747.71 ha from forest and woodlots, 124.2 ha from the area occupied by built-up, 61.2 ha from the bare land area and 287.55 ha from water bodies. However, the agriculture and grassland also lost. 1770.66 ha were transformed into built-up area, 934.2 ha to forest and woodlots; 13.59 ha were degraded to bare land and 11.52 ha were occupied by water bodies. This means that the overall gain in agriculture and grassland between 2000 and 2019 was 42.57% (8,481.69 ha) mainly from deforestation.

In 2000, the built-up area in the 5.1km-10km belt was 584.91 ha (1.60%). In 2019, the unchanged built-up occupied 458.55 ha (78.40%). The area gained 2,936.52 ha (502.02%). The land occupied by the buildings includes 1,770.66 ha from agriculture and grassland, 1,152 ha from forest and woodlots, 2,714.85 ha from water bodies and 2.43 ha of bare land. The built-up area lost 126.36 ha (21.60%). The buildings were mainly replaced by agriculture and grassland that took 124.2 ha, forest and woodlots (2.07 ha) and water bodies (0.09 ha). Most of these buildings were demolished in the rural area between 2005 and 2010 when the government relocated people from dispersed settlements to grouped settlements. Those that were replaced by water bodies were demolished between 2005 and 2010 when the government was restoring shores of the lakes and enforced the law to protect 50m along the shores of the lakes across the country. The overall increase in the area of built-up in the 5.1km-10km between 2000 and 2019 is 2,810.16 ha (480.44%).

In 2000, the forest and woodlots land in the 5.1km-10km belt was 12,915.36 ha (35.31%). In 2019, the unchanged forest and woodlots land was 995.49 ha (7.71%). The area gained 1,022.13 ha (7.91%). This gain was 934.2 ha from agriculture and grassland, 2.07 ha from built-up land, 79.47 ha from water bodies and 6.39 ha from bare land. Between 2000 and 2019, the forest and woodlots land lost 11,919.87 ha (92.29%). Forests and woodlots were mainly cut down for pasture and agriculture

development, which took away 10,747.71 ha (90.16%). This was followed by the built-up that occupied 1,152 ha (9.66%) while 6.39 ha (0.05%) of this area was degraded into bare land and 13.77 ha (0.11%) occupied by water bodies. The overall forest and woodlots loss in the 5.1km-10km belt between 2000 and 2019 was 84.38% (10,897.74ha). These data show that even the 5.1km-10km belt is undergoing an alarming rate of deforestation. This exacerbates the threat to the VNP because this means that this park remains the only available source of firewood, construction materials and bean poles for people in the 0km-5km belt given that they cannot source them from 5.1km-10km.remains Also, considering that between 2000 and 2019, the forest and woodlots area lost 11,919.87 ha and only gained 1,022.13 ha, this study reveals that the deforestation and afforestation ration is 12:1. These types of land use pose a big threat to the VNP resources and biodiversity.

In 2000, water bodies in the 5.1km-10km belt occupied 3,084.30 ha (8.43%). In 2019, the unchanged water bodies area was 2,714.85 ha (88.02%). Between 2000 and 2019, this area gained 25.38ha (0.82%). These include 11.52 ha from agriculture and grass land, 13.77 ha from forest and woodlots and 0.09 ha from built-up. Between 2000 and 2019, Water bodies lost 369.45 ha (11.98%). These include 278.55 ha that were dried up and transformed into agriculture and grassland, 79.47 ha into forest and woodlots, 11.43 ha into built-up. This is because between 2000 and 2005 a lot of lakes were encroached by farmers for crops production and animal grazing. Also, some of the areas were occupied by built-up such as commercial and residential houses. This encroachment stopped after 20005 when the environmental law was created and reinforced to protect 50 m of the lakes' shores. Overall, water bodies in 5.1km-10km belt lost 344.07 ha (11.16%). This is mainly due to the encroachment mentioned above and the sedimentation due to land degradation linked to the rate of deforestation that is very high in the 5.1km-10km belt.

In 2000, the bare land in the 5.1km-10km belt occupied 70.02 ha (0.19%). In 2019, the totality of this land was transformed into agriculture and grassland (61.2 ha), built-up (2.43 ha), and forest and woodlots (6.39 ha). In 2019, the area gained 19.98 ha (28.53%). This includes 13.59 ha from agriculture and grassland and 6.39 ha from forest and woodlots. This means that the overall loss of bare land between 2000 and

2019 is 50.04 ha (71.47%). Like the bare land in 0km-5km belt, based on ground truth data, the bare land in the 5.1km-10km belt does not result from the long-term land degradation. It is rather from the short-term cultivation of the land and the harvest of woodlots (table 4.7).

Table 4.7: Gain, loss and no change from the 5.1km-10 km belt between 2000 and 2020

Class name	2000 to 2019											
	Gain (ha)	Gain (%)	Loss (ha)	Loss (%)	Unchanged (ha)	Unchanged (%)	Total 2000 (ha)	Total 2000 (%)	Total 2019 (ha)	Total 2019 (%)	Overall gain/loss in 2019	Overall gain/loss in 2019 (%)
Agriculture & grass	11,211.66	56.27	2,729.97	13.7	17,194.23	86.3	19,924.20	54.47	28,405.89	77.66	8,481.69	42.57
Bare land	19.98	28.53	70.02	100	-	-	70.02	0.19	19.98	0.05	-50.04	-71.47
Built-up	2,936.52	502.05	126.36	21.6	458.55	78.4	584.91	1.6	3,395.07	9.28	2,810.16	480.44
Forest & woodlots	1,022.13	7.91	11,919.87	92.29	995.49	7.71	12,915.36	35.31	2,017.62	5.52	-10,897.74	-84.38
Water bodies	25.38	0.82	369.45	11.98	2,714.85	88.02	3,084.30	8.43	2,740.23	7.49	-344.07	-11.16
Total							**36,578.79**		**36,57879**			

Source: Field Survey, February 2019

4.2.5 Comparison of land use and cover dynamics between 0km-5km and 5.1km-10km belts

In 2000, in the 5.1km-10km belt the area under agriculture and grassland occupied a smaller percentage (54.47%) compared to the 0km-5km belt where the agriculture and grassland occupied (80.13%). This is because a big part of the Musanze city is in this 5.1km-10km belt. However, the percentage of unchanged agriculture and grassland in the two belts between 2000 and 2019 is almost the same (86.30% in 5.1km-10km belt and 86.15% in 0 km-5km belt).

The percentage of the overall gain of agriculture and grassland in 5.1km-10km belt is almost 6 times the percentage in the 0km-5km belt (42.57% vis a vis 7.33%). This is due to a higher rate of deforestation (10,747.71 ha of forest and woodlots transformed in agriculture and grassland compared to 5,589.18 ha in 0km-5km, bigger bare land transformed in agriculture and grassland (61.2ha compared to 11.79 ha) and a bigger area of water bodies that shrank and transformed into agriculture and grass land (278.55 ha compared to 0.27 ha). The 5.1km-10km belt includes several lakes including Burera, Nyirakigugu and Karago. Between 2000 and 2005, these lakes were highly degraded by encroachment for crops cultivation, cattle grazing and sedimentation due to heavy soil erosion.

In 2000, the built-up area in the 5.1km-10km belt occupied a higher percentage than in the 0km-5km belt (1.60% and 0.58% respectively). This is because the big part of the Musanze city is in this 5.1km-10km belt. However, the findings of this study reveal that the increase in built-up land within the 0km-5km belt is three times the growth in 5.1km-10km belt (3,049.11 ha (1,546.99%) and 2,936.52 ha (502.02%) respectively. The built-up takes over mainly agriculture and grassland (2,638.71 ha) and forest and woodlots (409.95 ha). Only 0.45 ha of bare land was transformed into built-up between 2000 and 2019. This is a threat to VNP conservation because while 93% of households in the 0km-5km rely on subsistence agriculture, the already small agricultural plots and woodlots that they own are being bought for construction of hotels, commercial centers and residential houses and in many cases these households sell their land using the government expropriation law that does not help the land owner to get enough money that they can use to buy new plots elsewhere. Thus, the

number of landless households is high in the vicinity of the park. In the Kabatwa focus group discussion, all participants indicated that it is difficult to reduce illegal use of the park because there are a lot of landless households that have no other livelihoods alternatives apart from collecting the park resources and working for neighbours on agricultural land. They explained that from June to August, these households cannot get jobs on farms and this is the period when illegal use of the park resources increases. Also, the continued deforestation poses a general threat to the VNP biodiversity because almost 100% of local households use firewood to cook and timber for construction as there are no other alternatives to VNP trees and bamboo that are continuously illegally harvested. Gas in Rwanda is not affordable and thus it is mainly used in cities by also a limited number of middle- and high-income households. Charcoal is also sourced from different woodlots across the country and sold in cities. 93% of households around VNP are poor farmers and cannot afford to buy gas or charcoal from far away. Thus, landlessness and deforestation in the vicinity of VNP are big threats to the sustainable conservation of this park. The percentage of the lost built-up area between 2000 and 2019 was higher in the 0km-5km belt than in 5.1km-10km belt (63.93% and 21.60% respectively). This could be because after the 1994 genocide against the Tutsi a lot of people illegally occupied the VNP buffer zone and settled there for crop cultivation and cattle grazing. The government relocated them to grouped settlements within 2km from the park edge between 2000 and 2005.

In 2000, the percentage of land covered by forest and woodlots in the 5.1km-10km belt was almost double of the size in the 0km-5km belt (35.31% and 19.25% respectively). The two belts underwent almost the same high rate of deforestation between 2000 and 2019. The 5.1km-10km belt lost 92.29% of its forest and while the 0km-5km belt lost 92.52%. Forests and woodlots were mainly cut down for pasture and agriculture development in the two belts, (90.16% in 5.1km-10km belt and 93.01% in 0km-5km belt). Other land uses and cover that took over forest and woodlots in both belts were not significant including the buildings (9.66% in 5.1km-10km belt and 6.77% in 0km-5km), bare land (0.05% in 5.1km-10km and 0.14 % in 0km-5km and water bodies (0.11% in 5km-10 km and 0.01% in 0km-5km). Although the two belts underwent the same rate of deforestation between 2000 and 2019, the

afforestation efforts in the 0km-5km belt are double the efforts in the 5.1km-10km belt (16.58% and 7.91% respectively). This is well in line with the reports of the VNP management that the government, the VNP management and stakeholders are making efforts to increase forest cover and sources of wood products to reduce local pressure on the VNP. However, as indicated by the report of (Republic of Rwanda, 2019) on Rwanda forest cover, efforts invested in afforestation within the overall 10km (within the sectors bordering the park) are far low compared to the efforts made beyond these sectors as described below. The gain in forest and woodlots for the two belts was mainly from the agriculture and grassland (91.39% in 5.1km-10km belt and 99.87% in 0km-5km belt). The gain from other land uses were not significant (0.20% in 5.1km-10km and 0.10% in the 0km-5km from built-up land, 5.77% in the 5.1km-10km belt and 0.62% in 5.1km-10km belt from water bodies and 0.02% in the 0km-5km from bare land). Given that the deforestation-afforestation ratio is pretty wide (12:1 in 5.1km-10km and 6:1 in the 0km-5km), afforestation efforts need to be increased in the two belts if the human pressure has to be reduced on the VNP resources as this park remains the only available source of firewood, construction materials and bean poles for households in the two belts. These findings corroborate with the data from the Republic of Rwanda (2019) on the changes in Rwanda forest cover between 2009 and 2019 as the report shows that the rate of afforestation in the Sectors bordering the park is the lowest (8.3%) compared to other sectors within the same districts (31.1%) and the country. There might be less attention to this issue given that the overall forest cover of this sector in the report includes the VNP, making the rate of deforestation low compared to several other sectors. Planning for interventions that reduce local pressure on VNP would require disaggregating data on determinants of local food insecurity including the availability of energy for cooking outside the park.

In 2000, water bodies in the 5.1km-10km belt occupied 3,084.30 ha (8.43%) of the land while in 0km-5km it occupied only 0.27 ha (0.00%). This is because there are very few and small water sources in the 0km-5km belt as the area is a volcanic plain and three lakes (Burera, Nyirakigugu and Karago) and Mukungwa river in the 5.1km-10km belt. The gain in water bodies was not significant in the two belts (0.82% in 5.1km-10km belt and the 2.97 ha in the 0km-5km belt are not a real water bodies as in

this belt only temporary water run to the Mukungwa river from the volcanoes' mountains). The lack of water bodies in the 0km-5km belt causes serious problem of water scarcity in this belt compared to 5.1km-10km belt. Thus, increasing the number of people who enter the park for water collection especially in Kabatwa area where the government water system is far away. Different NGOs and the VNP management support local community to harvest rainwater but the systems are still not enough as explained by 90% of the respondents from the focus groups discussions.

In 2000, the bare land in both the 0km-5km and the 5.1km-10km belts was non-significant (0.04% and 0.19% respectively). In 2019, the totality of this land was transformed into agriculture and grassland, built-up, and forest and woodlots in the two belts. Between 2000 and 2019 the 0km-5km belt gained 36 ha while the 5.1km-10km gained 19.98 ha (Figure 4.10). The gains are from agriculture and grassland and forest and woodlots for the two belts. Basing on ground truth data and the fact that the entire bare land of 2000 in the two belts was transformed into agriculture and grassland, built-up and forest and woodlots, the bare land in the study area does not results from the long-term land degradation. It is rather from short term cultivation of the land and the harvest of woodlots as explained above.

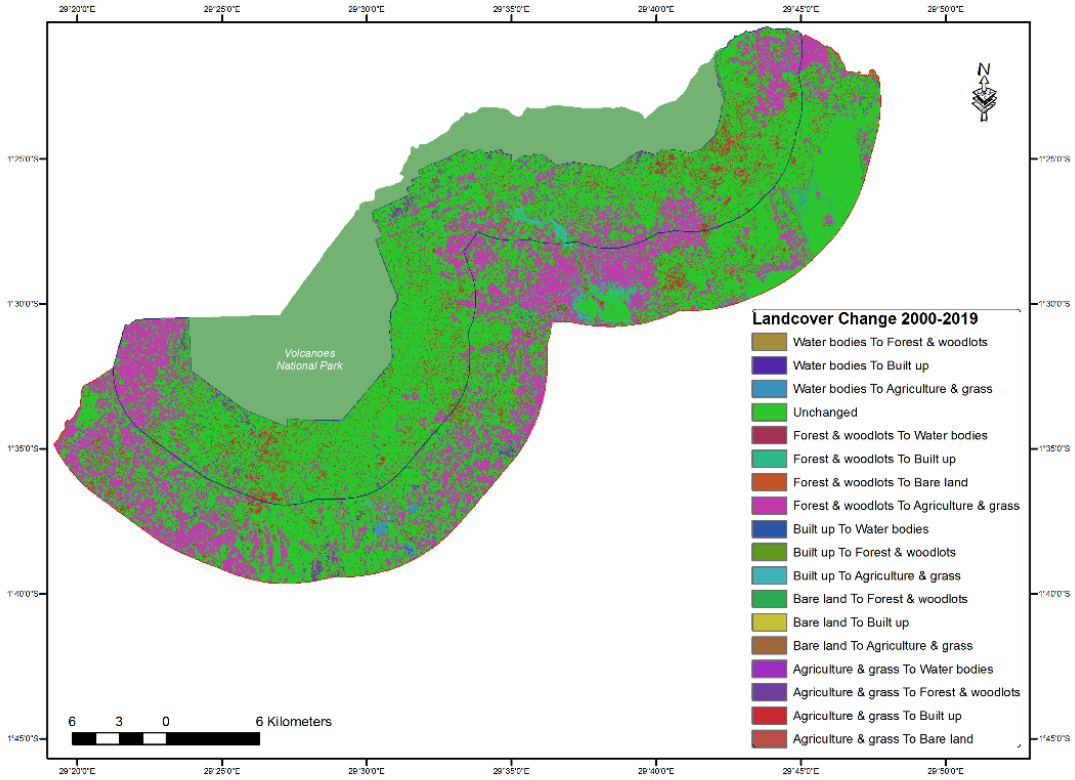

Figure 4.10: Overall land use and land cover dynamics in the area of the study between 2000 and 2019

Source: GIS data, 2019

4.2.5 The relationship between land use and land cover dynamics around VNP and the status of the park resources

To better understand the relationship between the land use and cover dynamics around VNP and the park resources' status, the changes in land cover inside the park were also analysed. The findings show that there was no change in the size of the park, only changes in the vegetation cover took place between 2000 and 2019. Between 1990 and 2000, the VNP underwent a high rate of deforestation primarily caused by the war and genocide against the Tutsi that the region went through. For this reason several areas of the park were encroached for farming and cattle rearing, others became settlements for refugees and rebel groups. In 1999, some conservation NGOs and the government resumed conservation and tourism activities in the park that were implemented together with park restoration.

With conservation and restoration efforts, the size of the open forest increased from 78.14% in 2000 to 88.33% in 2019 (table 4.8 and Figure 4.11). This does not mean local people did not illegally use the park resources during this period. The fact is rather that the magnitude of illegal use of the park was smaller than massive invasion that took place between 1990 and 2000.

Table 4.8: Land cover changes inside Volcanoes National Park between 2000 and 2019

Class name	2000		2019	
	Area (ha)	Area (%)	Area (ha)	Area (%)
Open forest	12,503	78.14	14,133	88.33
Alpine	2,355	14.72	1,751	10.94
Sub alpine	1,137	7.11	116	0.73
Bare soil	5	0.03	0.741	0.00
Total	**16,000**	**100**	**16,000**	**100**

Source: Field Survey, February 2019

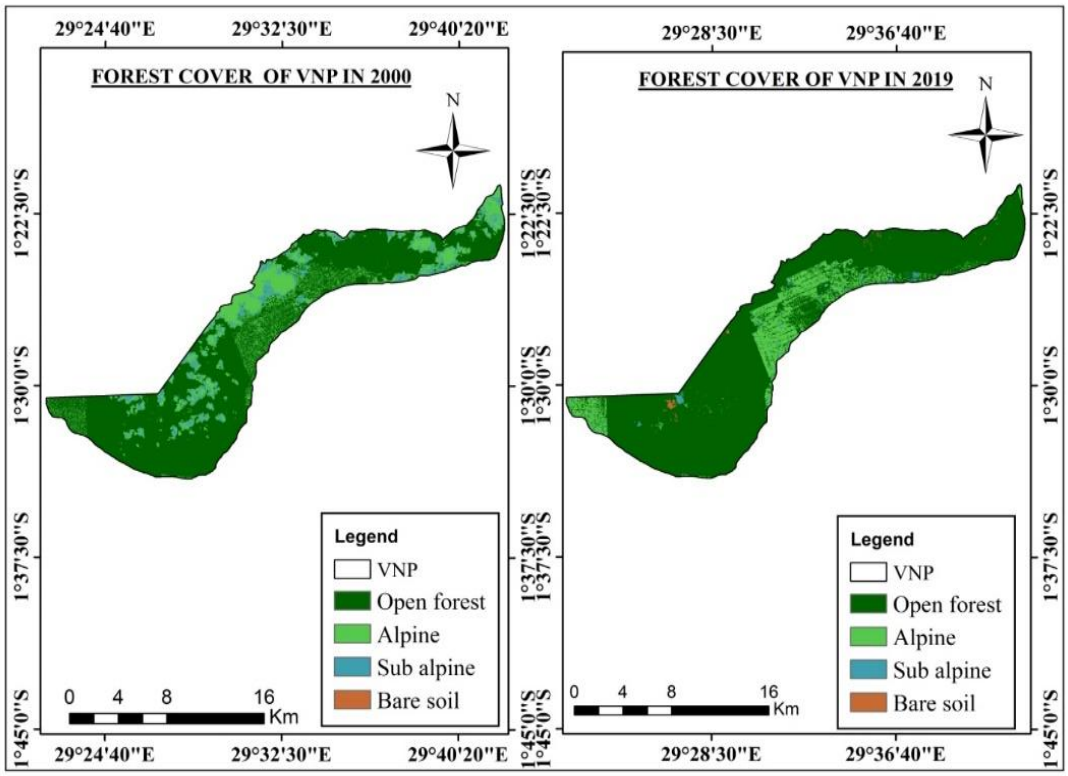

Figure 4.11: Land cover changes inside Volcanoes National Park between 2000 and 2019

Source: GIS data, 2019

With this background, it was difficult to link the detected forest cover changes with the findings on land use and land cover changes dynamics in the study area outside VNP. Therefore, ranger-based monitoring data that were collected by rangers inside the park from 2000 to 2019 were analyzed. The findings show that local people still illegally enter the park in search of water, wild meat, bamboo, timber and honey as shown in figure 4.12 below.

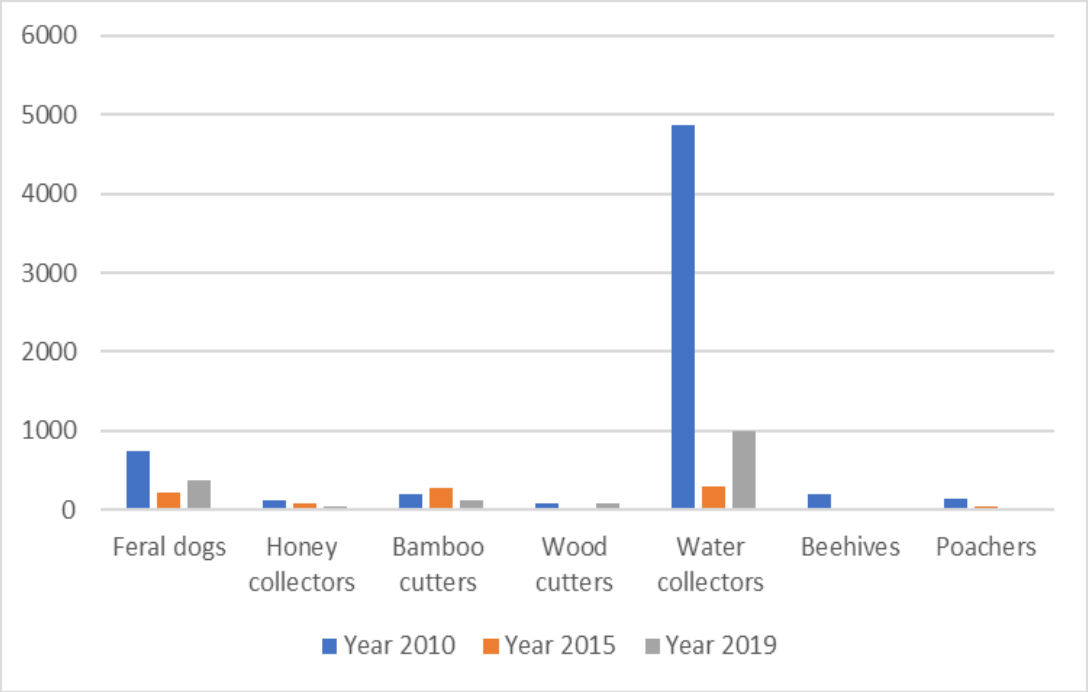

Figure 4.12: Illegal use of VNP resources between 2010 and 2019

Source: Field Survey, March 2019

The above data show that over the years, no significant changes occurred to counters illegal activities including poaching and bamboo harvesting despite a reported corresponding on the increase in community development support, and collaboration (Republic of Rwanda, 2015b). The same observation was made by Sabuhoro (2006) in his study on ecotourism as a potential conservation incentive for local communities around VNP.

These findings are well linked to the changes in land use and land cover that occurred in both 0km-5km and 5.1km-10km belts between 2000 and 2019. Analysis of land use and cover in the two belts between 2000 and 2019 revealed that the area around the park developed a very high rate of deforestation. The 5.1km-10km belt lost 92.29% of its forest while the 0km-5km belt lost 92.52%. The findings from the ranger-based monitoring data show that firewood collection and timber harvesting within VNP remain big issues. Also, illegal bamboo cutting at night is increasing. In 2015, 18 bamboo cutters were arrested. Furthermore, crop raiding by wild animals was reported to be a big issue. However, there are not enough efforts being made to reduce this issue. The land cover/use analysis under this study showed that between 2000 and

2019, in the 0km-5km belt, of 6 hectares of trees cut down only 1 hectare is afforested while in the 5.1km-10km the ratio is 11:1. This finding is justified by the revenue sharing data of 2005 to 2019 that show that RDB did not support any activity on energy saving and only 1.4% of revenue sharing went on reforestation/afforestation activities. Among 422 projects equivalent to USD 2,382,076.87 that were supported through revenue sharing between 2005 and 2019, only 15 of them equivalent to USD 33,583 (1.4%) were on reforestation/afforestation. These include one reforestation project of USD 1,000; one project of bamboo planting of USD 3,500 and 13 projects of woodlots planting of USD 29,083 (Republic of Rwanda, 2021). With these findings, there is an urgent need for the VNP management and stakeholders to address VNP deforestation by increased afforestation/reforestation efforts around the park, reducing the deforestation rate in the vicinity of the park, providing alternative cooking energy like biogas and LPG if the illegal harvesting of firewood, timber harvesting and bamboo cutting inside VNP have to be reduced.

The ranger monitoring data revealed that the highest illegal activity in VNP is water fetching. This finding is very well linked with the findings of land use and cover analysis in the 0km-5km belt that showed that there are no water bodies in the area and the revenue sharing data that showed that only 2.85% of revenue sharing revenue between 2005 and 2019 went to water supply and rainwater harvesting systems (Republic of Rwanda, 2021). The findings are also supported by the answers of 50% of the participants in focus groups discussions who said that they enter the park in search of water due to local water scarcity. It is well known that when local people enter the park to fetch water, this can be an opportunity to identify the location of other park resources that they can directly collect or come back later to harvest. Also, more interaction with wildlife may cause zoonotic diseases in the area and put gorillas, golden monkeys and other wildlife inside VNP at risk of communicable diseases between people and wildlife. To solve this issue, VNP management and stakeholders should increase efforts to supply water to communities around VNP.

The land use and cover analysis between 2000 and 2019 revealed that the built-up area quickly increases over time taking over agriculture and forest and woodlots land. In 2000, the built-up area occupied 0.58% of the 0km-5km belt. This increased to

9.25% in 2019. The almost similar quick growth also took place in belt 5.1km-10km. The built-up area increased from 1.60% in 2000 to 9.28% in 2019 also taking over agriculture and forest and woodlots land. These findings justify why poaching remains a big threat in VNP (Republic of Rwanda,2015b), During the household survey of this study, it was found out that the average land owned by the household around VNP is 0.3 ha and 98% of the households depend on subsistence agriculture, with the average household size of 5 people. Infrastructure development in this area poses a big threat to the VNP biodiversity because it reduces arable land for food production and creates landlessness. VNP management and stakeholders should create off-farm jobs or limit infrastructure development in the area if poaching and illegal harvesting of other park resources inside VNP must be reduced. Revenue sharing data show that only 0.92% of revenue sharing between 2005 and 2019 went to enterprise development. This is still a very small investment to create off-farm jobs in the area especially for those who are landless. However, it is good to mention that 14% of revenue sharing was invested in supporting local people to get livestock as an alternative to the wild animal protein. This is good effort that should be maintained to reduce poaching in addition to creating off-farm jobs.

The RDB ranger-monitoring report shows that most of illegal activities take place between May and September. This may be the evidence that the pressure on the park is due to food insecurity because these are the months that local people do not have enough food because they harvest in June/July and December/January. The VNP management and its partners keep increasing assertive management measures to reduce illegal harvesting of natural resources from the park and promote biodiversity conservation. However, these are still not enough to address the complex issues of food insecurity, deforestation and landlessness that increase local pressure on VNP resources. For instance, the persistent illegal use of the VNP resources despite park protection thus protecting the presence of tourists and the large research groups justifies the finding of this study that 71% of local households are food insecure. Food secure people cannot take the risk of illegally using the VNP resources because this can result in imprisonment or life loss. Food insecurity and high population growth in the area also justify why forest and woodlots land and agricultural land continue to

shrink over time while built-up area grows. Local poor have no other choice than selling their land to investors in hotels or private sellers due to more people who come to the area for jobs and businesses related to gorilla tourism. Also, some of the land was used for construction of public buildings including schools and health centers. Since decades, migration and occupation of land in the vicinity of VNP have been happening in an uncontrolled and unregulated way. Farmers moved from other parts of the country in search of fertile volcanic soils and better weather conditions suitable for agriculture (Bush et al., 2010). With the increasing population, the land became more and more scarce. Thus, high population density and reduced agricultural production that over time increase pressure on VNP natural resources (Plumptre et al., 2004).

80% of key informants indicated that due to the small land owned by households (0.3 ha on average), farmers even uproot tree seedlings provided or planted by the government and NGOs around VNP to reduce local pressure on the park. This may be the reason for the wide deforestation-afforestation ratio in the area.

This study revealed that crop raiding remains a big issue where people are not properly compensated. This exacerbates the issue of local food insecurity, thus creating more pressure on VNP resources (Plumptre et al. 2004and Guinness 2014)

4.3 Contribution of the benefits from the Volcanoes National Park to local food security

The third objective of this study was to assess the contribution of the benefits from the park to local community food security. This section focuses on analyzing the status of food security around VNP and its relationship with the benefits the local people derive from this park.

4.3.1 Status of food security around Volcanoes National Park

In this study, food security was analysed in 10 km around VNP. 400 households were visited, and questions including livelihood activities, household income, household assets, productive assets, agricultural production, expenditures, food sources and consumption, coping strategies, chocks, external assistance and distance to socio-economic services (market, health centre, roads) were asked to get data on each

household's food security status. These data helped to produce the food security index under table 4.9 below for the area of the study:

Table 4.9: Overall status of food security around VNP

Domain	Indicator	Food security status			
		Food secure	Marginally food secure	Moderately food insecure	Severely food insecure
Food consumption	Food consumption group or score	Acceptable 29.00%	NA	Borderline 29.00%	Poor 42.00%
Economic vulnerability	Food expenditure share	19.25%	6.5%	2.00%	72.25%
Assets depletion	Livelihood coping strategy categories	31.50%	2.50%	4.75%	61.25%
Food security index		27.19%	2.25%	16.19%	54.38%

Source: Field Survey, April 2019

This food security index reveals that around VNP, 27% of households are food secure, 2% are marginally food secure, 16% are moderately food insecure while 55% are severely food insecure. Classifying these 4 groups in two categories shows that only 29% of the households around VNP are food secure and the rest 71% are food insecure concurring with Munanura (2013) observations that a high proportion of households that live in the vicinity of VNP are poor and food insecure. This study revealed that food insecurity around VNP is 3 times higher the country average which is 19% of households (Republic of Rwanda, 2018a). The relationship between households' food security status and the benefits they get from the park is well described under subsection 4.3.3.

In this study, food secure households are those that reported data that revealed that they were able to meet their essential needs both food and non-food without resorting to unusual coping strategies. These households showed that they consumed adequate food items in the week prior to being surveyed, their expenses on food were less than 50% of their income and they did not need any strategy to deal with livelihood shocks or vulnerability.

The households in the marginally food secure category showed that they consumed food that was minimally adequate without resorting to coping strategies that cannot be reversed and/or they were unable to afford some non-food expenditures that were essential to them during the previous 7 days of the interview. These households used 50-65% of their income on food and employed livelihood stress coping strategies to meet their additional food and non-food needs such as spending their savings or borrowing money and therefore reducing their ability to cope with future shocks.

Moderately food insecure households are those that have shown that they marginally met their minimal food needs only by using coping strategies that were irreversible or have shown significant gaps in food consumption. These households have shown that they spent 65-75% of their income on food items and employed livelihood crisis coping strategies that include sale of assets that are productive, direct reduction of the household future productivity that includes formation of human capital.

Severally food insecure households are those that have shown that their food consumption gaps were extreme or that their livelihood assets were extremely lost in a way that this would result in the household food consumption gaps if not worse. Also, they showed that food purchases took more than 75% of the household income and they employed emergency livelihood copying strategies that are usually the last resort as they are more dramatic and may inhibit the household future productivity such as selling owned land.

This study shows that many farmers around VNP grow beans (41%), followed by Irish potatoes (29%), maize (12%), sorghum (3%), wheat (2%), sweet potatoes (1%) and pyrethrum (1%). 75% of those who reported that they grow Irish potatoes do not grow beans. People around VNP rely on Irish potatoes and beans for survival. The household survey data showed that the household's average total stock duration of crops for season A was 2.2 months, 1.8 months for season B and 1.4 months for season C.

During focus groups discussions local people explained that they cannot store Irish potatoes for more than 2 months because they rot. They then must sell most of the harvest and buy beans that they store. Also, farmers expressed the issue of low prices of Irish potatoes while inputs are expensive and therefore cause a deficit for them. In

addition, this study reveals that on average, 84% of agricultural produce by farmers' households is consumed by themselves and only 16% is sold to local markets.

This study reveals that the number of food insecure households decreases as we move from belt 1 at the park edge toward belt 10 outside. In each of the 10 belts, 40 households were interviewed. The highest proportion of households that were found to be food insecure is located near the park. The belt 2 (1km-2km buffer from the park edge) has the highest percentage which is 90% (36 of 40 interviewed households) followed by belt 1 (0km-1km buffer from the park edge) that has 82.5% (33 of 40 interviewed households). The lowest percentage of food insecure households (40%) was found in belt 9 followed by belt 10 with 60%. The percentages of food insecure households in the belts in between (3 to 8) vary from 70% to 75%. In a nutshell, the findings of this study show that households within the 0km-5km buffer are more food insecure (77.5%) than the households in the 5.1km-10km buffer (64.5%) as shown in table 4.10 and figure 4.13 below. These findings corroborate the observations of Munanura (2013) and Bush et al. (2010) who stated that most of the poorest households live in the vicinity of the VNP boundary while the wealthier households live near or in the village centres.

Table 4.10: Variation of food security from 1km belt to 10km belt outside the park

Belt	Food insecure HH	% of food insecure HH	Food secure HH	% of food secure HH
1	33	82.5	7	17.5
2	36	90	4	10
3	29	72.5	11	27.5
4	29	72.5	11	27.5
5	28	70	12	30
Total 5km buffer	**155**	**77.5**	**45**	**22.5**
6	29	72.5	11	27.5
7	28	70	12	30
8	30	75	10	25
9	18	45	22	55
10	24	60	16	40
Total 10km buffer	**129**	**64.5**	**71**	**35.5**

Source: Field Survey, April 2019

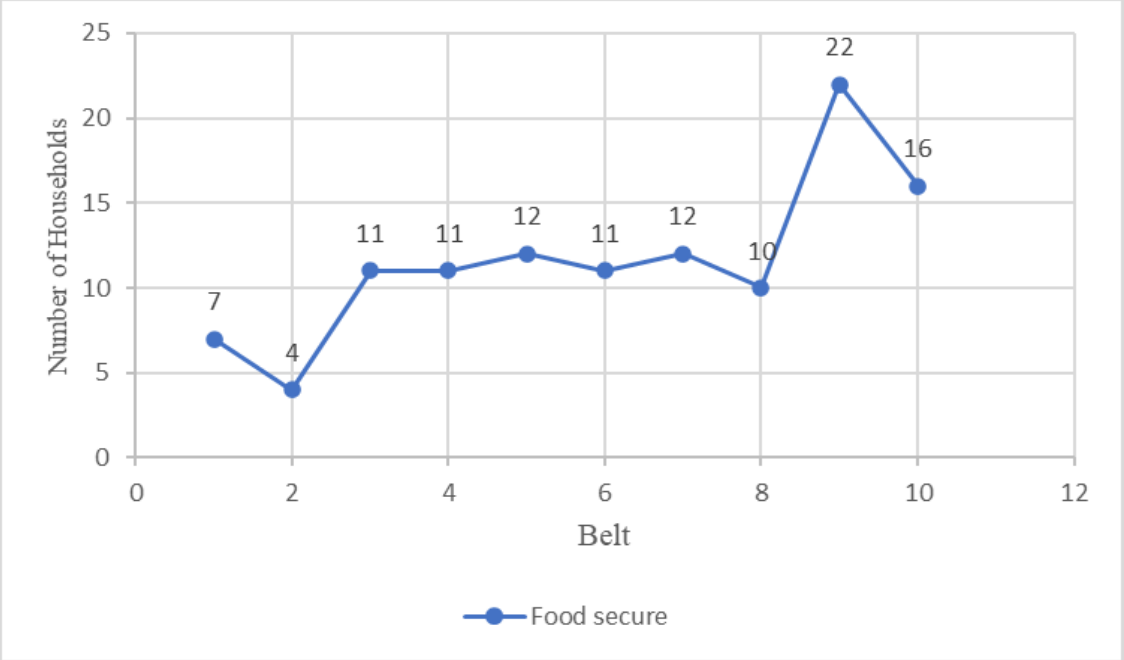

Figure 4.13: Variation of food security from 1km belt to 10km belt outside the park

Source: Field Survey, April 2019

These findings from food security analysis confirm the above results from policy gaps analysis in linking local food security with conservation of VNP. The policy gap analysis revealed that policies, strategies and action plans related to VNP conservation do not take into consideration of the local food security. Out of the 7 policy documents reviewed, none of them includes a food security mainstreaming framework or clearly shows where and on whom to focus to improve food security. Only 2 of the analyzed policy documents mentioned food security in relation to PAs conservation. However, they did not use this term but related terminologies such as food, food production, food supply and food sovereignty. Other documents used the terms livelihoods and poverty reduction/alleviation to reflect the link between the conservation of protected areas and local benefits. These terms are too broad to target people who are food insecure or to link interventions to the direct causes of the human pressure on the park as observed by Glamann et al. (2015); Barrett (2010) and Lindenberg (2002) in their studies on intersection of food security and biodiversity

conservation; measuring food insecurity and assessing livelihood security at community and household levels in developing countries respectively.

The finding that 71% of households around VNP are food insecure with the highest proportion (77.5%) found in the 0km-5km belt compared to the 5.1km-10km belt (64.5%) is supported by the information revealed by the land use change analysis in the same area. The 0km-5km buffer is highly affected by crop raiding issue where people are not properly compensated resulting in reduced crop production and losses compared to investment made. Also, this study shows that local people travel several kilometres to look for water inside the park. The time spent by household members in search of water could be used for income generating activities. This also increases absence and drop out of children from schools, something that inhibits local development. During the household survey of this study, it was found out that the average land owned by the household around VNP is 0.3 ha and 98% of the households depend on subsistence agriculture, with the average household size of 5 people. These agricultural plots are too small to produce crops that can meet food needs of these large families. The issue is exacerbated by the increase in built-up environment that over time takes over the already limited arable land, forests and woodlots reducing crop production and increasing landlessness. Also, the revenue sharing data from RDB for the 200 -2019 period show that the number of households that benefit from the park is still small (38%), limiting opportunities for off-farm jobs. The high deforestation rate in the two belts (92%) also increases food insecurity in the area. Some households spend a lot of time illegally looking for firewood inside the park while others spend a lot of money to buy it. This time could be spent on activities that generate household income and the money spent should be saved or used to buy food.

This finding on local food insecurity also concurs with previous studies that suggested that the role of gorilla tourism, the revenue sharing scheme and community conservation interventions in improving local livelihoods remains unclear (Bush et al., 2010; Sabuhoro, 2006). Also, it corroborates Guinness (2014); Bush et al. (2010); Adams et al. (2004); McShane & Wells (2004) and Brown (2002) who suggested that

community conservation programs around protected areas in Rwanda and across Africa failed to address the local needs and reach the poor.

This food security analysis shows which households are food insecure, where they are located and why they are food insecure. These findings provide a basis for targeted interventions to reduce local food insecurity and local pressure on the VNP resources. They also provide useful information for updating policies, plans and institutional framework to integrate local food security and conservation of VNP.

To ensure sustainable conservation of biodiversity, Mandima et al. (2011) recommend that conservation programs should consider benefits to local livelihoods, good governance, incentives and compensation for lost access to natural resources inside the parks and for damages caused by the wildlife. Both food security analysis and policy gaps analysis in this study show that the VNP management and partners are not doing enough to reduce food insecurity around the park while this should be the priority community to receive this support to reduce their pressure on the park resources. Local household remain food insecure and most of existing policies do not provide for linking conservation of VNP and local food security. Also, crop raiding remains an unsolved issue around VNP as few households get compensation for crops destroyed by the wildlife.

4.3.2 Contribution of Volcanoes National Park conservation to local food security

i) Benefits

The analysis of policy documents related to VNP conservation revealed that although the VNP Management Plan emphasizes linking VNP conservation with improving local livelihoods to reduce human pressure on the park resources, it does not show clear concepts of how this should be done and makes no mention of improving local food security. Consequently, local people do not benefit from VNP conservation as revealed by the findings from the household interviews. Among 400 interviewed households only 152 (38%) indicated that they benefited from the park. The livelihoods of the 62% remaining mainly depend on small scale agriculture that households practice on small plots of 0.3 hectares on average with a small number (1.3%). 3.8% of interviewed households mentioned that they have no activity for

livelihoods and all of them are landless. 72% of households that reported to benefit from the park are located in the 0km-5km buffer. Of 400 households interviewed, two households, one in belt 3 and another in belt 6 reported that their members earned income from employment in tourism. The same household in belt 6 is the only one among the 400 households that reported that its members earn money from a local tourism enterprise and from selling agricultural produce to tourism entrepreneurs. It also reported that its members earn money from supporting events organized by the park management such as through provision of contracted services related to baby gorilla naming ceremony (Kwita Izina) in addition to another household in belt 3. Only 2 respondents reported that their household member (s) benefited from support for education (one in belt 1 and another in belt 6), and only 4 (2 in belt 2 and 2 in belt 6) said that they benefited from their membership in a community development group.

Only 2 respondents (in belt 2) reported benefiting from construction of modern houses. 3 households (2 in belt 1 and 1 in belt 2) reported that they have benefited from tourism revenue. This is an indication that although still few (1%) some of the households around the VNP benefit from the revenue sharing scheme. 11 respondents most of them in the vicinity of the park reported that their household members are involved in the park management (3 in belt 1, 2 in belt 2, 2 in belt 3, 1 in belt 4, 2 in belt 6 and 1 in belt 7). These include porters and those who benefit from the revenue sharing that participate in stone wall repair and chasing away wild animals that get outside the park to destroy crops. 2 respondents from belts 7 and 10 reported that their household members got collective income from community enterprises. These are members of handcraft cooperatives established by the park management to improve local livelihoods. In many cases, these cooperatives are not run by people from Musanze town because they are more open to quickly grab opportunities. Among the 400 households interviewed none of them mentioned that their household members benefited from livestock assets. 16 households (6 in belt 1, 7 in belt 2 and 3 in belt 3) reported that they were supported to access water tanks (examples are shown in plate 4.1 below). This was also observed during households visit.

Plate 4.1: Water tanks constructed for households around VNP
Source: Republic of Rwanda, 2019

The VNP management and stakeholders provide rainwater harvesting systems to households in the vicinity of the park to reduce their entrance to the VNP in search of water as explained above. Although it is still a small number (4%), it is good to see that all of the beneficiaries are within 3km belt from the park edge. 49 (12%) of respondents reported that their household members were supported to get Health insurance (Mutuelle de Sante). Given how the numbers are distributed almost evenly across the 10 belts and the efforts of the local government across the country to support poor household to get access to health services, it would be difficult to relate this benefit to the support provided by the park.

The lowest proportion of households that benefited from the park is in the belt 7 (3%) followed by belts 8 (5%) and 9 (5%). Belts 1 and 2 have the highest percentage of households that benefited from the park (22% and 21% respectively). 30% of 400 households interviewed indicated that they benefit from improved roads (among these 71% are within 5 km from the park edge and 45% within only the 2km belt from the park edge). Also, 20% of respondents indicated that they benefit from constructing health centers with 49% within the 2km belt from the park edge. 16% responded that they benefit from new or improved market for local goods with 34% of those in the 2km belt from the park edge. 7% responded that their household members benefit from schools' construction with 55% of them are located within the 2km belt from the park edge. The number of households that reported that their members get indirect benefits from the park is 5 times larger the number of households that reported that

their household gets direct benefits (Munanura, 2013). The findings were confirmed in focus group discussions where 91% of them indicated that there are enough schools in the area around VNP estimating one school per Cell. This is also justified by the fact that several students do not go to the nearest schools. They are seen crossing their cells to others looking for better quality of education. This means that revenue sharing should shift from this benefit to others such as providing more direct benefits to households in needy because it is no longer an issue.

Belts 1 and 2 have the highest percentage of households that benefited from the park yet they are the most food insecure as explained above. This is because very few households receive direct benefits and the indirect benefits they get from the park do not directly address their livelihood issues. Although the number of households that benefit from the park is still small (38%), it is encouraging to see that 72% of them are located in the 0km-5km buffer. This reveals that community conservation and revenue sharing programmes are more invested in the zone of VNP influence than far away. This finding is well in line with the land use analysis data that have shown that reforestation efforts are more concentrated in 0km-5km belt than in 5.1km-10km belt.

Although it seems that the park and partners are addressing the issue of water scarcity by providing rainwater harvesting tanks (16% of respondents have access to rainwater harvesting system). During focus group discussions, local people mentioned the need for expanding this support and supplementing it with connecting villages to piped clean water systems. During household interviews, 10 respondents mentioned that local people still go to fetch water inside the park while only one respondent mentioned that local people enter the park for other uses such as hunting, collecting bamboo; bean poles, honey, handicraft-making materials, fodder and animal grazing (Figure 4.14). This shows that water scarcity is a big issue in the vicinity of the park.

In Gataraga, Shingiro, Jenda, Bigowe and Kabatwa Sectors, local people fetch water inside the park. This affects sanitation and then food security and nutrition among children and women. People in Nyange, Rugarama and Cyanika Sectors reported that they have access to water outside the park for household use however they still enter the park to fetch water used in agriculture to spray pesticides on Irish potatoes. The reason is that the settlements are far away from their agricultural plots that border the

park. Also, respondents expressed that water is very scarce during the dry season (June-August) because during the rainy season they use rainwater although not enough because of limited capacity to construct rainwater harvesting systems. This is an issue because people who enter the forest to fetch water may go back to illegally use the park resources and are exposed to aggressive wild animals such as golden cats, buffaloes, etc. Also, this increases the risk of communicable diseases between people and wildlife especially the endangered mountain gorillas. While the national water supply policy suggests that water collectors should not walk more than five hundred meters (Republic of Rwanda, 2016), people around VNP walk several kilometers to fetch water inside VNP. The time spent in water collection affects food security because adult people do not get enough time to work on farms or do other paying work to generate income to buy food and non-food items. For children, water scarcity affects school enrolment and attendance and increases dropout rates. These findings concur with the observations of Guinness (2014); Munanura (2013); Sabuhoro (2006); Plumptre et al. (2004) that a large number of households near VNP live in poverty, characterized by food insecurity, low income and water shortage.

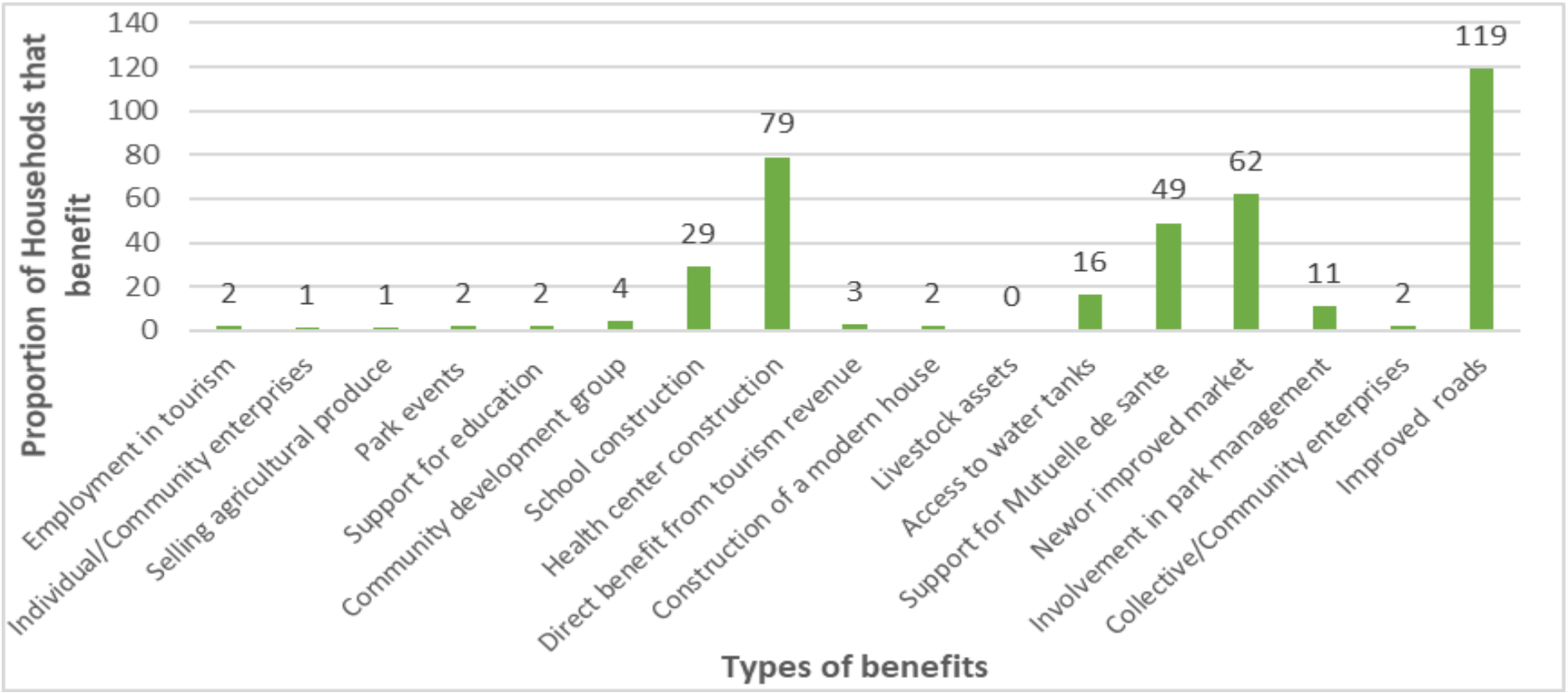

Figure 4.14: Benefits from Tourism and Community Conservation Projects

Source: Field Survey, April 2019

ii) Disbenefits

About 20% of respondents from the household survey reported that wild animals damaged their crops. Only 40 households (10%) reported that they claimed compensation for damages made by wildlife and only one person among them said that he was compensated for the damage. The 39 households that did not receive compensation mentioned that the reason was that documents, statements and approvals requested for justification of the damage were difficult to get and that the process is complicated, and people do not get fair compensation. The information was confirmed by 7 of the 10 focus groups that reported that wild animals damaged their crops, but they did not claim compensation because the cost related to it is more than the benefit they get from compensation. They explained that this is due to the long process involving travel, phone calls and underestimation of the damages. All 21 key informants and 10 focus groups emphasized that the valuation of damages is complicated. 5 of the 10 focus groups indicated that only damages made by buffaloes and gorillas are compensated because they are easy to identify (buffaloes uproot potatoes while cows only eat leaves; and gorillas eat the barks of eucalyptus where RDB pays RWF 1000 per damaged tree). 2 of these 5 focus groups continued arguing that while they are the most expanded, no compensation is made for the damages made by monkeys, duikers, bushbucks and porcupines because those ones are not covered by the compensation law the reason behind being the fact that it is not easy to differentiate them from the damages made by goats and sheep. One Irish Potato farmer from the focus group interviewed in Rugarama Sector reported that buffaloes destroyed 50mx50m of his field of Irish potatoes. He had planted 500 kg of potatoes, but he was paid RWF 50,000 after spending RWF 30,000 of transportation for follow

up travels. He also calculated the expenses related to the fertilizers, pesticides and labor that he used and said that his loss was more than RWF 50,000.

About 90% of interviewees from the household survey reported that they prefer not to claim compensation and accept the loss. Out of 40 respondents who reported that their crops were damaged by wild animals during the household survey, 24 (60%) said that what is difficult/complicated about the process is the modality for calculating and awarding compensation; 12 (30%) said that it takes too much time to get the compensation while 4 (10%) said that the process is expensive. Usually, the damage is assessed on the plot where animals destroyed crops and compensation value in Rwandan francs is calculated there by park officials and local government representatives in presence of the farmer. These respondents from the household survey said that the authorities underestimate the damage and therefore do not get fair compensation. Other issues mentioned by two focus groups on crop raiding were that it is difficult for locals to plant crops that are not palatable to wild animals because their crops are for subsistence, and they own very little land.

In order to solve the issues related to a lot of waiting for compensation, expenses related to travels to Kigali and timely evaluation of the damages (when it delays the signs are no longer there and the fund never pays once it does not find signs in place), 9 focus groups suggested that the compensation fund should be decentralized to Sector level; 5 mentioned that RDB should provide the real value of the damage; 4 suggested that RDB should accept photos as proof of damages where locals can take photos of duikers, porcupines, bushbucks and share them with RDB (these ones destroy maize, potatoes, pyrethrum and peas) and should accept testimonies from local leaders and local people who can sign the statement of seeing animals making damages where photos cannot be taken.

When respondents from the household survey were asked whether their households benefit from the improved control of animals problem due to the stone wall that separates the park from agricultural plots, ranger patrols etc; only 7 (2%) of 400 respondents said yes. The same percentage was found for the answers to the question if household benefit from extension services. When asked whether any member of

their household got training on nutrition; 29% of respondents said that at least one member of their household was trained on nutrition while 76% said that they have a community-based nutrition programme in their Umudugudu (village) (Figure 4.15). These figures show good achievements in nutrition campaigns in the area. However, all 21 key informants and 10 focus groups stressed that food insecurity around VNP is mainly caused by poverty that is linked to landlessness and small size of plots owned by households compared to low level of awareness about poverty sanitation and preparing a balanced diet. The findings of this study confirm observations from previous studies that crop raiding remains a big issue around VNP and that support amongst local farmers for both tourism and conservation initiatives is undermined by human-wildlife conflicts (Guinness, 2014; Plumptre et al., 2004).

The VNP Community Warden mentioned during the key informant interview, that the VNP management signs performance contracts with cooperatives supported by the revenue sharing to ensure that they support the repairs for the stone wall and dig trenches to prevent animals from getting out of the park; raise local awareness; report poachers and other illegal users; take animals back to the park (mainly monkeys during the day), provide 5 people who guard the crops in their respective sectors every day, burry dead animals, support poor cooperative members and poor community members to pay health insurance, etc. All members of the 2 focus groups of those who benefited from revenue sharing indicated that they are not happy with these performance contracts and they requested that RDB hires staff to do all of this work because what they do is a way of paying back the money they receive from tourism revenue sharing. 2 of them went further and proposed that RDB should fence the park using stones and cement or put an electrical fence or pay workers who maintain the fence.

Also, the issue of crops that are damaged by floods from VNP were identified by the focus groups of Kinigi, Shingiro and Nyange Sectors and they proposed that RDB retain water inside the park or create wide water channels.

In addition, the focus group of Kabatwa Sector also suggested that RDB employ them for instance in trail maintenance inside the park instead of contracting companies

from Kigali or other places far from the park. This echoes the findings from the household survey that only two households earned income from employment in tourism.

Around 86% of focus groups also reported that landless people go to poach during the long dry season because during this period they cannot get employment from farmers because there is no work on farms therefore, they use the time to poach in order to get both employment and food. These same respondents suggested that instead of hiring companies that maintain trails inside the park, landless people should be employed if poaching and bamboo cutting must be reduced. These findings are consistent with the land cover and use changes that occurred between 2000 and 2019, whereby land has been more and more occupied by built-up leaving some of the households landless.

None of respondents reported that local people consumed wild meat. However, one household mentioned to have consumed wild cut fish from Mukungwa river that is outside of VNP. 33% of respondents also mentioned that they used wild medicinal plants. None of them reported that the medicinal plants were from VNP. They reported to harvest them from agricultural farms/gardens; woodlots and marsh/wetlands. The main reason of abstinence on telling whether they poach or collect medicinal plants from the park is that entering the park is not allowed and whoever is found inside the park gets punished by the park management.

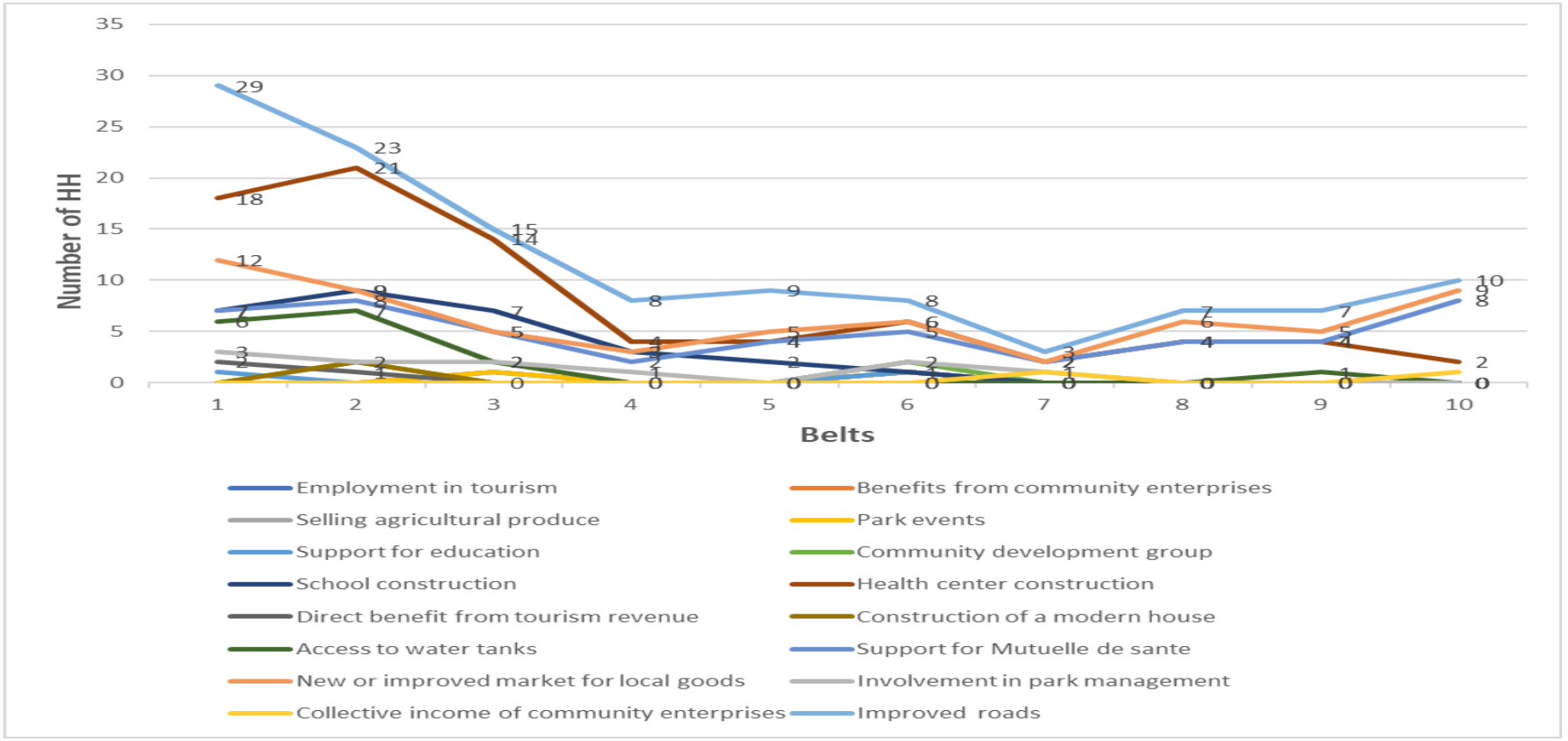

Figure 4.15: Variation of benefits from belt 1km to belt 10km outside the park

With limited local benefits from the park and pronounced food insecurity in the vicinity of VNP, it is uncertain how conservation efforts of this park will be sustainable. As above the data reveals, there is no significant contribution of benefits from VNP to the local community food security at HH level. This corroborates with the findings of Guinness (2014); Bush et al. (2010); Adams et al. (2004); McShane & Wells (2004) and Brown (2002) that despite wide implementation of ICDPs, several scholars documented their failure to yield either lasting conservation of the focal resources or local livelihoods benefits.

While the tourism was the first income earner for the country (USD 489 in 2019) (Butera, 2020). The revenue sharing data of 2005 to 2019 show that the total revenue sharing for this period was USD 2,382,076.87. 72.71% of this revenue sharing went to infrastructure development including construction of schools, health centers and markets (table 4.11). Also, the construction of the buffalo wall that occupied a significant percentage of the total revenue sharing (5.47%) to reduce human-wildlife conflicts came from revenue sharing that was already too small (5% of tourism revenue). This finding confirms the observation of Guinness (2014); Munanura (2013; Bush et al. (2010); Sabuhoro (2006) that there is inadequate tourism revenue sharing and limited opportunities for employment at VNP. This failure is not only observed around VNP. Díaz et al. (2019) study revealed that still a lot has to be done to ensure that local people get fair benefits from national parks worldwide. The study recommends facilitating contributions of local communities to sustainable management of national parks through granting them access and resources use rights, improved collaboration, co-management arrangements and equitable sharing of the benefits from the use of natural resources.

Table 4.11: Projects funded with the revenue sharing programme around VNP from 2005 to 2019

Category	Amount (USD)	%	Projects
Agriculture	600,350.70	25.20	215
Enterprise	21,810.50	0.92	5
Equipment	32,667.66	1.37	7
Human-Wildlife Conflicts	130,386.17	5.47	37
Infrastructure	1,596,861.85	67.04	158
Total	**2,382,076.87**	**100.00**	**422**

27.49% to direct benefits and 72.71% indirect benefits
Source: Republic of Rwanda, 2020

While the findings of this study show that people around VNP are food insecure with limited access to potable water and cooking energy, 67.04% of tourism revenue sharing goes to public infrastructure and less to household needs that are more associated with human pressure on the park resources. Successful long-term conservation of VNP depends on how local food security will be improved. For food security to be improved, it has to be integrated into the VNP conservation agenda. This should start with revising regulatory framework to include provisions for food security interventions and raise awareness of the decision-makers in park conservation, land use and community development and should involve understanding the institutional processes for identification of restrictions and opportunities that are important to design interventions that improve livelihood outcomes. Also, there is a need of improved coordination of different actors to identify trade-offs and synergies between natural capital management and food security goals. Importantly, placing local people livelihoods in the centers of conservation interventions is important to find sustainable solutions to biodiversity conservation. Institutions, policies and related processes influence household's choices of livelihoods strategies (Adato and Meinzen-Dick, 2002; Angelsen et al., 2011). Thus, without clear policies that support improvement of local food security, people around VNP will continue to illegally use the park resources to get food.

The status of food security of households around VNP depends on how policies to integrate food security and conservation are designed, viewed and implemented by

institutions and stakeholders, how households are affected by land use changes, income generated by households, assets owned, harvests, markets, seasonality and how they benefit from the conservation of VNP. Also, it assumes that the sustainable conservation of VNP will depend on how local households are food secure. People illegally use the park resources because they are food insecure. Thus, there is a need to integrate the VNP conservation and local food security.

4.3.3 Relationship between the benefits from the park and the households' food security status

This section is concerned with the test of the relationship between the surveyed households' food security status and their reported benefits from the park (Table 4.12). Food Consumption Group (FCG) is herein considered a measure of food security. Benefits from the park include tourism employment and/or income from tourism employment, collective income, construction of health centre, cooperative membership, education support, improved market, improved road, income from park events, part of park management team, health insurance, sales of farm produce, school construction, water tank and tourism revenue. Given that all these variables are either categorical or discrete, the dependence was tested using the Chi-Square, whose findings are detailed under table 4.15.

Results from the Chi-square show a positive and significant dependence of collective income, benefits from construction of health centres, benefits from improved market, and the benefits from being part of park management on the food security of the households around VNP. Positive association between collective income and food security indicates that although still few, the households that benefit from VNP in terms of collective income could improve their food security status. As such, food security improves with the increase in income. For the positive effect of the benefits from the construction of the health centers on the food security, it comes out that people around the VNP who get jobs from the economic activities funded through the revenue sharing from tourism or directly employed by the park management are likely food secure. The more people are employed, the more they get income and the more they afford different goods and services that sustain and improve their level of livelihood.

Table 4.12: Test for dependence of household's food security status on the benefits from VNP

Benefits from VNP	Dependence of FCG on VNP benefits	
	Chi2	**Prob > chi^2**
Tourism employment	0.919	0.632
Income from tourism employment	1.384	0.50
Collective income	4.921*	0.085
Construction of health centre	9.290***	0.010
Cooperative membership	2.242	0.326
Education support	9.919	0.632
Improved market	8.016**	0.018
Improved road	4.478	0.107
Income from park events	0.919	0.632
Part in park management	6.809**	0.033
Mutuelle de santé	3.614	0.164
Sales of farm produce	1.384	0.50
School construction	2.804	0.246
Water tank	1.031	0.597
Tourism revenue	4.174	0.124

Source: Field Survey, March 2019

Note: the dependence test is considered significant if the Prob>chi2 is at most equal to 10% or 0.10; *, **, and *** mean significance level at 1%, 5% and 10% respectively. Following Williams & Quiroz (2019) guidance, I have run an ordered logit regression with food security (1. Severely food insecure, 2. Moderately food insecure, 3. Marginally food secure, and 4. Food secure) as a dependent variable and the 15 indicators of the benefits from the park as independent variables. The estimates form the logit regression model came with only two independent variables which are 1) cooperative membership and 2) mutuelle de santé (Health insurance), whereby only cooperative membership has significance correlation with the household food security status, all other variables being omitted by the software (STATA) along the estimation process. Thus, chi2 analysis is useful although the dependence between variables does not always imply causation. Even though the dependence between variables does not always imply causation, we kept this because the ordered logit regression model (see Williams & Quiroz, 2019) accepted only two independent variables (cooperative membership and mutuelle de santé) whereby only coop membership is influencing significantly the food security.

Another factor with the positive effect of VNP conservation on food security is the improved market. This means that the people around VNP who have access to market for their agricultural produce as well as handcrafts (hotels, restaurants, sales to park management staff, and sales to tourists) are likely to be more food secure, because they earn income which they use to pay for food and non-food items necessary to support their life conditions, or to invest in farming and/or other income generating activities.

For the benefits for being part of VNP management, one household reported to have been a member employed by the park management that his salary is part of the household income and it is spent for the wellbeing of his family (food, clothes,

shelter, school fees, health care, etc.). The salary permanently provided contributes to the social sustainability of the household and as such the food security status becomes resilient.

This analysis shows that the more direct benefits local households get from the park, the more food secure they are. This corroborates the view of Brown (2002) that to ensure success in national parks' conservation, it is crucial to integrate them in local, national and regional economic and social contexts. Mulongoy & Chape (2004) suggest that national parks should significantly contribute to poverty reduction in order to make a solid contribution to poverty. Wittemyer et al. (2008) and Brown (2002) suggest that with the growing increase in global human population, particularly on the margins of national parks, it is a condition that the success of conservation has to be increasingly linked to the level of local support it receives and the nature of appropriate benefits it offers to communities. Also, Mulongoy & Chape (2004) indicate that for local communities to sustainably benefit from national parks, related issues should be addressed by institutions at different scales with appropriate roles.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1Introduction

This study had three objectives. The first objective was to examine policy and institutional framework in relation to biodiversity conservation at Volcanoes National Park and local food security; the second objective was to assess the effects of land use changes on Volcanoes National Park while the third was to evaluate the contribution of the benefits from Volcanoes National Park to local food security. To address these research objectives, this study used mixed methods involving a survey conducted on 400 sampled households to collect quantitative data and 21 key informants and 10 focus groups to collect qualitative data. The study area comprised 0km-5km and 5.1km-10km belts from the park edge to outside to enable comparison of findings in the vicinity of the park and places far away. This chapter summarizes the study's key findings, provides conclusions and draw recommendations for addressing issues arising from the study and for future research.

5.2 Summary of the results

In the case of the first objective, it can be summarized that there are policy action gaps and institutional challenges to integrate food security in conservation of VNP. The findings revealed that none of the 6 policy documents analyzed provides guidelines for integrating food security considerations in biodiversity conservation planning and implementation. Only 2 of the analyzed policy documents namely wildlife and biodiversity policies, mentioned food security in relation to conservation of national parks. However, they did not use this term rather related terminologies such as food, food production, food supply and food sovereignty. Other documents used terms like livelihoods and poverty reduction/alleviation to reflect the link between the conservation of protected areas and local benefits. These terms are too broad to target people who are food insecure or to link interventions to the direct causes of the human pressure on the park.

The lack of food security mainstreaming in policy documents related to VNP conservation results into absence of a framework for decision-makers to guide integration of local food security in the VNP conservation. Thus, it is hard for conservationists, local government, park management and their stakeholders to plan related activities.

Understanding institutional processes helps to identify barriers and opportunities that are important for designing interventions which improve sustainable livelihood outcomes. The VNP Management Plan emphasizes linking VNP conservation with improving local livelihoods to reduce human pressure on the park resources. However, it does not show clear concepts of how this should be done and it does not mention improving local food security. This Plan stresses that the community conservation and awareness activities remain a priority in the sectors around the park. In this regard, the park has two Community Based Conservation Wardens and one of their responsibilities is to raise local awareness about conservation and new laws and regulations. Yet, 90% of the households interviewed around VNP during this study revealed that they were not aware of the policy documents related to biodiversity and food security including the VNP Management Plan. This limited participation of local communities in policy development had an implication on the benefits they get from the park. Compensation for damages made by wildlife at VNP remains limited and unfair and few local households benefit from the RDB Tourism Revenue Sharing Programme and other Community Conservation initiatives implemented by NGOs and the Private Sector around VNP.

Successful VNP conservation in long-term is dependent on how local food security will be improved and for this to be achieved, it has to be integrated into the VNP conservation agenda. This should start with revising regulatory framework to include provisions for food security interventions and raising awareness of decision-makers in both park conservation and land use and communities. Also, there is a need of improved coordination of different actors to identify synergies and trade-offs between park conservation and local food security goals. Importantly, placing local people livelihoods in the center of conservation interventions is important to find sustainable solutions to biodiversity conservation. Policies, institutions, and processes are key in

shaping households' choices of their livelihood strategies (Angelsen et al., 2011; Adato & Meinzen-Dick, 2002). Thus, without clear policies and institutional framework that support improvement of local food security, people around VNP will continue to illegally use the park resources to get food.

From the second objective it can be summarized that the LULC map of 2019 shows that the 0km-5km belt and the 5.1km-10km belt around VNP are dominated by agriculture and grassland (86% and 77.66% respectively) followed by built-up (9.25% and 9.28% respectively). In both belts, agriculture and grassland area increased between 2000 and 2019 from 80.13% to 86% in 0km-5km belt and from 54.47% to 77.66% in 5.1km-10km belt mainly at the expense of forests. The two belts underwent almost the same and high rate of deforestation between 2000 and 2019. The 5.1km-10km belt lost 92.29% of its forest, while the 0km-5km belt lost 92.52%. Forests and woodlots were mainly cut down for pasture and agriculture development in the two belts, (90.16% in 5.1km-10km belt and 93.01% in 0km-5km belt). Other land uses and cover that took over forest and woodlots in both belts were not significant including the buildings (9.66% in 5.1km-10km belt and 6.77% in 0km-5km), bare land (0.05% in 5.1km-10km and 0.14 % in 0km-5km) and water bodies (0.11% in 5km-10 km and 0.01% in 0km-5km). Although the two belts underwent the same rate of deforestation between 2000 and 2019, the afforestation efforts in the 0km-5km belt are double the efforts in the 5.1km-10km belt (16.58% and 7.91% respectively). This reveals that the VNP management and stakeholders are making efforts to increase forest cover and sources of wood products to reduce local pressure on the VNP although still limited. Given that the deforestation-afforestation ratio is pretty wide (12:1 in 5.1km-10km and 6:1 in the 0km-5km), afforestation efforts need to be increased in the two belts if the human pressure has to be reduced on the VNP resources as this park remains the only available source of firewood, construction materials and bean poles for households in the two belts.

The built-up area considerably increased and almost at the same overall rate in the two belts between 2000 and 2019 (from 1.7% to 9.25% in the 0km-5km belt and from 1.6% to 9.28% in the 5.1km-10km belt). The area increased overtime in the 5.1km-10km belt while in the 0km-5km belt the area only increased between 2010 and 2019.

The overall increase in the area of built-up in the 0km-5km belt between 2000 and 2019 was 2,923.11 ha (1483.06%). This high increase of the built-up area results from the rapid population growth around the park as people migrate to the area because of fertile volcanic soils. Also, a lot of people from across the country move to this area because there are a lot of job opportunities due to quick gorilla tourism development that attracts a lot of Private Sector investments and the growing number of NGOs in the area for gorilla conservation work. In 2000, the built-up area in the 5.1km-10km belt occupied a higher percentage than in the 0km-5km belt (1.60% and 0.58% respectively). This is because the big part of the Musanze city is in this 5.1km-10km belt. However, the findings of this study reveal that the increase in built-up land within the 0km-5km belt is three times the growth in 5.1km-10km belt (3,049.11 ha (1,546.99%) and 2,936.52 ha (502.02%) respectively. The built-up takes over mainly agriculture and grassland (2,638.71 ha) and forest and woodlots (409.95 ha). Only 0.45 ha of bare land was transformed into built-up between 2000 and 2019. This is a threat to VNP conservation because while 93% of households in the 0km-5km rely on subsistence agriculture, the already small agricultural plots and woodlots that they own are being bought for construction of hotels, commercial centers and residential houses and in many cases these households sell their land using the government expropriation law that does not help the land owner to get enough money that they can use to buy new plots elsewhere. Thus, the number of landless households is high in the vicinity of the park.

Between 2000 and 2019, bare land area in the two belts was not significant. It increased from 0.04% to 0.11% in 0km-5km and decreased from 0.19% to 0.05% in the 5.1km-10km belt. In 2019, the totality of this land was transformed into agriculture and grassland, built-up, and forest and woodlots in the two belts. Ground truth data confirmed that bare land does not result from the long-term land degradation but rather from short term cultivation of the land and the harvest of woodlots.

In 2000, water bodies in the 5.1km-10km belt occupied 3,084.30 ha (8.43%) of the land while in 0km-5km belt they occupied only 0.27 ha (0.00%). This is because there are very few and small water sources in the 0km-5km belt as the area is a volcanic

plain and there are three lakes (Burera, Nyirakigugu and Karago) and Mukungwa river in the 5.1km-10km belt. The gain in water bodies was not significant in the two belts (0.82% in 5.1km-10km belt and 0.01% in 0km-5km belt). The 2.97 ha in the 0km-5km belt are not real water bodies as in this belt only temporary water run to the Mukungwa river from the volcanoes' mountains after rain when the satellite image was taken. This is also justified by the fact that the 0.27 hectares of water bodies in 2000 were totally changed to agriculture and grassland in 2019 and during the field visit there was no sign of new sources of water in the area. The lack of water bodies in the 0km-5km belt causes a serious problem of water scarcity in this belt compared to 5.1km-10km belt. Thus, increasing the number of people who enter into the park for water collection especially in Kabatwa area where the government water system is far away. Different NGOs and the VNP management support local community to harvest rainwater but the systems are still not enough.

The findings of this study show that there was no change in the size of the park, only changes in the vegetation cover took place between 2000 and 2019. Between 1990 and 2000, the VNP underwent a high rate of deforestation mainly caused by the genocide against the Tutsi and the war due to the war that the region went through. For this, several areas of the park were encroached for farming and cattle rearing, others became settlements for refugees and rebel groups. In 1999, some conservation NGOs and the government-initiated conservation and tourism activities in the park that were implemented along the park restoration. With conservation and restoration efforts, the size of the open forest increased from 71.88% in 2000 to 84.22% in 2019. This does not mean that local people did not illegally use the park resources during this period. The fact is rather that the magnitude of illegal use of the park was smaller than massive park invasion that took place between 1990 and 2000. There has been little or no change in the occurrence of illegal activities including poaching and bamboo harvesting inside VNP (Republic of Rwanda, 2015b) despite a reported corresponding increase in community development support. This puts the wildlife inside the park at risk.

The findings from the third objective reveal that food secure households around VNP are 27% while 2% are marginally food secure, 16% moderately food insecure

and 55% severely food insecure. These findings show that food insecurity around VNP is 3 times higher the country average that is 19% of households. The data also indicate that households within the 0km-5km buffer are more food insecure (77.5%) than the households in the 5.1km-10km buffer (64.5%). They also show that only 38% of interviewed households benefited from the park with the majority of them (72%) located in the 0km-5km buffer. These findings reveal that the VNP management and stakeholders focus more on the source of local pressure on the park resources, which is the 0-5km belt for community support. This finding is well in line with the land use analysis data that have shown that reforestation efforts are more in 0km-5km belt than in 5.1km-10km belt. However, efforts are still small as 0km-5km that has the highest percentage of households that benefited from the park is the most food insecure. This is due to the fact that very few households receive direct benefits and the indirect benefits they get from the park do not directly help to address their livelihoods needs. The number of households that reported that their members get indirect benefits from the park is 5 times larger than the number of households that reported that they get direct benefits. About 30% of 400 households interviewed indicated that they benefit from improvements of the roads, 20% from constructing health centers, 16% from new or improved market for selling local goods and 7% from schools' construction. These results concur with the findings of previous studies that community conservation projects focus on the improvement of roads and construction of schools and health centers rather than addressing direct needs at household level (Munanura, 2013). This was confirmed by the analysis of RDB Revenue Sharing data that revealed that 67.04% of the tourism revenue sharing between 2005 and 2019 went to public infrastructure.

Crop raiding around VNP continues to undermine the support amongst local farmers for both conservation and tourism initiatives. About 30% of respondents from the household survey reported that wild animals damaged their crops. Only 40 households (10%) reported that they claimed for compensation of damage made by wildlife and only one person of them said that he was compensated for the damage. The 39 households that did not receive compensation mentioned that the reason was that documents, statements and approvals requested for justification of the damage were difficult to get and that the process is complicated, and people do not get fair

compensation. The information was confirmed by 7 of the 10 focus groups that reported that wild animals damaged their crops, but they did not claim compensation because the related costs are greater than the benefits. Also, all 21 key informants emphasized that the valuation of damages is complicated due to the long process involving travel, phone calls and underestimation of the damages. Two focus groups mentioned that it is difficult for locals to plant crops that are not palatable to wild animals because their crops are for subsistence, and they own very small land.

Local and international conservation NGOs provide some local development support although it is still small and not directly linked to addressing the food security issue. Local people who benefit from revenue sharing are grouped into cooperatives and they sign performance contracts with the VNP management that entail several conservation activities that they perform such as repairing the stone wall and dig trenches to prevent animals from getting out of the park; report poachers and other illegal users; chase away wild animals back to the park, provide 5 people who guard the crops in their respective sectors every day, burry dead animals, support poor cooperative members and poor community members to pay health insurance, etc. Respondents from these cooperatives indicated that they do not get real benefits from the park conservation given that in addition to damages made by wild animals, the cost of these activities is higher than the money they receive under the Revenue Sharing Programme. Most of handcraft cooperatives that benefit from community conservation and Revenue Sharing Programme are run by people from Musanze town because they are more open to quickly grab opportunities rather than local people who have a direct relationship with the park. This reduces chances for local people to improve their food security.

Water scarcity remains an important issue in the vicinity of the VNP. The park management and partners tried to provide some rainwater harvesting tanks to households, but they remain few and some households still fetch water inside the park. Also, 36% of the respondents indicated the issue of crops that are damaged by floods from the park and suggested that the VNP management should support them to create water channels. To reduce poaching, 65% of the focus groups suggested that

RDB should employ landlessness people for trails maintenance inside the park instead of contracting companies from Kigali or other places far from the park.

With these limited local benefits from the park and pronounced food insecurity in the vicinity of VNP, it is uncertain how conservation efforts of this park will be sustainable. As the above data reveals, there is no significant contribution of benefits from VNP on local food security at household level. This corroborates the findings of Guinness (2014); Bush et al. (2010); Adams et al. (2004); McShane & Wells (2004) and Brown (2002) that despite wide implementation of ICDPs, several scholars documented their failure to yield either lasting conservation of the focal resources or local livelihoods benefits.

The results from the Chi-square analysis show a positive and significant dependence of collective income, benefits from construction of health centres, benefits from improved market, and the benefits from being part of park management on the food security of the households around VNP. Positive association between collective income and food security indicates that although still few, the households that benefit from VNP in terms of collective income; people around the VNP that get jobs from the economic activities funded through the revenue sharing from tourism or directly employed by the park management and people around VNP who have access to market for their agricultural produce as well as handcrafts (hotels, restaurants, sales to park management staff, and sales to tourists) are likely food secure. This analysis shows that the more direct benefits local households get from the park, the more food secure they are. This corroborates with the views of Wittemyer et al. (2008) and Brown, 2002) that with the growing increase in global human population, particularly on the margins of national parks it is a condition that the success of conservation has to be increasingly linked to the level of local support it receives and the nature of appropriate benefits it offers communities.

5.3 Conclusions

This study revealed that there is a need to integrate food security in conservation of VNP if the human pressure on the park resources has to be reduced. **In the case of the first objective**, it is concluded from the analysis of the policy documents that, the policies are not keen on addressing the local community food security issue but rather

are interested in the improvement of their livelihoods and poverty reduction/alleviation, thus, making it difficult for the institutions involved in conservation and those involved in socio-economic development around VNP to integrate the food security component in their interventions.

Secondly, the majority of the people around VNP are not aware of the policy documents related to biodiversity conservation and food security. Therefore, this makes it difficult for them to claim for their rights such as compensation for wildlife damages and direct benefits from the VNP Revenue Sharing Programme, thus hindering, sustainable conservation of the park.

Thirdly, despite a lot of weaknesses, several entry points exist to mainstream food security in the VNP conservation agenda. These include the wildlife and the biodiversity policies that recognize the need for alternatives to reduce the illegal use of the park resources and recognize that most of the reviewed policy documents that Rwanda viability depends on to conserve its biodiversity, ensure it contributes to the country sovereignty in food provide the incentives that are linked to the nature of the biodiversity threat, address poverty in communities living around national parks, and that indicate that biodiversity conservation issues are cross-sectoral, should be used to tackled in a collective and diverse way the challenges facing food insecurity in the VNP park.

Fourthly, also, most of the reviewed policy documents including the VNP's Community Partnership Programme, recognize that under the existing circumstances of high edges, where high population densities live in the vicinity of national parks in Rwanda, gaining the support of the community for their conservation is critical. In addition, with the current government commitment to eradicate malnutrition in Rwanda and the call for collective efforts, it is anticipated that decision-makers are getting more aware of the importance of mainstreaming food security in their plans.

Finally, the Rwanda vision 2050, the national strategy for climate resilience and green growth and the strategy for transformation clearly show the link between

conservation/ecosystems and local food security and how both should be intertwined to ensure sustainability. Taking this linkage at the VNP scale can guide mainstream food security in this park conservation.

On the second objective, it can be concluded from the analysis of the effects of land use changes on VNP between 2000 and 2019 that the geospatial dynamics that took place in the last 19 years in the 10 km belt around VNP have brought profound transformations and changes in the landscape. For instance, the agriculture and grassland and forest and woodlots are being replaced by built-up land over time due to rapid population growth and tourism development around VNP. Unfortunately, more afforestation efforts are being done only in the vicinity of the park (0km-5km belt) than far away (5km-10km belt). This at least gives a little hope that the VNP management and stakeholders are tackling the human pressure on the park resources including trees and bamboo that are illegally harvested for firewood and construction material that are difficult to find outside due to the high rate of deforestation albeit not sufficient enough.

Under the third objective, it can be concluded that people around VNP are food insecure mainly due to land scarcity, high dependence on subsistence agriculture, large household size, dependence on potato crop and limited alternative livelihoods including insufficient earnings from tourism and the revenue sharing scheme.

Secondly, although it seems that the park and partners are addressing the issue of water scarcity by providing rainwater harvesting tanks, the fact that a good number of local people still go to fetch water inside the park, water scarcity for household use and for mixing with pesticides to spray Irish potatoes, it still remains a big issue in the vicinity of the park especially in the 0km-5km belt that has no rivers. Allowing people to enter the park to fetch water not only puts wildlife at risk of poaching and their habitat at the destruction and fire, but it also puts locals especially the children on the risk of being killed by wild animals such as buffaloes and golden cats and increases the risk of communicable diseases between people and wildlife especially the endangered mountain gorillas.

Finally, the time spent to collect water after working for a long distance of more than five kilometres affects food security because adult people do not get enough time to work on farms or do other paying work to generate income to buy food and non-food items. For the children, water scarcity affects the school enrolment and attendance and increases dropouts, right to education, etc.

5.4 Recommendations

With regard to the first objective, it is recommended from the policy gap analysis firstly that the process of integrating local food security in parks conservation should start with mainstreaming food security in policies, laws, strategies and ministerial orders on conservation, tourism, community conservation; Parks Management Plans; Districts Development Plans; local donors' plans and business plans of local private companies. For this to succeed, a multi-sectoral approach should be used to bring on board institutions in charge of land use, agriculture development and community development for joint efforts within the landscape. This will ensure that coordination of different actors is improved, and the right institutional frameworks are put in place for integration of parks conservation and local food security goals.

Secondly, it is recommended that VNP management and other national parks in Rwanda develop guidelines for food security mainstreaming in all community conservation interventions done by RDB, NGOs, Private Sector, Districts surrounding parks and other donors.

Thirdly, joint planning and monitoring should be reinforced between the parks management and stakeholders to ensure that commitments to mainstream food security are reflected in interventions on the ground.

Finally, it is recommended to the VNP management to raise local people's awareness about policies related to conservation of this park and local food security. Emphasis should be put on policies' provisions, laws as well as guidelines on biodiversity, tourism and socio-economic development around the park especially on measures that can help to improve local food security and reduce human-wildlife conflicts.

Relating to the second objective of this study, it is recommended from the analysis of the effects of land use changes on VNP that the park management and stakeholders should increase efforts in afforestation to provide alternative sources of wood materials, provide other alternative energy sources such as biogas, LPG and solar systems, support family planning, improve land use planning to ensure that the available limited land is adequately used and create off-farm jobs for the local youth.

Regarding the third objective of this study, it is recommended from the analysis of the contribution of benefits from the park to local food security that, firstly, for long term conservation of the VNP, it should be important to increase revenue sharing percentage that goes directly to households' support from 5% to between 10% and 15% and mainstream food security in the community conservation programme including the revenue sharing scheme. Secondly, the VNP management should improve collaboration with other sectors such as agriculture, land use, community development and social security for joint efforts to address food security issues.

Thirdly, water access in the vicinity of the park should be increased and compensation done timely and fairly to the local people on the damages made by the wildlife.
Fourthly, it is recommended that the VNP management reviews the terms of the performance contracts that this institution signs with Revenue Sharing Cooperatives to ensure that their members benefit from these contracts.

Lastly, it would be important for the park management to employ local people starting with the landless because this study revealed that these are the people who go to poach during the long dry season because during this period, they cannot be employed by farmers given that there is no work on the farms and thus, they use the time to poach in order to get both employment and food.

5.5 Contribution of the study and areas for further research

This study is the first to examine food security status around VNP in depth. Its findings help to fill the research gap on biodiversity conservation and food security nexus at VNP where previous studies examined the link between local people and VNP conservation in the wider perspective of poverty, aggregating indicators. None

of the known previous studies at VNP calculated livelihood coping strategies consoles, food expenditure share and FCS. This first ever constructed food security index around VNP shades light on the importance of food security in the conservation of national parks. The food security analysis shows that households are food insecure, while indicating where they are located and why they are food insecure. These details provide a basis for targeted interventions to reduce local food insecurity and local pressure on national parks resources such as VNP. They also provide useful information for updating policies, plans and institutional framework to integrate local food security and the conservation of national parks such as VNP.

This study sets a baseline for studying local community food security and conservation of national parks such as VNP and lays out the methodology that other researchers can use in the studies that attempt to link biodiversity conservation and local community food security. It provides useful information to researchers that can be used to identify knowledge gaps and opportunities for further research. For instance, one of the future research projects would be to go into depth on linkage between food security and the nutrition status of households around national parks such as VNP in order to understand how future generations are likely going to be healthy in sustain socio-economic development and conservation successes that this study recommends.

This study attempted to fill this gap by formulating a new conceptual framework that combines the Integrated Landscape Framework and the Sustainable Livelihoods Framework for integrating biodiversity conservation and food security at national parks as well as other kinds of protected areas. This new framework is recommended to other researchers and practitioners interested in biodiversity conservation and food security nexus.

Finally, a recent literature review of 91 papers by Glamann et al. (2015) has shown that there are still gaps in developing a nuanced and holistic approach to address the nexus between biodiversity conservation and food security and recommends integrating social-political approaches and biophysical-technical approaches in studying the linkage between local food security and conservation of national parks such as VNP.

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APPENDICES

Appendix 1: Household Survey questionnaire

Section A: General information

A.1 Household identification

Do you agree to be interviewed? *If the HH member disagree, end here and interview the nearest household*		0=No 1=Yes

Coordinates HH location	
HH number	
Village	
Cell	
Sector	
District	
Name of the Enumerator	

Date of Interview	
Date Interview started	
Date Interview ended	

Number of HH members	
Hectares of Land owned	

A.2 Details of Household(HH) members

Please provide information on members who live in the household. Start with the Household Head (HHH) and include household members who were not around for a period not more than 3 months (write corresponding codes).

2.1 No	2.2 Name of HH member	2.3 Relationship to Head of Household	2.4 Sex 1= Male 2= Female	2.5 Age (Year)	2.6 Date of birth (only for children below 5 years)	2.7 Marital Status (12 yrs old and over)	2.8 Education Level (3 yrs old and over)	2.9 Principal Occupation (6 yrs old and over)	2.10 Secondary Occupation (6 yrs old and over)	2.11 Did the student miss out the school for a week or more than that starting with January this year? 0=No 1= Yes	2.12 What was the main reason for the student to be absent from school?	2.13 Health status 1=Ok 2=Bad	2.14 Does (NAME) suffer any chronic illness (≥ 3 months)? 0=No 1= Yes	2.15 What major disease that (NAME) suffered during the last 6 months?	2.16 Did [NAME] eat meals in this house-hold in the last 7 days? 0=No 1= Yes	2.17 For How many days in the last 30 days [NAME] was present?	2.18 Is (NAME) an orphan (only for children under 18)? 0=No 1= Yes 99=Not applicable
1																	
2																	
3																	

4																	
5																	
6																	
7																	
8																	
9																	
10																	
11																	
12																	

Details of Household(HH) members Codes

Relationship to HHH: 1=HHH, 2= HHH spouse, =3= HHH daughter/son, 4= HHH foster/adopted/step, 5= HHH father/mother, 6= HHH brother/sister, 7= HHH grandchild, 8= HHH parent-in-law, 9= HHH sister/brother in-law, 10= other relationship, 11= there is no relationship to HHH, 12= waged HH helper, 13= other, specify: …

Education: 1=no school, 2= still/some primary, 3= completed primary, 4= completed vocational education, 5= still/some secondary, 6= completed secondary, 7 still/some university, 8= completed university, 9= nursery, 88= do not know

Marital status (only for household members of 12years old and above): 1=single, 2=married, 3= divorced, 4= separated, 5= widowed, 99= not applicable

Reasons of absenteeism from school: 1=sickness, 2= working for cash, 3= housework, 4= looking after siblings, 5= school located far from home, 6= no school fees, 7= refused to go to school, 8= other, specify: …..

Main occupation: 1= farmer, 2= help family in agriculture, 3= employed in agriculture, 4= labor on livestock farm, 5= off-farm job, 6= artisan that is self-employed, 7= Employed artisan, 8= trader, 9= civil servant, 10= student, 11= domestic worker, 12= has no occupation, 99= Not applicable

Secondary occupation: 1= farmer, 2== help family in agriculture, 3= employed in agriculture, 4= labor on livestock farm, 5= off-farm job, 6= artisan that is self-employed, 7= Employed artisan, 8= trader, 9= civil servant, 10= student, 11= domestic worker, 12= has no occupation, 99= Not applicable

2.19 Do you have any HH members who returned in the last 3 months from outside Rwanda to stay with you?	10= No; = Yes
2.20 How many are these returnees?	
2.21 Is your HH hosting any person who is a temporally resident (from 1 day to 3 months)?	0=No; 1=Yes
2.22 These temporary residents are how many?	
2.23 The HHH has how many spouses or partners?	

Section B: Policy and institutional framework in relation to biodiversity conservation at Volcanoes National Park and local food security

B.1 Inclusion in policy formulation and implementation processes

1.1Are you aware of the following policies/laws/plans?			**1.2If yes, how is this policy beneficial to improving local food security and nutrition** (describe for each policy where the answer is yes)?
1.Rwanda Biodiversity Policy, law or National Biodiversity Strategy and Action Plan (NBSAP) 2016		0=No 1=Yes	
2.Wildlife Policy		0=No 1=Yes	
3. Law no 26/2011 of 27 July 2011 on compensation for damages caused by wild animals, the prime minister order no 26/03 of 23 May 2012 determining rates, calculating method and criteria for determining compensation to the victim of damages caused by wild animals, ministerial order no 14/MINICOM/12 of 18 April 2012 determining the list of wild animal species concerned with the law on compensation for damages caused by wild animals		0= No 1=Yes	
4.Rwanda Tourism Policy		0=No 1=Yes	
5.Volcanoes National Park Management Plan		0=No 1=Yes	
6. Rwanda National food and Nutrition Policy and Rwanda National Food and Nutrition Strategic Plan (2013-2018)		0=No 1= Yes	
7.MINAGRI Strategic Plan for the Transformation of Agriculture Phase III (PSTA III) or the MINAGRI Nutrition Action Plan (NAP) (2013-2018)		0=No 1=Yes	

8.School Health Policy (2013)		0=No 1=Yes	
9.MINALOC National Social Protection Strategy (2011)		0=No 1=Yes	

B.2 Gaps and strengths in Policy implementation

Have you ever claimed for compensation of any damage made by wildlife? *If no, skip to 2. 8*		0=No 1=Yes
2.2 If yes, what was the damage?		1= Crops, 2=Property, 3= Human injuries, 4= Death of a HH member, 5= Disability of a HH member, 6= Other, Specify…
2.3 Did you get compensation for the damage mentioned above?		0=No 1=Yes
Were documents, statements, approvals requested for justification easy to get?		0=No 1=Yes
If no, what was difficult or complicated with the process?		1= Modalities for calculating and awarding compensation; 2= It takes too much time; 3= It is expensive; 4= Other, Specify…….
Do you find the compensation paid fair compared to the damages made?		0=No 1=Yes
If no, why?		
2.8 Did you household benefit from improved control of problem animals (fencing, ranger patrols)?		0=No 1=Yes
2.9 Does your household benefit from extension services?		0=No 1=Yes
2.10 Did any member of your household get training in nutrition?		0=No 1=Yes
Do you have a community-based nutrition programme in your Umudugudu?		0=No 1=Yes

Section C: The effects of land use changes on Volcanoes National Park

C.1 Land

1.1 Are you from this village (or migrant)?		0=No 1=Yes	
1.1 2 If no, since when you are in this village (year)?			
1.2 What is your major livelihood activity?		1= Agriculture 2= Other, Specify----------	
1.3 Are there any changes in land use that occurred in this area between 1930s and 2015?		0=No 1=Yes 88= Do not know	
1.3.2 If yes, please describe		1= Changes in livelihood mechanism 2= Increased cultivation of marginal lands 3= overgrazing	4= cutting of trees e) 5= Other (specify)……. 88= Do not know 99= Not applicable
1.4 What is the kind of land you own?		1= inherited 2= purchased	3= gifted 4= rented
1.5 Of this land tha you own, how much (in ha) is:			
1.5.1 cropping by the household		Ha	
1.5.2 fallow/idle		Ha	
1.5.3 pasture		Ha	
1.5.4 rented out		Ha	
1.6 Has your household extended the agricultural land since the original allocation?		0=No 1=Yes 99=Not applicable	
1.6.2 If yes, what was the main reason for this?			
1.7 Do you see any signs of soil erosion in the area ***(do not ask, Observe)?***		0=No 1=Yes	
1.7.2 If yes, what is the type of erosion that is dominant?		1= wind sand dunes	3= both

		2= water runoff	
1.8 Is land scarce in this area (ask this question)?		0=No 1=Yes	
1.8.2 If yes, what is the impact on the area?		1= slight 2= moderate	3= severe

C.2 Forests

2.1 Does your household have any planted woodlots? ***If no, skip to 2.3***		0=No 1=Yes
2.1 2 If yes, how big in ha are your planted woodlots?		
2.1.3 What is the main use of the trees from the woodlots?		1= firewood to use home, 2= firewood to sell, 3= fodder for livestock, 4= fodder to sell, 5= Poles and/or timber to use home, 6= Poles and/or timber to sell, 7= Other HH use, 8= Oter products to sell
2.3 Does your HH have any agro-forestry tries? ***If no, skip to 2.4***		0= No 1= Yes
2.3.2 If yes, approximately how many trees are there?		Number of trees
2.4 Did your HH clear any woodlot or natural forest for agricultural development ***in the last past 12 months? If no, skip to 2.6***		0=No 1=Yes
2.5 If YES,		
2.5.1 How much land was cleared?		Hectares
2.5.2 What was the new use of the cleared land?		1= cropping 2= pasture
2.5.3 If used for cropping, which crops were grown by the HH?		
2.5.4 What is the type of forest that you cleared?		1= natural forest 2= woodlot
2.5.5 What was the age of this forest?		In years

2.5.6 What is the distance from the house to this plot?		km	
2.6 Has your HH over cleared forest or woodlots for agricultural development over **the last *five* years**?		0=No 1=Yes	
2.7 Did your HH plant any trees in the **last past 12 months?**		0=No 1=Yes	
2.7.2 If yes, how many?		Number	
2.8 What is the primary HH energy for cooking?		1= Fire/fuelwood 2= Charcoal	3= Other Specify----------
2.9 How do you acquire firewood? ***If only collected skip to 2.10***		1= Collected 2= Bought	3= Both
2.9 2 If collected and bought, how much firewood is bought and how much is collected?		1= > 50% collected 2= > 50% bought	3= 50/50
2.9.3 How much money do you spend on firewood per week? *If only bought skip to 2.14*		RWF	
2.10 Where do you collect firewood?		1= Own farm 2= Neighbor farm 3=Public woodlot 4=Crop residues	5=Natural Forest 6=Other - Please specify: ……..
2.11 How often do you collect firewood per week?		Times	
2.12 How much (Kg) firewood do you collect on average each week?		Kg	
2.13 What is the average time spent on firewood collection per week?		1 = less than 30 minutes 2 = between 30-60 minutes	3 = between 1-3 hours 4 = more than 3 hours
2.14 Among the following, what other types of fuel have you used for cooking since January this year?		0= none 1= Maize cobs 2= Maize stalks	3= Twigs 4= Sawdust 5= Other, Specify_____
2.15 What are the challenges that your HH faces while collecting and/or transporting wood?	1st |___| 2nd	1= wood scarcity 2= distance travelled is long	3= high cost 4= other, speficy:…

	|___|	
2.16 Did your household sell any loads of fuelwood in the last past 12 months? *If no, skip to 2.17*		0=No 1=Yes	
2.16. 2 How many loads of fuelwood did you sell in the last month?			
2.16.3 Approximately how many loads of fuelwood did you sell in the last 12 months?			
2.16. 4 Is this fuelwood primarily sold to people in village or outside of the village?		1= to the village people; 2= to people outside the village	
2.16.5 Did you sell any loads of fuelwood to local tourism businesses?		0=No 1=Yes	
2.16.6 If yes, approximately how many loads?			
2.16.7 What is the average price per load that you sell fuelwood for?		RWF	
2.17 Did your household utilize wood for charcoal making in the last 12 months? *If no, skip to 2.18*		0=No 1=Yes	
2.17 2 If yes, within the last month, how many loads of wood did your household collect to make charcoal?			
2.17.3 Did your HH in the last 12 months sell any charcoal?		0=No 1=Yes	
2.17 4 If yes, how many loads of charcoal did you sell in the last month?			
2.17 5 Approximately how many loads of charcoal did you sell in the last 12 months?			
2.17. 6 Is this charcoal primarily sold to people in village or outside of the village?		1= to the people in our village; 2= to the people outside our village	
2.17. 7 Did you sell any loads of charcoal to local businesses?		0=No 1=Yes	
2.17.8 If yes, approximately how many loads per month?			
2.17.9 What is the average price per load that you sell charcoal for?		RWF	
2.18 Did your household collect **bean/peas poles** in the last 12 months? ***If No, skip to 2.18.11***		0=No 1=Yes	
2.18.2 If yes, within the last month, how many loads of bean/peas poles did your			

household collect?		
2.18.3 Did your household sell any bean/peas poles in the last 12 months? ***If No, skip to 2.18.9***		0=No 1=Yes
2.18.4 If yes, approximately how many loads of bean/peas poles did you sell in the last 12 months?		
2.18.5 Is this bean/peas poles primarily sold to people in village or outside of the village?		1= to the people in the village; 2= to the people outside the village
2.18. 6 Did you sell any loads of bean/peas poles to local tourism businesses?		0=No 1=Yes
2.18.7 If yes, approximately how many loads?		
2.18.8 What is the average price per load that you sell bean/peas poles for?		RWF
2.18.9 Did your household utilize any bean/peas poles that you collected in the last 12 months (any of the three growing seasons)?		0=No 1=Yes
2.18.10 If yes, approximately how many loads of bean/peas poles did your HH utilize in the last 12 months?		
2.18.11 Did your household buy bean/peas poles in the last 12 months? *If No, skip to 2.19*		0=No 1=Yes
2.18.12 Approximately how many loads of bean/peas poles did you buy in the last month?		
2.18.13 Are these bean/pea poles primarily bought from people in village or outside of the village? (In / Out)		1= to the people in oir village; 2= to the people outside our village
3.18.14 What is the average price per load that you buy bean/peas poles for?		RWF
2.19 Did your household collect timber in the last 12 months? *If No, skip to 2.19.10*		0=No 1=Yes
2.19.1 Within the last month, how many loads of timber did your household collect?		
3.19.2 Did your HH in the last 12 months sell any timber? *If No, skip to 2.19.8*		0=No 1=Yes
2.19.3 Approximately how many loads of timber did you sell in the last 12 months?		
2.19.4 Is this timber primarily sold to people in village or outside of the village?		1= to the people in oir village; 2= to the people outside our village

2.19.5 Did you sell any loads of timber to local tourism businesses or tea factories?		0=No 1=Yes
2.19.6 If yes, approximately how many loads?		
2.19.7 What is the average price per load that you sell timber for?		RWF
2.19.8 Did your household utilize any timber that you collected in the last 12 months?		0=No 1=Yes
2.19.9 Approximately how many loads of timber did your HH utilize in the last 12 months? _____		
2.19.10 Did your household buy timber in the last 12 months? *If No, skip to C.3*		0=No 1=Yes
2.19.11 Approximately how many loads of timber did you buy in the last month? _____		
2.19.12 Is this timber primarily bought from people in village or outside on the village?		0=No 1=Yes
2.19.13 What is the average price per load that you buy timber for?		RWF

C.3 Crop intensification

3.1 What are your major crops?	1. 2. 3. 4.	
3.1.2 Were you planting these same crops before the last 10 years?	1. 2. 3. 4.	0=No 1=Yes
3.2 Did you use any fertilizer on PLOTs owned or cultivated during last 12 months?		0=No 1=Yes
3.2.2 If yes, please specify the type of fertilizer and quantity (Kg) used		

	Type	Kg
1	Animal waste (Organic)	
2	Compost (Organic)	
3	Di-ammonium Phosphate (DAP) (Chemical)	
4	UREA (Chemical)	
5	Nitrogen Phosphate Potassium (NPK) (Chemical)	

	6	Lime (Chemical)		
	7	Other (Please specify)		
3.3 Did you use any pesticides or fungicides on PLOTs owned or cultivated during the last 12 months?			0=No 1=Yes	
3.3.2 If yes, please specify the type of pesticides/fungicides and quantity (Kg) used for each PLOT owned or cultivated during the last 12 months		Type	Kg	
	1	Dithane		
	2	Dursban		
	3	Sumicombi		
	4	Oxychorure de cuivre		
	5	Ridomil		
	6	DDT		
	7	Thiodan		
	8	Other (Please specify)		
3.4 Do you intercrop ?			0=No 1=Yes	
3.5 Is any of your plots under land use consolidation?			0=No 1=Yes	
3.5 If yes, does land use consolidation benefit your household?			0=No 1=Yes	
3.5.2 If no, why?				

Section D: The contribution of the benefits from Volcanoes National Park to local food security

D.1 Benefits from Volcanoes National Park

D1.1. Direct benefits from Tourism and Community Conservation Projects

1.1 No	1.1.2 Name of HH member	1.1.3 Earn income from employment in tourism? 0= No 1= porter 2= guide 3= hotel 4= Other specify----------	1.1.4 Earn income from local tourism enterprises 0= No 1=handicraft 2= performance to tourists 3= other Specify-------	1.1.5 Earn income from selling agricultural produce 0= No 1= supply hotels with fruits 2= supply hotels with potatoes 3= supply hotel with vegetables 4= Other Specify--------	1.1.6 Earn income from VNP events such as local tenders for Kwita Izina event 0=No 1=Yes	1.1.7 Obtain support for education 0=No 1= tuition fees 2= school materials 3= both tuition fees and school materials	1.1.8 Benefit from membership in community associations or Cooperative? 0=No 1=Yes	1.1.9 Benefit from school construction? 0=No 1=Yes	1.1.10 Benefit from health center construction? 0=No 1=Yes
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									

12									

1.1.11 Does you household benefit from tourism revenue?		0=No 1=Yes	
1.1.11 Did your household benefit from facilitation to construct and own modern houses?		0=No 1=Yes If yes what was the source_____	
1.1.12 Did your household obtain livestock assets (cattle, goats)?		0=No 1=Yes If yes what was the source_____	
1.1.13 Do you have alternatives to park resources that you or used to collected from the VNP?		0=No 1= honey 2= bamboo planting 3= tree planting	4= briquettes 5= improved cooking stoves 6= Water tanks
1.1.14 Did your household get support for Mutuelle de sante?		0=No 1=Yes If yes, what was the source: …….	
1.1.15 Did you household benefit from new or improved market for local goods?		0=No 1=Yes	
1.1.16 Does your household benefit from involvement in park management?		0=No 1=Yes	
1.1.17 Does your household benefit from collective income of community enterprises?		0=No 1=Yes	
1.1.18 Does you household benefit from improved infrastructure (roads)?		0=No 1=Yes	

D.1.2 Park dependence

1.2.1 Do some members of this community go to VNP for poaching as a source of meat to feed HH members?		0=No 1=Yes

1.2.2 Do some members of this community go to VNP for poaching as a source of meat for sale and earn HH income?		0=No 1=Yes
1.2.3 Do some members of this community go to VNP for poaching as a source of meat for medicinal use at HH level?		0=No 1=Yes
1.2.4 Do some members of this community go to VNP for bamboo collection to use home?		0=No 1=Yes
1.2.5 Do some members of this community go to VNP for bamboo collection to sell and earn money?		0=No 1=Yes
1.2.6 Do Some members of this community go to VNP to collect beans/peas poles?		0=No 1=Yes
1.2.7 Do some members of this community go to VNP to collect honey?		0=No 1=Yes
1.2.8 Do some members of this community go to VNP to collect materials for handcrafts making?		0=No 1=Yes
1.2.9 Do some members of this community go to VNP to fetch water?		0=No 1=Yes
1.2.10 Do some members of this community go to VNP to collect fodder for livestock?		0=No 1=Yes
1.2.11 Do some members of this community go to VNP to graze domestic animals?		0=No 1=Yes

D.1.3 Wild Food Consumption

1.3.1 In the past month, did members of this household consume any wild MEAT?		0=No 1=Yes
1.3.2 In the past month, did members of this household consume any wild FISH?		0=No 1=Yes
1.3.3 In the past month, did members of this HH use medicinal PLANTS?		0=No 1=Yes

1.3.4 Please list the wild MEAT species your household consumed in the last month

	Wild MEAT Species	How much was consumed (kg)?	What was the main source?			
			Natural Forest	Bought	Gift	Other: Specify_____

	1						
	2						
	3						
	4						

1.3.5 Please list the wild FISH species your household consumed in the last month		Wild FISH Species	How much was consumed (kg)?	What was the main source?			
				1= Local River	2= Bought	3= Gift	4= Other specify:…….
	1						
	2						
	3						
	4						

1.3.6 Please list the wild PLANT species your household consumed in the last month		Wild Plant Species	How much was consumed (Kg)?	What was the main source?				
				Natural Forest	Marshland/wetland	Bought	Gift	Other specify--------
	1							
	2							
	3							
	4							

D.1.4 Attitudes toward the park conservation

1.4.1 Do you think it was a good idea to create the VNP?		0=No 1=Yes 88= Do not know
1.4.1.2 Why?		

1.5.2 How do you consider the relationship between you and the park management?		0= Bad 1=Good 88= do not know
1.5.2.2 Why?		
1.5.3 Do you think your HH gets a fair share from VNP?		0=No 1= yes 88= Do not know
1.5.3.2 Why?		
1.5.4 What is the overall impact of the park on your household?		0=None 1=Negative 2= Positive

D.2 Food Security

D.2.1 Housing status and facilities

What is the main material that makes up the floor and the roof of the HH main house (Enumerator to observe and choose from the below) ?			
2.1.1 Hose Roof		1=Thatch/straw Leaves/Grass 2= Metal sheet/corrugated iron 3=Clay Tiles	4=Cement/Concrete 5=Wood/bamboo 6=Other, specify: …..
2.1.2 House Floor		1=Earth/Mud 2=cement concrete 3=Hardened Dung 4=Clay tiles	5=Wood 6=Bricks 7=Other, specify: …..
2.1.3 House Wall		1= Just mud bricks 2=Mud bricks covered by cement 3=tree trunks with mud	4= tree trunks covered by mud mixed with cement 5=Oven fired bricks 6=Other, specify: …….
2.1.4 Is this house that your family is living in located in umudugudu/new recommended grouped settlement?		1=Yes, it's in the new recommended grouped settlement 2= It is not, we are in a town 3= We have not yet moved to new recommended grouped settlement	
2.1.4.2 If yes, since how long has your HH been living here?		1=since less than 3months 2=Between 3 and less than 6 months	3= Between 6 months and 1 year 4=More than 1 year

2.1.4.3 You occupy this house under which status?		1= We own it 2= We rent it 3= we do not pay the rent although we do not have its ownership		
2.1.5 How many sleeping rooms does this house have?				
2.1.6 What type of toilet does your HH use here? ***If none, answer 2.1.6.2 below and skip to 2.1.7***		1= flush latrine; 2= pit latrine that has floor, walls and roof; 3= pit latrine, with floor, walls without roof; 4= pit latrine without roof; 5= open pit without floor, wall nor roof; 6= None		
2.1.6.2 If your HH does not have its own toilet, then what do you use?		1= Our neighbours' toilet; 2= village/public toilet ; 3= inappropriate place such as bush		
2.1.6.3 Does your HH share the toilet with other HHs?		0= No 1=Yes		
2.1.7 What kind of lighting energy does you HH use?		0= We have no lighting energy 1= Electricity 2= Kerosene	4= Battery Flashlights 3= Lantern 5= Candles	6= Firewood 7= Solar lamp/s 8= other, specify
2.1.8 What fuel does your HH us for cooking?		1= Gas 2= Electricity 3= Firewood	4= Charcoal 5= Kerosene 6= Biogas	7= Crop residue/cow dung 8 = Other, specify: …..
2.1.9 From where does your HH get drinking water?		1= village/public tap/ piped water 2 = Water tap at home 3= River, stream, pond, lake 4= Borehole with pump	5= rain 6= Protected dug well/spring 7= Unprotected well or spring 8= Vendor 9= Other, Specify: …..	
2.1.9.2 Does your HH pay to get this water?		0= No 1=Yes		
2.1.9.3 How do you or members of your HH you travel to the source of water?		1. Walk 2. Bicycle 3. Motorbike or vehicle	4. Hire someone 5. Other, Specify: ……..	
2.1.9.4 How far is that?		Hours|__|__|Minutes		
2.1.10 Do you have an alternative source of drinking water that sometimes you go to?		0= No, this is the only source we have 1= Yes, there is another source		
2.1.10.2 What is the other alternative source of drinking water for your		1= village/public	5= rain	

household?		tap/piped water 2= Water tap at home 3= River, stream, lake, pond 4= Borehole with pump	6= Protected dug well/spring 7= Unprotected well/spring 8= Vendor 9= Other, specify: ….
2.1.10.3 Do your HH pay for this water?		0= No 1= Yes	
2.1.10.4 How do you or members of your HH you travel to the source of water?		1= walk 2= bicycle 3= vehicle/motorbike	4= Hire someone 5= other, specifcy: …..
2.1.10.5 How far is that?		Hours I___I___I Minutes	
2.1.11 What do you do to purify water before you drink it in your HH?		1= we boil it 2= we strain it through a cloth 3= we filter it using sand or other material	4= Use tablets or bleach chlorine 5= sediment it 6= We do nothing, just drink it
2.1.12 How many liters of water in average do you use per day in this HH?		Liters	

D.2.2 HH Livelihoods

2.2.1 What is the number of livelihood activities does your HH have?																Number
2.2.1.1 In order of their importance, what are three main livelihoods activities that your HH was involved in during this year?		2.2.1.2 Can you estimate the contribution in cash or in-kind to the HH livelihood of each of activities?	2.2.1.3 Who from the HH participates in this activity (use member code)	2.2.1.4 Is this livelihood activity seasonal? 0=No 1=Yes	2.2.1.5 If yes, this activity is important to your HH in which months?											
					Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
The main activity		%														

The second activity		%															
The third activity		%															

2.2.2. Do you know what your last month's HH total income was?	0= No 1= Yes 88= Do not know
2.2.2.1 If you know, what was this total income in RWF	RWF

Livelihoods codes

1= Agriculture on HH owned land or other land without rental payment 2= Daily labour agricultural work on others land for cash or in-kind compensation other than VUP 3= Livestock 4= Gathering, fishing or hunting 5=Unskilled non-agricultural daily labour 6=Skilled non-agricultural labour	7= Purchase and sale of products from hunting, gathering or hunting 8= Purchase and sale of agricultural products 9= Purchase and sale of livestock products 10= Purchase and sale of livestock 11=Informal sale or petty trade 12=Handicrafts/artisanal work 13=Transport 14= Salaried	15= Pension 16=Own business or self-employed 17= VUP public work 18= VUP direct transfers or other social transfers 19= Remittances from relatives or friends 20= Begging 21= other, specify

D.2.3 Household Assets and Productive Assets

2.3.1 Do you own agricultural land (including crop land and ranches for livestock)? If no, skip to 2.3.8			0= No 1= Yes	
2.3.2 What was the size of this land in season A?			0=none 1= 0ha-0.1ha 2= 0.1ha-0.19ha 3= 0.2ha-0.49ha	4= 0.5ha-0.99ha 5= 1ha-1.99ha 6=2ha-5ha 7= > 5ha
2.3.3. What is the proportion of the land you farm that is	5.3.2 Share cropped		%	
	5.3.3 Leased		%	
2.3.4 Does your household have land that is under land use consolidation?			0= No 1= yes	
2.3.4. 2 If yes how much of your land is in consolidation?			%	

2.3.5.1 Do you have some land that has been registered for public use like construction of a heath facility, road, school or other?		0=No 1=Yes
2.3.5.2 If yes how big is this		%
2.3.6 Is any part of your land under soil protection such as with radical terraces, progressive terraces, agroforestry, grass (such as Pennisetum, setaria) or trenches		0= No 1= Yes
2.3.6.2 If yes how big is that?		%
2.3.7 Do you have a HH vegetable garden?		0=No 1=Yes
2.3.8 Does your HH own any of the following items: *See codes on the next page and enumerate the codes for items that the household own*		1=Yes 0=No
Codes for households owned items 1= Hoe, 2= Shovel, 3= Rake, 4= Spade 5=Pick, 6=Wheelbarrow, 7=Plough/Ox Plough, 8= Motorized Vehicle of any kind, 10= grinding mill, 11= oil press, 12= sewing machine, 13=iron machine, 14=Radio, 15=Tape or CD player, 16= Mobile phone, 17= chairs/sofa, 18= Bed, 19=Bicycle, 20= canoe/boat		
2.3.9 Do you own or manage any livestock? *If No, skip to D.2.4*		1=Yes 0=No

2.3.9. 2 If yes, how many of each of the following livestock does your HH own? (*write 0 if none owned*)

Livestock	**Total managed by the HH but not owned**	**Total owned by the HH**	**What is the major use of this livestock? 1= HH subsistence; 2= business**
Chicken			
Ducks or other poultry			
Goats			
Sheep			

Pigs			
Cattle			
Rabbits			
Other			

D.2.4 Agricultural production

2.4.1 Does your household practice agriculture?		1=Yes 0=No	88= Do not know
2.4.2 Is any person in this HH member of a farmers' cooperative or association?		0= No 1= Yes	88= Do not know
2.4.3 Did your HH cultivate any crops in the last 12 months?		1=Yes 0= No	
2.4.4 Is any of your HH land irrigated? *If No or Do not know, skip to 2.4.5*		1=Yes 0=No	88= Do not know
2.4.4.2 If yes how big is that?		…%	
2.4.5.1 Is your HH currently renting any land? *If No or Do not know, skip to 2.4.6*		1=Yes 0=No	88= Do not know
2.4.5.2 How big is that?		0=none 1= 0ha-0.1ha 2= 0.1ha-0.19ha 3= 0.2ha-0.49ha	4= 0.5ha-0.99ha 5= 1ha-1.99ha 6=2ha-5ha 7= > 5ha
2.4.6.1 Does your HH have a non-owned land that you farm for free or rent? If no or do not know, go to 2.4.7		0= No 1= Yes	88= Do not know
2.4.6.2 How big is that?		0=none 1= 0ha-0.1ha 2= 0.1ha-0.19ha 3= 0.2ha-0.49ha	4= 0.5ha-0.99ha 5= 1ha-1.99ha 6=2ha-5ha 7= > 5ha

2.4.7Did you use chemical fertilizers and/ or pesticides during this year? If not, go to 2.4.8							1= No 2= Yes, fertilizers only	3=Yes, pesticides only 4=Yes, both	
2.4.7.2 How much of them were bought with cash?							%		
2.4.7.3 How much of them were bought with voucher system?							%		
2.4.7.4 How much of them were received from government, NGO or another institution							%		
2.4.7.5 How much of them were from your own production or received for free?							%		
2.3.8 You planted how many crops last year? If 0, go to D.2.5									
2.4.9 By order of importance what are 4 main crops that your HH planted? Enumerator can copy crops from 3.1 under C.3: Crop intensification		2.4.9.2 Is this crop perennial or annual? *(Do not ask fill yourself)* 1= Perennial crop 2= Annual crop	2.4.9.3 In which month or season did your HH plant this crop? This question is for annual crops only. 0= Did not plant crops during this season 1= Planted crops 99= Not applicable			2.4.9.4 How long did your HH have stocks of food from the harvest of this crop. Please copy for C and B 2017, and A 2016 …… months 88+ do not know 99= Not applicable			
			Season C 2017 *(July-September)*	Season B 2017 *(March-June)*	Season A 2016 *(September 2016-February 2017)*	Season C 2017(number of months)	Season B 2017(number of months)	Season A 2016(number of months)	Perennial crops and other non-annual crops such as sugan canes, cassava, etc. ……..months
1	Beans								
2									
3									

4										
List crops in same order as above		2.4.9.5 What % of the total land owned did your HH use for this crop?	2.4.9.6 With reserved seeds for planting during the next season and food for livestock, what is the proportion of this crop production that you consumed directly in your HH? ……% consummed 0= none	2.4.9.7 What is the proportion did you sell or donated? …..% 0= none	2.4.9.8 What proportion that your HH lost or spoiled due to post harvesting low value? ….% 0= none	2.4.9.9 How does your HH acquire seed or plant material for this crop? 1= purchase 2= exchange with other farmers 3= gifted from family/relatives 4= reserved from previous harvest 5= From government or other donors 6= other, specicy: …..		2.4.9.10 Where did your HH sell the largest proportion of this crop? 1= not sold 2= sold on the farm 3= sold in the village market 4= sold in the district market 5= sold to individual consumers 6= sold to a local cooperative 7= sold on international market 8= other, specify: …..		
1										
2										
3										
4										

Codes for crops

Cerals	**Roots and tubers**	**Vegetables**	**Fruits**	**Pulses**	**Cash crops**
1= wheat 2= maize 3= Sorghum 4= rice 5= other cereals	6= sweet potato 7= Irish potato 8= cassava 9= taro 10= yam 11= other roots/tubers, specify:….	12= tomato 13= cabbage	14= Banana for beer 15= fruit banana 16= passion fruit 17= cooking banana 18= pineapple 19= other fruit, specify:…	20= beans 21= peas 22= soybeans 23= ground nuts 24= other pulses, specify:….	25= tea 26= coffee 27= tobacco 28= sugar canes 29= pyrethrum 30= other specify: …

D.225 Remittances and migration

2.5.1.1 Did any members of your HH or from your extended family work away from here and have sent you some money during the last 12 months? If no or do not know, go to D.6		0= No 1=yes 88= Do not know
2.5.1.2 If yes, how many ae they?		
2.5.1.3 how much in total did they send?		

D.2.6 Credits' sources

2.6.1 Has any member of your HH requested for a loan during the past 12 months?			0= No 1=Yes 88= Do not know
2.6.2 If yes, was/were he/she/they given the loan requested?			1 = Yes 0 = No
2.6.3 How much did he/she receive in total?			RWF
2.6.4 Where had they/he/she requested the loan from?		1= family/friends in Rwanda 2= micro-finance institution such as SACCO 3= family/friends outside Rwanda	5= traders 6= Ikimina/community group 7= VUP

		4= bank	8= Other, specify:….
2.6.5 If not, why were they/he/she not given the loan requested? *If the answer to question 2.6.1.2 is no, skip to 2.7*		1= Bad credit 2= Did not have enough collateral	3= Other reasons, specify: …..
2.6.6 How was the loan utilized?		1= buying agricultural inputs 2= Buying food 3= construction of other than a house 4= health emergency 5= invested in business 6= Wedding/bride price	7= buying land 8= funeral 9= buying or constructing a house 10=buying medicine 11= home improvement 12=other, specify:…

D.2.7 Expenditures

D.2.7.1 Household food expenditure in the past 30 days

2.7.1.1 Did you HH spend any money on the below good and/or services for HH consumption over the last 30 days? *If the answer is No or Do not know, skip to 9.2* 0= No 1=Yes 88= Do not know	2.7.1.2 How much money did you HH spend on these good and/or services?	2.7.1.3 Which means other than cash did you HH use to get this item in the last 30 days (mark for each item)? *If none go to next.* 0= none 1= own production 2= hunting, gathering, fishing 3= exchange labour/items for food 4= borrowed 5= bought from market on credit 6= gifted from family/friends/relatives 7= food aid from frm government or other donors 88= do not know	2.7.1.4 What is the value of the mean used by your HH to acquire this food item in cash?
1. Cereals and Grain: rice, sorghum, maize, millet, fonio, pasta, bread/donuts/cake			
2. Roots and tubers: Irish potatoes, taro, yams, sweet potatoes, cassava or other tubers			
3. Legumes and nuts: beans, peas, soybeans, peanuts, rentals or other nuts			
4. Orange vegetables (rich in vitamin A): carrots, orange sweet potatoes, pumpkins, red pepper or other orange vegetables			

5. Green leafy vegetables: amaranth, cassava leaves, broccoli, spinach or other			
6. Other vegetables: tomatoes, onions, green peas, green beans, cucumber, lettuce, radish or other			
7. Orange fruits (rich in vitamin A): papaya, orange, mango or other orange fruits			
8. Other fruits: passion fruits, tree tomato, banana, apple, lemon, avocado or other fruits			
9. Meat: beef, goat, chicken, sheep, pork, rabbit or other (not as condiments rather in large quantities)			
10. Heart, liver, kidney or other organ meats			
11. Fish: tilapia, captain, isambaza, indagara, indugu, saldine or other (not as a condiment rather in large quantities)			
12. Eggs			
13. Milk and other dairy products: fresh milk, yogurt, cheese or other dairy products (this does not include small amounts of milk for tea, coffee, margarine or butter)			
14. Oil, butter and fat: palm oil, vegetable oil, margarine, butter or other oil or fat			
15. Sugar and sweets: regular sugar, honey, jam, sugar drinks, cakes, cookies, candy, pastries, or other sweets.			
16. Condiments and spices: salt, tea, coffee, garlic, mixed species, cocoa, baking powder, yeast, tomato-sauce, powder meat, powder fish, small amount of milk for tea or coffee, other condiments or species			
17. Drinking water			
18. Other non-alcoholic drinks			
19. Meals and drinks taken outside the household			
20. Other food items, specify: ….			

D.2.7.2 Non-food HH expenditures in the last 30 days

2.7.2.1 did your HH spend any money on the below good and/or services for strict HH consumption overt the last 30 days? *If no, go to the next line.*	2.7.2.2 How much money did you spend on these goods and/or services in RWF?

0= No 1=Yes 88= Do not know	
1.Tobacco and alcohol	
2. Soap or other hygiene items	
3. Transport	
4. Lightening energy such as electricity, kerosene, candles, solar energy	
5. Cooking energy such as charcoal, firewood, gas	
6. Disposal of waste	
7. House or land renting	
8. Milling	
9. Communication like buying mobile phone, internet, me2u	
10. Other non-food items, specify: …..	

D.2.7 3 Other HH expenditures over the last 3 months

9.3.1 Did your HH spend money on any of the following items in the last 3 Months (either paid with cash or credit)? *If no or do not know skip to the next item.* 0= No 1=Yes 88= Do not know	9.3.2 How much did you pay in cash? (in RWF)	9.3.3 How much did you pay in credit in RWF?
1. Health care, medical expenses		
2. Uniform, school fees, other education expenses		
3. Shoes, clothes, appliances, household furnishing		
4. House construction or repair		
5. Agriculture and related expenses such as seeds, tools, labour, fertilizers, storage, transport, pesticides, terracing, irrigation, etc.		
6. Livestock and related expenditures such as feed, livestock purchasing, labour, medicine, etc.		
7. Hiring non-agricultural labour		
8. Loan, mortgage, debt repayment		
9. Fines, taxes		
10. Ceremonies		
11. Gifts, donations		

D.2.8 HH Food Sources and Consumption

2.8.1.1 How many times in this HH adults ate yesterday?		…..times	
2.8.1.2 Is this usual at this time of the year?		1=Yes, it is usual 0= No, it is more than usual	2= No, it is less than usual
2.8.2 How many times in this HH children ate yesterday (less than 15 years old)?		……times	
2.8.3 Is this usual at this time of the year?		1=Yes, it is usual 0= No, it is more than usual	2= No, it is less than usual

2.8.4 In the last 7 days, how many days has your HH consumed foods below and indicate the source?

Food products *If no, go to the next line*	Yesterday (over the last 24 hours), has your HH eaten these foods 0= No 1= yes	How many days has your HH eaten these foods in the past 7 days? *If 0, do not specify the source*	What is the primary source of the consumed foods?
1. Cereals and Grain: rice, sorghum, maize, millet, fonio, pasta, bread/donuts/cake			
2. Roots and tubers: Irish potatoes, taro, yams, sweet potatoes, cassava or other tubers			
3. Legumes and nuts: beans, peas, soybeans, peanuts, rentals or other nuts			
4. Orange vegetables (rich in vitamin A): carrots, orange sweet potatoes, pumpkins, red pepper or other orange vegetables			
5. Green leafy vegetables: amaranth, cassava leaves, broccoli, spinach or other			
6. Other vegetables: tomatoes, onions, green peas, green beans, cucumber, lettuce, radish or other			
7. Orange fruits (rich in vitamin A): papaya, orange, mango or other orange fruits			
8. Other fruits: passion fruits, tree tomato, banana, apple, lemon, avocado or other fruits			
9. Meat: beef, goat, chicken, sheep, pork, rabbit or other (not as condiments rather in large quantities)			
10. Heart, liver, kidney or other organ meats			
11. Fish: tilapia, captain, isambaza, indagara, indugu, saldine or other (not as a condiment rather in large quantities)			
12. Eggs			

13. Milk and other dairy products: fresh milk, yogurt, cheese or other dairy products (this does not include small amounts of milk for tea, coffee, margarine or butter)			
14. Oil, butter and fat: palm oil, vegetable oil, margarine, butter or other oil or fat			
15. Sugar and sweets: regular sugar, honey, jam, sugar drinks, cakes, cookies, candy, pastries, or other sweets.			
16. Condiments and spices: salt, tea, coffee, garlic, mixed species, cocoa, baking powder, yeast, tomato-sauce, powder meat, powder fish, small amount of milk for tea or coffee, other condiments or species			
17. Drinking water			
18. Other non-alcoholic drinks			
19. Meals and drinks taken outside the household			
20. Other food items, specify: ….			

Food sources 1= Own production (crops, animals)	2 = gathering, hunting, fishing 3 = items for food, exchange labour	4 = Market (purchased with cash or on credit) 5 = Food gifted by family/relatives 6 = Food provide by the government or other donors

2.8.4 Other than beans what is your HH preferred food?		1= cereals 2= roots/tubers	3= cooking banana
2.8.5 What was the source of beans and the main staple food that your HH consumed during the last 12 months?		0= not consumed 1= own production 2= market	3= gifted/aid 4= VNP 5= other, specify: ….

	N 2016	D 2016	J 2017	F 2018	M 2017	MA2017	M 2017	MJ2017	J 2017	A 2017	S 2017	O2017
Main staple food mentioned												
Beans												

D.2.9 Coping strategies

2.9.1During the last 7 days, are there times that you HH could not get enough food or money to buy food? *If no, go to the next line*		0 = No 1 = Yes
How often has your HH had to adopt the following strategies in the last 7 days:		

2.9.1.2 Adopted Strategies	Number of days (put 0 if the strategy was not adopted)
1. Relied on less expensive and/or less preferred foods	
2. Borrow food and/or relied on food support from relatives/friends	
3.Reduced portions of meals taken	
4. Food was only given to children; adults did not eat	
5. Reduced number of means eaten per day	

2.9.2 Did lack of food or money to buy food lead to any of the below behaviors by some members of your HH during the last 30 days? *If no, go to the next line*	
2.9.2.1 List of behaviors	0= Yes 1= No, because it was not necessary 2= No, because we already sold these assets or we did this activity and we could not continue to do it 3= No, because we did not have possibility to do so 99= Not applicable

A	Sold household assets: radio, television, furniture, bicyle, jewellery, etc.) (Stress)	
1. Stress: sold HH assets such as radio, television, furniture, bicycle, jewellery, etc.		
2. Stress: spent HH savings		
3. Stress: sold more livestock (male or non-productive) than usual		
4. Stress: borrowed food or bought food on credit		
5. Crisis: harvested immature crops		
6. Crisis: consumed seed stocks that could be saved for the next planting season		
7. Crisis: decreased expenditures on pesticides, fertilizers, animal feed, veterinary care, etc.		
8. Emergency: begged		
9. Emergency: sold last female animals		
10. Emergency: Entire HH migrated		

D.2.10 HH shocks and food security

1.2.1 In the past 12 months, were there months that your HH had no enough food or money to buy food? *If no, go to 12.2*		0=No 1=yes 88= do not know

12.1.2 If yes, in which months your HH did not have enough food or money to buy food? Choose all that apply.	Nov 2016	Dec 2016	Jan 2017	Feb2017	Mar 2017	Apr 2017	May 2017	Jun 2017	Jul 2017	Aug 2017	Sep 2017	Oct 2017	All

12.1.3 Were you used to this situation at the same time of the year?	0= Yes, it was usual 1= No, it was better than usual 2= No, it was worse or less than usual
12.2 During the past 12 months, did your HH experience any unusual situation that affected your ability to eat as you were used to or that affected what your HH owned? *If no, skip to 13*	0= No 1=Yes 88= Do not know

Enumerator: Do not ask this question rather put the answers: By order of importance, what are the problems that affected your HH this year?

12.3 By order of severity, enumerate shocks using these codes	12.4 Has the shock/problem cause any reduction/loss of your HH income (in nature or in cash)? 0= No 1= Yes 99= Not applicable	Did this shock/problem cause any decrease/loss of your HH assets or belongings? 0= No 1= Yes 99= Not applicable	In which months of the year did the shock/problem occur? **Circle the month/s**												Is your HH now recovered from this shock/problem? 1= not at all 2= partially 3= fully 99= not applicable	What did your HH do to compensate itself for the shortcomings of the problem/shock? ***Use these codes below for strategies***
			Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct		
1																
2																
3																
4																

Codes for shocks 1= Drought, prolonged dry spell, illegal rains 2= Floods 3= Mudslides, landslides 4= Unusual high level of crop diseases and pests 5= Unusual high level of livestock diseases	6= Unusual high level of human diseases or epidemics 7= Unusual high food prices 8= Unusual high cost of agricultural inputs such as seeds, fertilizers, pesticides, etc. 9= Reduced/loss of employment income of a HH member	10= Fire 11= Accident or serious sickness of a HH member 12= Death of HH Head 13= Death of a working HH Head 14= Death of other HH member 15= Theft of productive resources	16= Insecurity or violence 17= hailstones 18= Earthquake 19= Volcanic eruption 20= Other, specify: …. 99= Not applicable

Codes for survival strategies **A. Reduced HH food consumption** 1= HH members ate at relatives/friends 2= Reduced consumption by adult to leave food to children 3= Working members ate at the expense of non-working members	4= Reduced the number of meals per day 5= Spent the whole day without eating **B. Looked for more and different food** 6= Borrowed food r relied on food support from relatives/friends	7= Relied on less preferred or less expensive food 8= Borrowed or purchased food on credit 9= Collected unusual amount of wild food of poached 10= Consumed seed stock that was saved for the next growing season	**C. Increased work** 11= Increase casual labor 12= One or more HH members migrated 13= Some HH members worked for food only 14= Worked for money 15= Spent savings 16= Borrowed money	17= Sold HH assets 18= Sold productive assets **D. Reduced expenditures** 19= Children dropped out from school 20= Reduced expenditures on education and/or health 21= Other, specify… 99= Not applicable

D.2.11 HH External Assistance or Programme participation

2.11.1 What is the former Ubudehe category of your HH?		1= Those in abject poverty (Umutindi nyakujya), 2= The very poor (Umutindi), 3= The poor (Umukene),	4= The resourceful poor (Umukene wifashije), 5= The food rich (Umukungu), 6= The money rich (umukire), = 88= Do not know
2.11.2 What is the new ubudehe category of your HH?		1= 1 2=2	3=3 3=4 88= Do not know
2.11.3 In the last 12 months, did any of your HH members get any food assistance? *If no, go to the next line*		0= No 1=Yes	88= Do not know
2.11.3.1 What kind of food assistance did he/she receive?		2.11.3.2 What was the source of this food assistance? Chose appropriate codes below on right	

1. Food for school children eaten at school or taken home		**Source of assistance:** 1 = District/Sector/Cell/Village, 2= MINISANTE, 3= WFP, 4 = Other UN agency, 5 = NGO, 6 = Church or Mosque, 7 = Community, 8= Relatives or Friends, 9= RDB, 10= Other, specify……, 88= Do not know		
2. Food for breastfeeding or pregnant women and small children				
3. Food for work				
4. Food for training				
5. One cup of milk per child				
6. Food distributed for free				
7. Other food assistance, specify: …				
2.11.4 Did any of your HH members get any of these financial assistance from the government during the past 12 months? *If no, go to the next line*		0= No 1=Yes 88= Do not know		
1. Direct support from VUP				
2. Public works from VUP				
3. Access to financial services from VUP				
4. Ubudehe loan or credit scheme				
2.11.5 In the past 12 months, did any member of your HH get any other non-food assistance?		0=No 1=Yes		
2.11.5.2 If yes, what was the kind of assistance received? *Circle what you choose from the list.*	2.11.5.3 What was the source of this non-food assistance? Pick from codes below on the right	**Provider/source:** 1= District or Sector 2= MINISANTE 3= WFP 4= Other UN agency	5 = NGO 6 = Church or Mosque 7 = Community 8=Relatives or Friends	9= RDB 10= Other, specify… 88= Do not know
1. Access to loans, credits or micro-credit other than VUP for activities related to agriculture and/or livestock				
2. Access to loans or credits for activities not related to agriculture or livestock rearing				
3. Agricultural inputs such as seeds, tools, fertilizers, herbicides, pesticides, etc.				
4. Technical assistance and trainings in extension services such as improved practices in agriculture and livestock				
5. Large livestock (cows)				
6. Small livestock (goats, sheep, hens, rabbits, etc.)				
7. Fishponds				

8. Veterinary services		
9. For education such as school fees, material, etc.		
10. Non VUP direct transfers		
11. Medical services including mutuelle de sante		
12. Construction materials		
13. Water and/or sanitation		
14. Training in nutrition		
15. Other, Specify : ….		

E. Distance travelled (in km) to:

Market	Health facility	Paved road	Non paved road

How do you access the market		1= Walk; 2= Moto; 3= Car
Is the market accessible all the year		0=No; 1=Yes
What are the barriers to access the market		1=Distance; 2=Food prices; 3= Poor Road

Thank you for taking this survey. Your responses are very important

Appendix 2: Focus group discussions guide

Section A. General Information

A.1 Village identification

Do you agree to be interviewed	0=No 1=Yes

Coordinates village location	
Village	
Cell	
Sector	
District	

Date	
Time interview starts	
Time interview ends	

A.2 Description of Participants

2.1 Number of participants:			
2.2 Group category		1= Irish Potatoes growers 2= Pyrethrum growers 3= Community Tourism association 4= Porters Association/cooperative 5= ANICOs 6= Cooperative supported by Revenue Sharing or CCDPs 7= Handcraft making cooperative	8= Small business Association/Cooperative 9= Cooperative of Tea growers 10= Beekeeping cooperative 11= Other – specify 12= Agroforestry cooperative 13= Bamboo growers 14= Livestock 15= Seeds IP
2.3 How many women are in this group?			

Section B. Policy and institutional framework in relation to biodiversity conservation at Volcanoes National Park and local food security

B.1 Coordination and policy actors' involvement in processes of policy formulation and implementation

1.1 Are you aware of the following policies/laws/plans?			1.2 If yes, do you know to what extent this policy is beneficial to improving food security and nutrition around protected areas, especially VNP)?		1.3 If yes, describe	1.4 Did you participate in the formulation and/or implementation process of this policy?		1.5 If yes, how?
1.Protected Areas Concessions Management Policy		0=No 1=Yes		0=No 1=Yes			0=No 1=Yes	
2. Rwanda Biodiversity Policy, National Biodiversity Strategy and Action Plan		0= No 1= Yes		0= No 1=Yes			0= No 1=Yes	
3. Wildlife Policy		0= No 1= Yes		0= No 1=Yes			0= No 1=Yes	
4. Law on compensating people for damages caused by wildlife, order of the Prime Minister determining the rates, calculating method and criteria for determining compensation to the victim of damages caused by wild animals, ministerial order determining the list of wild animals concerned with the law on compensation for damages caused by wildlife		0= No 1= Yes			0= No 1=Yes			
5.Rwanda tourism policy		0=No 1=Yes		0=No 1=Yes			0=No 1=Yes	
6.Volcanoes National Park Management Plan		0=No 1=Yes		0=No 1=Yes			0=No 1=Yes	
7. National Food and Nutrition Policy, National Food and Nutrition Strategic Plan		0=No 1=Yes		0=No 1=Yes			0=No 1=Yes	
8. Strategic plan for Agricultural transformation Phase III, national Nutrition Action Plan		0=No 1=Yes		0=No 1=Yes			0=No 1=Yes	
9. School Health Policy		0= No 1=Yes		O=No 1=Yes			0=No 1=Yes	
10 National Social Protection Strategy		0=No 1=Yes		0=No 1=Yes			0=No 1=Yes	

1.6 Do you know revenue sharing or Community Conservation and Development Projects that directly support food security and nutrition around VNP?		0=No 1=Yes

1.7 If yes, which ones including yours?	1.8 How does this project directly support food security and nutrition around VNP?
Project1:	
Project2:	
Project3:	
Project4:	
Project5:	
Project6:	

B.2 Gaps and strengths in Policy implementation

Did wildlife ever made damage in your village?		0=No 1=Yes
2.2 If yes, what was the damage?		1= Crops, 2=Property, 3= Human injuries, 4= Death of the HH member, 5= Disability of the HH member, 6= Other, Specify…….
2.3 Do you know whether the victims have been compensated?		0=No 1=Yes
Is compensation in your village a fair process?		0=No 1=Yes
If no, what is complicated?		1= Modalities for calculating and awarding compensation; 2= It takes too much time; 3= It is expensive; 4= Other, Specify…….
Do you find the compensation paid fair compared to the damages made?		0=No 1=Yes
If no, why?		

Do the park fence and patrols of rangers have any benefit?		0=No 1=Yes
If yes, which benefits?		
2.9 Does your village benefit from extension services?		0=No 1=Yes
If yes, how?		
2.10 Did any of your HH member get training in nutrition? (write the number)		0=No 1=Yes
Do you have a community-based nutrition programme in your Village?		0=No 1=Yes

Section C: The effects of land use changes on Volcanoes National Park

C.1 Changes in vegetation

1.1 Is there any change in vegetation composition since 2000s?		0=No 1=Yes
1.2 If yes, what are the dominant species now?		
1.3 What were dominant species 15 years ago?		
1.4 What were dominant species 30 years ago?		
1.5 Are there forests and/or woodlots in this area?		1=Yes, 0= No
1.5.1 If yes, what is the rate of deforestation in this area?		1 =Fast, 2= moderate, 3= slight
1.6 Is charcoal making practiced in this area?		0=No, 1=Yes
1.6.1 If yes, which are preferred trees cut to make charcoal?		
1.6.2 Are these trees disappearing or new ones are being planted as they cut them?		0=No, 1=Yes
1.6.3 If they are disappearing, what is the rate?		1= Fast, 2= moderate,

		3= slow
1.7 What is the rate of afforestation in the area?		1= Fast, 2= moderate, 3= slow, 4= no afforestation

C.2 Crops

2.1 What are major crops planted in this area?	1. 2. 3. 4.
2.2 What are the benefits of crop intensification in this area?	
2.3 What are the benefits of land use consolidation in this area?	

Section D: The contribution of the benefits from Volcanoes National Park to local food security

D.1 Benefits from Volcanoes National Park

D.1.1 Forest dependence

1.1.1 What do poor residents in this area do for a living?	
1.1.2 How often do residents go into VNP for park resources?	
1.1.3 Which season do they mostly go into VNP for park resources?	
1.1.4 Would they get similar resources elsewhere other than VNP?	
1.1.5 What would they do if these resources became unavailable?	
1.1.5 Are there other alternative resources that they would consider instead?	
1.1.6 What are the common forest resources that people here need from VNP?	
1.1.7 Are there any activities that people do in VNP to practice their rituals and cultural beliefs?	
1.1.8 Is tourism at VNP beneficial to local people? Why do you think that?	
1.1.9 In what ways have people in this area benefited from tourism?	
1.1.10 In what way have people in this area been negatively impacted by tourism?	
1.1.11 What opportunities are available in this area because of tourism?	
1.1.12 Which opportunities at VNP do people in this area have access to? How do they use these opportunities?	
1.1.13 What opportunities do people in this area including you, wish to have access to at VNP? Why?	
1.1.14 What are the main limitations for people in this area to access tourism opportunities at VNP?	

1.1.15 In your view, can tourism help people in this area to overcome the need for forest resources? How?	

D2. Food Security

D.2.1 Demographic and Community Type Information

Do not ask, observe, or ask the local leader if in place

2.1.1 How many HH does this village have?			
2.1.2 How would you qualify this village in terms of urbanization?		1= Rural 2= Urban organized	3= Urban slum
2.1.3 What scheme is for your village?		0= None 1= VUP 2= land use consolidation 3-= IDP model village	4=Structured modern settlement (Umudugudu), 5=Other Specify------

D.2.2 Community Infrastructure

2.2.1 What is the % of HH that have access to electricity in this village?		……%
2.2.2.1 Does your village have one or more primary schools?		0= No 1= Yes
2.2.2.2 How long does it take to reach the nearest primary school if there is not any in your village?		Walk of of___hours____Minutes
2.2.3.1 Do you have a health center, health post or hospital in this village?		0= No 1=Yes
2.2.3.2 How long does it take to reach the nearest health center, health post, hospital if there is not any in your village?		Walk of of___hours____Minutes

D3. Markets

2.3.1 Do you have a market in your village?		0 = No, 1 = Yes		
2.3.1.2 If Yes, is this the main market for your community?		0 = No, 1 = Yes		
2.3.1.3 If No, for how long do you have to travel to the main market in your village?		Walk of of___hours____Minutes		
2.3.2 Do vehicles use the road to the main market in your village all the year round with no issues of blockage by landslides or other?		0= No 1= Yes		
2.3.2.1 If no, which months is the rod not accessible?		0= All months of the year 1= January 3= February	5= May 6= June 7= July	9= September 10= October 11= November

		4= April	8= August	12= December
2.3.3 Your village faces which main issue concerning markets for foods?1=		1= Limited food demand 2= Limited supply 3= High food prices 4= Unpredictable changes in food prices 5= Market location is very far 6= Road to market is bad 7= Other, specify: …		
2.3.4 What are three most important food items that people eat in this village? Answers can be items belonging to roots, tubers, cereals, vegetables, pulses, etc.		Use code below		
2.3.5 In the last 12 months, when were these crops in the main market that HHs of this village use?		Tick the month when available		

Crops		**Oct 2016**	**Nov 2016**	**Dec 2016**	**Jan2017**	**Feb 2017**	**March 2017**	**Apr 2017**	**May 2017**	**Jun 2017**	**Jul 2017**	**Aug 2017**	**Sep 2017**
Cereal or tuber													
Pulse													
Veg													

Codes for three most important food items eaten by HHs in the village							
Cereals/tubers 1= wheat 2= Maize	3= Sorghum 4= Rice 5= Sweet potato	6= Irish potato 7= Cassava 8= Taro	9= Yam 10= Cooking banana 11= Other cereal/ root, specify: ….	**Pulses** 12= Beans 13= Soybeans	14= Other, Specify: …	**Vegetables** 15= Tomato 16= Cabbage	17= Amaranth 18= Other, specify: ….

D.2.4. Food Items sold in the market

2.4.1 Did your HH sell this food item in the market in the last 12 months?	If yes, how many kg and what was the price per kg?		If you compare with the prices for the rest of the year, was this price higher or lower? 1= Lower 2= Almost the same 3= Higher
	kg	**Unit price**	
Rice			

Maize				
Sorghum				
Wheat				
Millet				
Beans				
Cassava				
Peas				
Irish potatoes				
Sweet potatoes				
Cabbages				
Cooking banana				
Bana fruit				
Chicken				
Meat				
Fish such as tilapia, catfish, filet				
Milk				
Small fish such as isambaza, indagara				
Pyrethrum				
2.4.2 Market Prices for livestock	1-Was any of this livestock sold in your village during the last 12 months? **0=No, 1=Yes**	What was the price for one adult (RWF)?		If you compare with the rest of the year, was this price higher or lower? **1= Lower** **2= Almost the same** **3= Higher**
Cow				
Goat				
Sheep				
Chicken				

Pig		
2.4.3 Daily wages for labour	What are the current daily labor wages in this village (RWF)?	If you compare with the rest of the year, was this price higher or lower? **1= Lower** **2= Almost the same** **3= Higher**
Unskilled agricultural labour		
Unskilled non-agricultural labour		

D.2.5 Crop calendar

2.5.1 is agriculture practiced in your village?						0 = No 1 = Yes		
2.5.2. By order of importance what are the major crops grown in this village?								
1= Wheat 2= Maize 3= Sorghum 4= Rice	5= Other cereals, specify: …. 6= Sweet potato	7= Irish potato 8= Cassava 9= Taro 10= Yam	11= Cooking banana 12= Other roots/tubers, specify: …	13= Tomato 14= Cabbage 15= Other vegetables, specify: …	16= Beer banana 17= fruit banana 18= passion fruit	19= pineapple 20= other fruit, specify: .. 21= Beans 22= Peas	23= Soya 24= Ground nuts 25= Tea 27= Coffee	28= Tobacco 29= Sugar cane 30= Pyrethrum 31= Other cash crops, specify: ….

Major planted crops	**Oct 2016**	**Nov 2016**	**Dec 2016**	**Jan 2017**	**Feb 2017**	**Mar 2017**	**Apr 2017**	**May 2017**	**Jun 2017**	**Jul 2017**	**Aug 2017**	**Sept 2017**
Main crop planting and sowing												
Main crop harvest												

D.2.6 Assistance projects

2.6.1 HHs that are in category 1 of ubudehe have which approximate percentage?			%
2.6.2 HHs that are in category 2 of ubudehe have which approximate percentage?			%
2.6.3 HHs that are in category 3 of ubudehe have which approximate percentage?			%
2.6.4 HHs that are in category 4 of ubudehe have which approximate percentage?			%
2.6.5 What percentage of HHs in this village are not classified in any of these classes so far?			%
2.6.5 HHs that are not yet put under any of these categories have which approximate percentage?			%

	……% of HHs in the village participating in:	How are these HHs selected? **1= selected based on HH Ubudehe category, 2=**	How do you rate how HHs in this village were selected? **1= Fairly good (few exclusion or**

		community selection not based on Ubudehe category 3= Government list was used, 4=Other, specify……	**inclusion errors) 2= Somehow bad 3= Bad, 4= Very Bad (a lot of exclusion or inclusion errors)**
1. VUP public work			
2. VUP direct support			
3. Other cash for work			
4. Food for work			
5. Food distributed for free			
6. Development project			
7. Crop intensification/terracing/ agroforestry/land use consolidation project			

D.2.7 Shocks

2.7.1 In the last 12 months, did your village experience any shock?		0=No, 1=Yes
2.7.2 If yes, by order of importance, what four key challenges that this village HHs faced during the last 12 months? *Enumerator to circle the answer and add the code for order of importance*		1= Most important 2= Second important 3= Third important 4= Forth important

Codes for main shocks 1= Drought, prolonged spell, irregal rains 2= Floods 3= Landslides 4= Unusual high level of crop diseases/pests	5= Unusual high level of livestock diseases 6= Unusual high level of human diseases/epidemies 7= Unusual high food prices 8= Unusual high prices of agricultural inputs such as fertilizers, pesticides, seeds	9= Reduced/lost employment, income of a HH member 10= Fire 11= Serious accident pr sickness of a HH member 12= Death of the HH head 13= death of a working HH member	14= Death of other HH member 15= theft of productive resources 16= Violence/insecurity 17= hailstones 18= Earthquake 19= Volcalic eruption 20= Other specify: …

E. Additional questions

What is the cost of a load of the following in this village:

Fuelwood:

Charcoal:

Bean poles:

Timber (1 timber)

Appendix3 : Key informants interviews guide

Section A. General Information

A.1 Village identification

Do you agree to be interviewed	0=No 1=Yes

Coordinates village location	
Village	
Cell	
Sector	
District	

Date	
Time interview starts	
Time interviews ends	

A.2 Description of Key informant

2.1 Institution of the person interviewed	a. District	i. RDB
	b. Sector	j. REMA
	c. Health Center	k. Rwanda Water and Forestry Authority
	d. VNP	l. MINIRENA
	e. NGO	m. MINISANTE
	f. Teacher	n. MINAGRI
	g. Church	o. RAB
	h. Farmer	p. Other – specify

2.3 Gender (woman or man)?		

Section B. Policy and institutional framework in relation to biodiversity conservation at Volcanoes National Park and local food security

B.1 Coordination and policy actors' involvement in processes of policy formulation and implementation

1.2 Do you know to what extent the following policies/laws/plans are beneficial to improving food security and nutrition around protected areas, especially VNP)?			1.3 If yes, describe	1.4 Did you participate in the policy formulation and/or implementation process?		1.5 If yes, how?
1. Policy on Protected Areas Concessions Management		0= No 1= Yes			0= No 1= Yes	
2. Policy, law and Strategic Plan for Rwanda Biodiversity		0=No 1=Yes			0=No 1=Yes	
3. Wildlife Policy		0= No 1= Yes			0= No 1= Yes	
4. Law on compensating people for damages caused by wild animals, order of the Prime Minister that determines the rates, calculating method and criteria for compensating victims of damages caused by wildlife, ministerial order enlisting animal species concerned with this law		0= No 1= Yes			0= No 1= Yes	
5.Rwanda Tourism Policy		0=No 1=Yes			0=No 1=Yes	
6.Volcanoes National Park Management Plan		0=No 1=Yes			0=No 1=Yes	
7. National Food Security and Nutrition Policy and related Strategic and Action Plans		0= No 1= Yes			0= No 1= Yes	
8. National Strategic Plan for Agricultural transformation		0= No 1= Yes			0= No 1= Yes	
9. National School Health Policy		0= No 1= Yes			0= No 1= Yes	
10. National Strategy for Social Protection		0= No			0= No	

		1= Yes			1= Yes	

1.6 Do you know any of revenue sharing or Community Conservation and Development Projects that directly support food security and nutrition around VNP?		**0=No** **1=Yes**
1.7 If yes, which one?	1.8 How does this project directly support food security and nutrition around VNP?	
Project1:		
Project2:		
Project3:		
Project4:		
Project5:		
Project6:		

B.2 What gaps and strengths do you think these policies have to address food security around VNP?

2.1 Policy	**Gaps**	**Strengths**
1. Protected Areas Concessions Management Policy		
2. Rwanda Biodiversity Policy, Law and National Biodiversity Strategy and Action Plan (NBSAP) 2016		
3.Wildlife policy		
4. Law, Prime Minister and Ministerial orders on compensation of damages caused by the wildlife		
5.Rwanda Tourism Policy		
6. Volcanoes National Park Management Plan		
7. Policy and Strategic and Action Plans for National Food and Nutrition Security		
8. Agricultural transformation Strategic Plan		
9. National policy on school heath		
10. National strategy on social protection		

B3. In your opinion, what are achievements and strengths of your institution with regard to linking local food security and conservation of VNP?

B4. What do you think might be key concerns in linking VNP conservation and improving local food security, basing on your experience working on the park conservation and/or community development?

B5. Based on your experience, what are the key barriers that lead to those issues/concerns you described?

B.6 What entry-points /opportunities do you see to address these barriers, gaps/concerns within your projects context?

B.7 Based on your experience / assumptions, what risks could an increased focus on conservation ignoring local food security bear?

B.8 Is there anything else you would like to share with me in this context?

Section C: The effects of land use changes on Volcanoes National Park

1. What do you think are effects of land scarcity on VNP?	
2. Do you think crop intensification in VNP vicinity can reduce local pressure on the park resources? Why?	
3. Do you think land use consolidation in VNP vicinity can reduce local pressure on the park resources? Why?	
4. What measures do you think can help reduce local pressure	

on the park resources?	

Section D: The contribution of the benefits from Volcanoes National Park to local food security

D.1 Benefits from Volcanoes National Park

D.1.1 Forest dependence

Only for staff working for VNP and local conservation NGOs

1.1.1What do poor residents in this area do for a living?	
1.1.2 Which season do residents mostly go into VNP for park resources?	
1.1.3 Are there other alternative resources that they would consider instead?	
1.1.4 What are the common forest resources that people here need from VNP?	
1.1.5 Are there any activities that people do in VNP to practice their rituals and cultural beliefs?	
1.1.6 In what ways have people in this area benefited from VNP conservation?	
1.1.7 In what way have people in this area been negatively impacted by VNP conservation?	
1.1.8 What opportunities are available in this area because of VNP conservation?	
1.1.9Which opportunities at VNP do people in this area have access to? How do they use these opportunities?	
1.1.10 What opportunities do people in this area, wish to have access to at VNP? Why?	
1.1.11 What are the main limitations for people in this area to access VNP conservation opportunities?	
1.1.12 In your view, can VNP conservation help people in this area to overcome the need for forest resources? How?	
1.1.13 What is local level of knowledge / understanding of the park benefits?	
1.1.14 How open do you think are the communities to explore and implement measures that lead to better relationship with the park?	

D2. Food Security

D.2.1 Demographic and Community Type Information

Do not ask, observe, or ask the local leader if in place

2.1.1 How many HH does this village have?			
2.1.2 How would you qualify this village in terms of urbanization?		1= Rural 2= Urban organized	3= Urban slum
2.1.3 What scheme is for your village?		0= None 1= VUP 2= land use consolidation 3-= IDP model village	4=Structured modern settlement (Umudugudu), 5=Other Specify------

D.2.2 Community Infrastructure

2.2.1 What is the % of HH that have access to electricity in this village?		……%
2.2.2.1 Does your village have one or more primary schools?		0= No 1= Yes
2.2.2.2 How long does it take to reach the nearest primary school if there is not any in your village?		Walk of of___hours____Minutes
2.2.3.1 Do you have a health center, health post or hospital in this village?		0= No 1=Yes
2.2.3.2 How long does it take to reach the nearest health center, health post, hospital if there is not any in your village?		Walk of of___hours____Minutes

D3. Markets

2.3.1 Do you have a market in your village?		0 = No, 1 = Yes		
2.3.1.2 If Yes, is this the main market for your community?		0 = No, 1 = Yes		
2.3.1.3 If No, for how long do you have to travel to the main market in your village?		Walk of of___hours____Minutes		
2.3.2 Do vehicles use the road to the main market in your village all the year round with no issues of blockage by landslides or other?		0= No 1= Yes		
2.3.2.1 If no, which months is the rod not accessible?		0= All months of the year 1= January 3= February 4= April	5= May 6= June 7= July 8= August	9= September 10= October 11= November 12= December

2.3.3 Your village faces which main issue concerning markets for foods?1=		1= Limited food demand 2= Limited supply 3= High food prices 4= Unpredictable changes in food prices 5= Market location is very far 6= Road to market is bad 7= Other, specify: …
2.3.4 What are three most important food items that people eat in this village? Answers can be items belonging to roots, tubers, cereals, vegetables, pulses, etc.		Use code below
2.3.5 In the last 12 months, when were these crops in the main market that HHs of this village use?		Tick the month when available

Crops		**Oct 2016**	**Nov 2016**	**Dec 2016**	**Jan 2017**	**Feb 2017**	**Mar 2017**	**Apr 2017**	**May 2017**	**Jun 2017**	**Jul 2017**	**Aug 2017**	**Sep 2017**
Cereal or tuber													
Pulse													
Veg													

Codes for three most important food items eaten by HHs in the village							
Cereals/tubers 1= wheat 2= Maize	3= Sorghum 4= Rice 5= Sweet potato	6= Irish potato 7= Cassava 8= Taro	9= Yam 10= Cooking banana 11= Other cereal/ root, specify: ….	**Pulses** 12= Beans 13= Soybeans	14= Other, Specify: …	**Vegetables** 15= Tomato 16= Cabbage	17= Amaranth 18= Other, specify: ….

D.2.4. Food Items sold in the market

2.4.1 Did your HH sell this food item in the market in the last 12 months?	If yes, how many kg and what was the price per kg?		If you compare with the prices for the rest of the year, was this price higher or lower? 1= Lower 2= Almost the same 3= Higher
	kg	**Unit price**	
Rice			
Maize			

Sorghum				
Wheat				
Millet				
Beans				
Cassava				
Peas				
Irish potatoes				
Sweet potatoes				
Cabbages				
Cooking banana				
Bana fruit				
Chicken				
Meat				
Fish such as tilapia, catfish, filet				
Milk				
Small fish such as isambaza, indagara				
Pyrethrum				
2.4.2 Market Prices for livestock	1-Was any of this livestock sold in your village during the last 12 months? **0=No, 1=Yes**	What was the price for one adult (RWF)?		If you compare with the rest of the year, was this price higher or lower? **1= Lower** **2= Almost the same** **3= Higher**
Cow				
Goat				
Sheep				
Chicken				
Pig				

2.4.3 Daily wages for labour	What are the current daily labor wages in this village (RWF)?	If you compare with the rest of the year, was this price higher or lower? **1= Lower** **2= Almost the same** **3= Higher**
Unskilled agricultural labour		
Unskilled non-agricultural labour		

D.2.5 Crop calendar

2.5.1 is agriculture practiced in your village?									0 = No 1 = Yes
2.5.2. By order of importance what are the major crops grown in this village?									
1= Wheat 2= Maize 3= Sorghum 4= Rice	5= Other cereals, specify: …. 6= Sweet potato	7= Irish potato 8= Cassava 9= Taro 10= Yam	11= Cooking banana 12= Other roots/tubers, specify: …	13= Tomato 14= Cabbage 15= Other vegetables, specify: …	16= Beer banana 17= fruit banana 18= passion fruit	19= pineapple 20= other fruit, specify: .. 21= Beans 22= Peas	23= Soya 24= Ground nuts 25= Tea 27= Coffee	28= Tobacco 29= Sugar cane 30= Pyrethrum 31= Other cash crops, specify: ….	

Major planted crops	**Oct 2016**	**Nov 2016**	**Dec 2016**	**Jan 2017**	**Feb 2017**	**Mar 2017**	**Apr 2017**	**May 2017**	**Jun 2017**	**Jul 2017**	**Aug 2017**	**Sept 2017**
Main crop planting and sowing												
Main crop harvest												

D.2.6 Assistance projects

2.6.1 HHs that are in category 1 of ubudehe have which approximate percentage?		%
2.6.2 HHs that are in category 2 of ubudehe have which approximate percentage?		%
2.6.3 HHs that are in category 3 of ubudehe have which approximate percentage?		%
2.6.4 HHs that are in category 4 of ubudehe have which approximate percentage?		%
2.6.5 What percentage of HHs in this village are not classified in any of these classes so far?		%
2.6.5 HHs that are not yet put under any of these categories have which approximate percentage?		%

	……% of HHs in the village participating in:	How are these HHs selected? **1= selected based on HH Ubudehe category, 2= community selection not**	How do you rate how HHs in this village were selected? **1= Fairly good (few exclusion or inclusion errors)**

		based on Ubudehe category 3= Government list was used, 4=Other, specify……	**2= Somehow bad 3= Bad, 4= Very Bad (a lot of exclusion or inclusion errors)**
1. VUP public work			
2. VUP direct support			
3. Other cash for work			
4. Food for work			
5. Food distributed for free			
6. Development project			
7. Crop intensification/terracing/ agroforestry/land use consolidation project			

D.2.7 Shocks

2.7.1 In the last 12 months, did your village experience any shock?		0=No, 1=Yes
2.7.2 If yes, by order of importance, what four key challenges that this village HHs faced during the last 12 months? *Enumerator to circle the answer and add the code for order of importance*		1= Most important 2= Second important 3= Third important 4= Forth important

Codes for main shocks 1= Drought, prolonged spell, irregal rains 2= Floods 3= Landslides 4= Unusual high level of crop diseases/pests	5= Unusual high level of livestock diseases 6= Unusual high level of human diseases/epidemies 7= Unusual high food prices 8= Unusual high prices of agricultural inputs such as fertilizers, pesticides, seeds	9= Reduced/lost employment, income of a HH member 10= Fire 11= Serious accident pr sickness of a HH member 12= Death of the HH head 13= death of a working HH member	14= Death of other HH member 15= theft of productive resources 16= Violence/insecurity 17= hailstones 18= Earthquake 19= Volcanic eruption 20= Other specify: …

E. Additional questions

What is the cost of a load of the following in this village:

Fuelwood:

Charcoal:

Bean poles:

Timber (1 timber):

Appendix 4: CARI food security classifications

	Severely food insecure	**Moderately food insecure**	**Marginally food insecure**	**Food secure**
Food security index	With extreme gaps in food consumption or has severe livelihood assets' depletion which will result in severe gaps in food consumption or worse	Those who have significant gaps in food consumption or are marginally capable of meeting minimum food needs only through coping strategies that are irreversible	Those who consume minimally adequate food without resorting to irreversible strategies or are not able to afford some essential non-food expenditures	Those who can meet their basic food and non-food needs without resorting to unusual coping strategies

Appendix 5: Definition of the variables of the study

Variable	**Description**
Status of HH Food Security	1= Food secure; 0= Food insecure
Sex of the HH Head	0= Male; 1= Female
Age of the HH Head	Age of the HH in years
Education of the HH Head	The highest level of education that the HH Head attained
Marital status of the HH Head	1= if married; 0= if otherwise
Family size	Number of the HH members
Occupation	Main activity of the HH head
Expenditures	Household expenditures in Rwandan Francs
Potato	The household grows potato, yes=1, no=0
Bean	The household grows bean, yes=1, no=0
Stock duration	Average duration of food stocks in the household per season
Distance to market	Distance to market in kilometers
Food access issues	Food access issues (yes=1, no=0)

Crops	Number of crops grown by the HH
Livestock	Number of domestic animals possessed by the HH
Land size	Land owned by the HH in acres
Location	Distance from the park edge (Belts)

Appendix 6: Research permit

RDB | RWANDA DEVELOPMENT BOARD

RESEARCH CONTRACT

This agreement is made between the Rwanda Development Board (RDB) Tourism & Co
(hereinafter referred to as "the board ") on one part and

.....(hereinafter referred to as "the researcher")

WHEREAS the researcher is the desirous of carrying out the research in the authority's protected area called ...Volcanoes National Park

And WHEREAS the authority has agreed to the said research to be carried out in the said protected areas, under the terms and conditions herein stipulated,

IT IS NOW AGREED AS FOLLOWS:

1. The authority has authorized and allowed the researcher to carry out the research described herein below, in ...ENV.....
2. The research shall be restricted to (project title) ...Implications of biodiversity conservation on food Security around Volcanoes National Park, Rwanda
3. The said research shall be commenced one days after execution of this agreement and shall have a duration of .....6.....**months** after which the said research shall cease to be carried out,
4. The researcher or the group of researchers as Foreign Citizen will pay the research application project fee of **50$** non refundable paid once as consideration for the permission to carry out the research above described.
5. The researcher as a Foreign students will pay the research application project fee of **30$** nonrefundable paid once as consideration for the permission to carry out the research above described.
6. Each of the researchers as Foreign Citizen shall pay **120 $** monthly research fee non refundable
7. Each of the researchers as Foreign Student shall pay **50 $** monthly research fee non refundable
8. The researcher or the group of researchers as Rwandan Citizen shall pay **5000 Rwf** monthly research fee nonrefundable and **5000 Rwf** of application paid once.
9. Each of the researchers as Rwandan Students who is doing undergraduate courses shall pay **5000 Rwf** of application.
10. Before commencement of any field work, the researcher shall pay a report/security deposit of 300$ refundable within 15 days following the submission of his/her final report.

11. The researcher shall produce a progress report in on the activities covered under the research to the authority and shall at the completion of the research submit a final report on the research which shall include analyzed data, findings and recommendations.

12. The researcher shall where necessary make an application for permission to collect, take and/or use any specimens for the carrying out of the said research. Such application shall be made to the Chief Executive Officer and shall indicate the exact need for the specimens and the number and the number and categories of specimens required.

13. The researcher shall not hunt , collect take, kill or injure any wild plant or animal or any part or derivative thereof and shall not collect , take or use any specimen without prior written approval of the Chief Executive Officer such approval shall bear a stamp of the authority.

14. The authority shall at all times have absolute discretion in deciding on whether or not to grant permission to collect, take or use any specimen and on whether or not to grant permission to hunt, collect, take, kill, or injure any wild plant or animal.

15. The board shall have a right to stop the research from commencing or continuing with the research herein above described, for good cause

16. This agreement shall be governed by and be subject to the Rwanda Wildlife Statute and all subsidiary legislation made there under , and to all other laws of Rwanda.

IN witness whereof, the duly authorized representatives of the parties hereto have set their hands hereunto on the day and year below mentioned.

For Rwanda Development Board
Tourism and Conservation

Eugene MUTANGANA
Head of Conservation Department
Rwanda Development Board

Signature

Date

For the Researcher

Names..... Madeleine Nyiratuza

signature

21 July 2017

Date