

What does the future hold for the Mlele District Forest Reserves?
The interaction of the social, political, and ecological spheres in
Tanzania's Katavi Region.

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FOREWORD

This master's thesis serves the purpose of obtaining a Master of Science in Geography in Development Studies at the University of Lausanne (UNIL), Switzerland. This is an individual project to demonstrate the acquired knowledge during the four semesters of studies and the ability to lead an autonomous scientific research.

The field work of this thesis was done in Inyonga, Tanzania, between June and September 2015, before the Presidential elections of October 2015. The statements of this study concern the practices which occurred before the current Presidential Administration, and the reforms recently undertaken.

All pictures without sources in this thesis are personal pictures taken during the field work. All the maps have been drawn for this study using field data and GIS base layers from the Association of the Development of Protected Areas (ADAP).

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ABSTRACT

National Forest Reserves cover more than half of the Mlele District, in Tanzania, and restrict the use of natural resources for the local population, whose livelihoods still depend on it. The District is undergoing major socio-economic changes that alter the society's organisation and increase the pressure on the resources. This master's thesis combines a political ecology approach with the commons theory to study the relationships between the users, the resources, and the rules governing the Forest Reserves and the influence of broader politico-economic processes. It shows that local government managers only partially enforce the laws, leaving many users, driven by their financial interests, to access resources not only legally but frequently illegally. This system is excessively beneficial for users with financial and social capital and corrupt state agents. It is due to a severe lack of resources but also to the way public institutions operate in Tanzania which impacts the work of local managers. Forest ecosystems harbour crucial natural resources but could collapse in the short term. Cultivated areas have increased by 250% in 13 years, encroaching on reserves. Moreover, even if 43 mammal species were inventoried, the patrimonial species were very scarce. The current governance of Forest Reserves does not allow for sustainable natural resources uses and jeopardises the local population's livelihoods in the long term. Consequently, governance arrangements need to be redefined to ensure a sustainable and fair use and create conditions for local users' involvement in Forest Reserve management. Community-based management provided by the Tanzanian legal framework could theoretically give users more rights but it still has limitations and requires a complex implementation. Moreover, the central state's power over natural resources and the lack of law enforcement question the incentives created by CBNRM approaches at local level.

Key words: Forest Reserves, natural resources governance, Tanzania, Social-Ecological System, political ecology, community conservation.

RÉSUMÉ

Des réserves forestières gouvernementales occupent plus de la moitié du district de Mlele, en Tanzanie, restreignant l'utilisation des ressources naturelles pour la population locale qui en dépend encore fortement. Le district subit d'importantes transformations socio-économiques qui affectent l'organisation de la société et exercent de fortes pressions sur les ressources. Ce mémoire allie une approche de *political ecology* avec la théorie des *commons* pour étudier les relations entre les ressources, les usagers et règles qui gouvernent les réserves forestières ainsi que l'influence de processus politico-économiques plus larges. Il en ressort que les gestionnaires locaux n'appliquent que partiellement les lois, laissant accéder illégalement de nombreux usagers poussés par leurs intérêts financiers. Ce système, qui profite démesurément aux usagers ayant des capitaux financiers et sociaux et aux agents étatiques corrompus, est dû à un cruel manque de moyens mais aussi au fonctionnement des institutions publiques. Les écosystèmes des réserves contiennent encore d'importantes ressources mais sont susceptibles de se dégrader très vite. Les surfaces cultivées ont augmenté de 250 % en 13 ans, empiétant sur les réserves, et bien que 43 espèces de mammifères aient été inventoriées, les espèces patrimoniales étaient peu présentes. La gouvernance actuelle des réserves forestières ne permet donc pas une utilisation durable des ressources et met en péril les moyens de subsistance de la population locale à long terme. Elle doit donc être repensée pour garantir une utilisation plus durable et plus juste et créer des conditions pour que les usagers locaux s'impliquent dans la gestion des réserves. La gestion communautaire prévue par le cadre légal tanzanien pourrait théoriquement permettre de leur redonner plus de droits mais montre cependant des limites sectorielles et une mise en œuvre complexe. De plus, le pouvoir de l'Etat central sur les ressources naturelles et le manque d'application des lois remettent en question les bénéfices que pourrait créer localement la gestion communautaire.

Mots-clés : Réserves Forestières, gouvernance des ressources naturelles, Tanzanie, Socio-Ecosystèmes, *political ecology*, gestion communautaire.

LIST OF ABBREVIATIONS

ADAP	Association for the Development of Protected Areas
BKZ	Beekeeping Zone
CBFM	Community Based Forest Management
CBNRM	Community Based Natural Resource Management
CBO	Community Based Organisation
CHF	Swiss Francs
COSTECH	Tanzania Commission for Science and Technology
CPR	Common pool resource
CT	Camera traps
DLNRO	District Land and Natural Resources Officer
DfID	British Department for International Development
FAO	Food and Agriculture Organization of the United Nations
FR	Forest Reserve
GCA	Game Controlled Area
GR	Game Reserve
GTZ	German Development Agency
hepia	Haute Ecole du Paysage, d'Ingénierie et d'Architecture
IBA	Inyonga Beekeepers Association
IUCN	World Conservation Union (International Union for Conservation of Nature)
JFM	Joint Forest Management
MNRT	Ministry of Natural Resources and Tourism
NGO	Non-governmental organisation
NP	National Park
NR	Natural resources
NTFP	Non-timber forest product
SES	Social-ecological system
SPSS	Statistical Package for the Social Sciences
TFS	Tanzania Forest Service
TSH	Tanzanian Shillings
UASWS	University of Applied Sciences of Western Switzerland
UNIL	University of Lausanne
VGS	Village Game Scout
WD	Wildlife Division
TANAPA	Tanzania National Parks
TAWIRI	Tanzania Wildlife Research Institute
UNDP	United Nation Development Programme
URT	United Republic of Tanzania
WMA	Wildlife Management Area

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1. INTRODUCTION

The present chapter aims to introduce this master's thesis by presenting the reasons motivating the choice of subject, to present the local context leading to the first investigations, to give an overview of the literature, to define the issue and finally to present the theoretical and analytical frameworks used to address it.

1.1. PURPOSE OF THE MASTER'S THESIS

When I had to think about a subject for the master's thesis, I¹ opted quickly for the natural resources² use in Western Tanzania (Mlele District – Katavi Region). I already had the opportunity to work in that region for the field work of my bachelor's thesis in Environmental Engineering from the University of Applied Sciences of Western Switzerland (UASWS). I compared the mammal species richness in two types of protected areas (one managed by a local community and another by the government) using camera traps. The survey was carried out in collaboration with a Swiss Non-Governmental Organisation (NGO)³, the Association for the Development of Protected Areas (ADAP). This association has been operating in the Inyonga Division since 2002 and aims to encourage the sustainable use of the area's natural resources and to improve the life of the local communities through its project "Inyonga Beekeeping Development Support Project". ADAP supports the development of a beekeeping value chain, the establishment of a community managed area, the setting up of a land use planning and management process in villages and the development of the local population's skills (local managers, beekeepers, women groups, etc.). ADAP achieves its objectives through the support of the Inyonga Beekeepers Association (IBA), a community-based organization that brings together local beekeepers⁴. ADAP supported the establishment of Tanzania's first Beekeeping Zone (BKZ) in a National Forest Reserve (FR)⁵, Mlele. Since 2010, following a transfer of management rights negotiated with the government, the BKZ of 850 km² is managed by IBA in collaboration with the District and the villages. The results in terms of honey production and the diversity of flora and fauna are quite satisfying for ADAP which demonstrates that the BKZ is a good way to reconcile local development and sustainable natural resource use. Wildlife monitoring, carried out by ADAP in collaboration with UASWS inside the Mlele BKZ, showed an impressive diversity of large and medium mammals with a

¹ The pronoun "I" is used only in the sections 1.1. and 4.3. which are the most personal parts.

² Natural resources are "*Materials or substances such as minerals, forests, water, and fertile land that occur in nature and can be used for economic gain*" (Oxford University Press, n.d.). Consequently, we could say that a natural resource is socially constructed.

³ ADAP is a Swiss NGO based in Geneva that was created in 1997. In addition to its committee of 6 people, 4 other persons volunteer for the follow-up of projects, communication activities and events in Switzerland. Currently ADAP has one project in Tanzania, one in its ending phase in Burkina Faso and a new one beginning soon in Madagascar. All concern the community management of natural resources. More information on www.adap.ch.

⁴ IBA, formed in 2002, consists of a central committee, 7 executive staff (cashier, accountant, manager, technical advisor and drivers) and the members (varying between 300 and 500). The ADAP supervisor and IBA executive staff are currently paid by ADAP's project.

⁵ A Forest Reserves is considered by the National Forest Policy (URT, 1998, p. ix) to be "*a forest area, either for production of timber and other forest product or protective for the protection of forests and important water catchments, controlled under the Forests Ordinance and declared by the Minister*".

total of 52 different species and high tree diversity in preserved forests (ADAP, 2014). In 10 years, beekeeping production reached an average of 120 tons per year from an initial 7 tons in 2002 and following an increase in quality, honey prices were multiplied tenfold at the District level. More information about ADAP and the project can be found in APPENDIX 1.

ADAP and its Tanzanian partners would like to extend the community-based management model tested in Mlele to other FRs of the District. The association therefore needed a preliminary study of the environmental and social conditions in those areas before considering a new project. As the field work carried out for my bachelor's thesis was a great personal and professional experience, I saw in my master's thesis an opportunity to make a contribution to this study and further develop my knowledge and understanding of the conservation and development nexus by apprehending the social dimensions of protected areas and natural resources in an interdisciplinary manner. I also found it useful to already know the area as I could more quickly be "operational" in the field. However, as a result, my time in the field was not fully autonomous and neutral as I was hosted by ADAP Inyonga and worked on a subject related to its project. Furthermore, I stayed involved in the project after the completion of my study by training local rangers in ecological monitoring and doing some tasks for the NGO in Geneva. I was seen as related to the ADAP's project and as a consequence, one could say that I have a particular – and possibly biased – position in "engaged research" but as Benjaminsen & Svarstad (2009) mention, research about the environment is never fully objective.

1.2. CONTEXT AND SUBJECT DEFINITION

The Mlele District of the Katavi Region⁶ is quite remote, has few public infrastructure networks, and still harbours preserved ecosystems (Stoner et al., 2007). The Region is the country's lowest population density with 12 inhabitants per km² and in 2012 the Mlele District had 564,604 inhabitants (URT, 2013). Inyonga, its twelve villages and Ilunde are surrounded by a dense network of protected areas, composed of a National Parks (NP), Game Reserves (GRs) and National FRs (see Figure 1). These protected areas cover more than 20,000 km² of reserved land⁷ while the village land covers 640 km². The nearest towns are Mpanda, the capital of the Katavi Region which is located 120 km northwest from Inyonga, and Tabora, the capital of the Tabora Region 220 km to the north. The Multidimensional Poverty Index⁸ reports that 72% of the population was considered poor in Rukwa Region in 2013 (no data available for Katavi) and 42% as extremely poor (UNDP & URT, 2015). This index ranks Rukwa 14th out of 21 Regions. Local communities in the Mlele District, like in most parts of Tanzania, are still highly dependent on natural resources (Hausser, Weber, & Meyer, 2009; Quinn, Huby, Kiwasila, & Lovett, 2007). Even if there were already protected areas all around the village territories 60

⁶ The Katavi Region was created in 2012, as a result of the division of the former Rukwa Region into two parts. The Mlele District was created during the same reform, as a result of the division of the Mpanda District into three parts (Mlele, Mpanda and Mpanda town).

⁷ In Tanzania all the land has been public since 1923 and is divided into 3 categories according to the Land Act and Village Land Act of 1999 (Akida & Blomley, 2006). There is the reserved land devoted to nature conservation like the FRs, GRs and NPs surrounding Inyonga, the Village Land managed by Village Councils and General Land which is neither reserved land nor village land.

⁸ "Multidimensional Poverty Index is a three-dimensional assessment that represents 10 basic indicators in human development (education, health and standard of living)" (UNDP & URT, 2015, p.4).

years ago, the local population was quite free to harvest resources in the forest because there were few law enforcement and few human pressures. However, traditional activities became progressively illegal, like hunting, or regulated, like beekeeping, fishing or gathering. Anti-poaching patrols have increased since the 90s and thus have limited and sanctioned the use of natural resources by local communities which are often considered illegal now (because they do not have permits for harvesting). Consequently, protected areas are subject to stakeholders' conflicts, especially between the local population and the government managers in charge of these areas. The conflicts concern the boundaries, access and rights, regulation of illegal use, benefit generation and damage by wildlife. Increasing human pressures on ecosystems in village land and protected areas were also noticed by Hausser et al. (2009).

The current situation results from the **socio-economic evolution** of the region. The 19th century in Rukwa Region was punctuated with tribal wars, ivory and slavery trade by Arabs and smallpox outbreak, which reduced considerably the population. The first explorers who crossed the region, such as Stanley or Livingstone, were quickly followed by the Catholic White Fathers and the German colonists in the 1880s (Waters, 2009). Tanganyika became a British protectorate in the 1920s. It was at that time that the Wakonongo, the original tribe of the study area, were displaced from their nomadic settlements in the bush to new villages in the clearing of Inyonga. The British displaced them in order to avoid the impact of the rapidly spreading sleeping sickness (Singleton, 2010). Before this event, Inyonga did not exist at all; it was only a wooded grassland. The Wakonongo kept their hunter-gatherer and slash-and-burn farming lifestyle in their new settlements but were encouraged to develop "modern" agriculture under the British mandate (Hausser et al., 2009). The Wakonongo were massively converted to Catholicism in the 1950s (Singleton, 2010).

Then came Tanganyika independence and the creation of Tanzania. The British indirect rule was replaced by the Tanzanian government which took a socialist turn in 1967 under the self-reliance concept of Nyerere. 1973 and 1974 were the years of *Ujamaa*: the villagization of widespread settlements into socialist villages in order to concentrate the people to make them benefit from farming techniques and public services (Akida & Blomley, 2006). There were other hidden agendas linked to the population control, taxation and the creation of Tanzanian national identity as well. Villages of our study area were rearranged a bit during *Ujamaa* but not radically as they had already been gathered together by the British. Consequently, the biggest changes were not spatial but concerned the governance⁹ and the conversion to socialist cultivated schemes. Having been quite autonomous and respected during colonial times, and even favoured by the colonists after having lost power during the 19th century (Waters, 2009), traditional chiefs saw their power progressively replaced by that of the state. Nevertheless, the Wakonongo were still nomads in the 1980s as Singleton (2010) found Mapili 10 km away from the place he had left 15 years before. In 1985, socialist policy collapsed and was followed by a neoliberal wave which was favoured by intergovernmental financial organisations and multilateral and bilateral cooperation agencies. Most of the public companies were privatised and the state, under donor pressure, had to implement Structural

⁹ Governance is an "integrative process of rule-making embedded in a broader societal process based on social practices, values and principles" (Ingram, Ros-Tonen, & Dietz, 2015, p. 43 based on Wiersum et al., 2013).

Adjustment Programs. The agriculture which was protected and subsidised during Nyerere time was liberalized. Tanzania was therefore included in the “new” globalisation (as we can consider the slavery and ivory trade of the 19th century as a kind of globalisation) and the big free market introduced rapid changes in this society. The East African context had some influence as well, as our study region has received more than 200,000 Burundian refugees since 1972, including 85,000 in the Katumba camp 80 km away from Inyonga (Akarro, 2001).

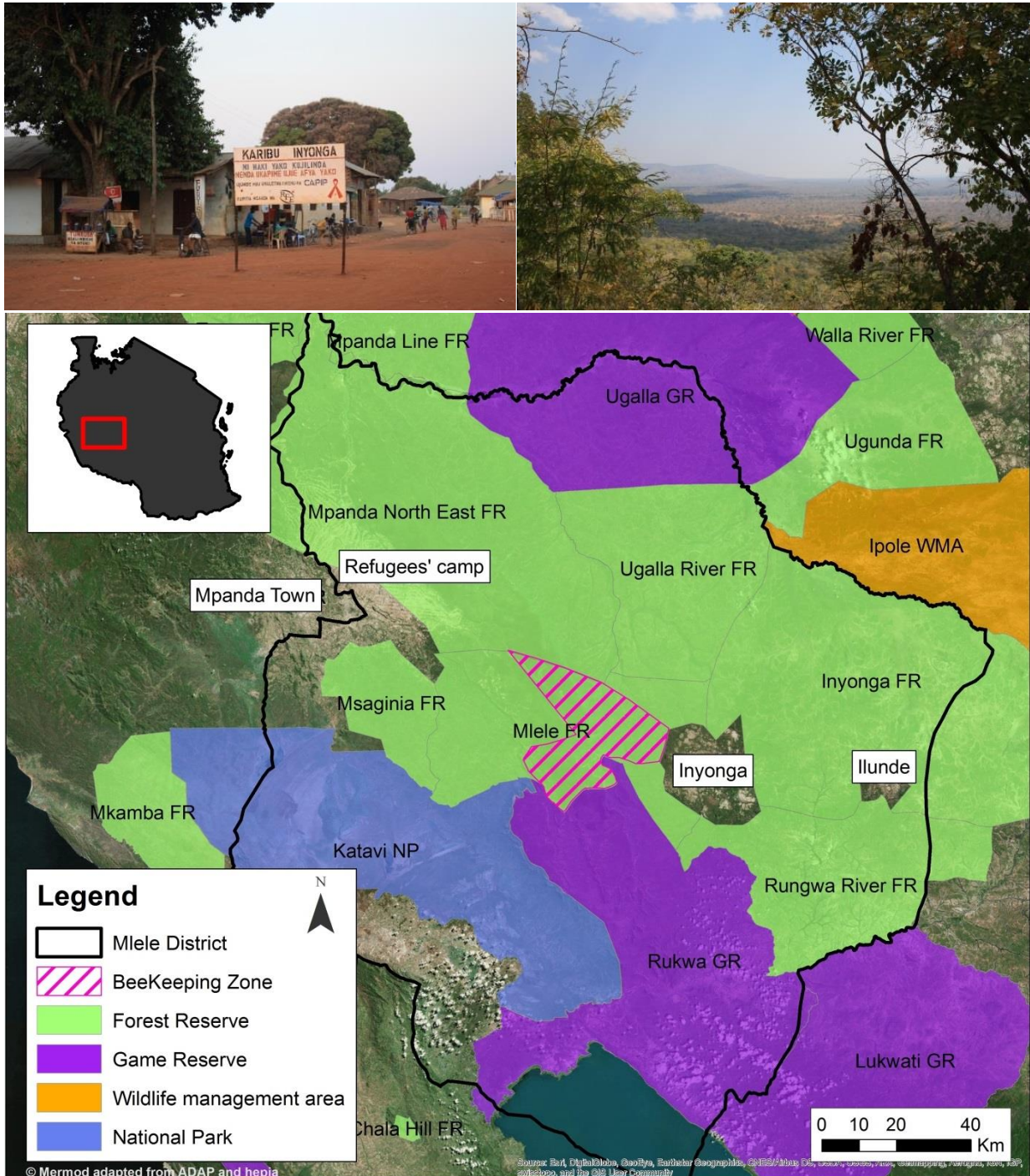


Figure 1 Situation map of the Mlele District with protected areas and introduction pictures of the area.

In the early 2000s, Inyonga was still a small village with nobody in the streets at night, no drugstore, no electricity and wildlife between villages (and sometimes even coming inside). There were few newcomers except some Wasukuma agro-pastoralists who already arrived in

the 70s and some neighbouring Wafipa and Wanyamwezi. Since 2000, Inyonga and its socio-economic context have changed a lot. Now, there are electricity, mobile phones, TVs, bars, traffic, prostitution and no more wildlife is seen. Even since 2012, there have been more new buildings and more traffic. The creation of the Mlele District in 2011 and its settlement in Inyonga in 2013 is partly responsible because it has brought many employees and Inyonga now has to meet some standards concerning infrastructure and communication means to connect Inyonga to regional and national markets. There are many newcomers in the centre of the village (working in shops, bars or guest houses) coming from Mwanza, Shinyanga or Kilimanjaro. A second wave of Wasukuma have been arriving massively for 4 years in the region and have settled outside the villages with their cows. The annual population growth rate of the Katavi Region is 3.2% (URT, 2013). As the village land becomes tight due to population growth, there are also many conflicts concerning land use and management. These socio-economic changes increase the **pressure on the ecosystem** due to a variety of activities: illegal land conversion within protected areas, illegal hunting, illegal logging, charcoal production, use of pesticides or uncontrolled bush fires (Hausser et al., 2009). The degradation has been greater and more visible since 2012, with significant encroachment in FRs and massive elephant poaching for ivory in all the protected areas (ADAP staff observations). The government cannot counter this degradation and in the early 2000s it already admitted that it was incapable of preventing illegal practices in GRs and NPs (MNRT & TANAPA, 2002). This situation is worsened by the poor governance of the natural resources assessed at the national and local level, which contributes substantially to an increase in illegal activities (Nelson & Blomley, 2010). The current situation leads us to suspect that protected areas of the District could be in a more or less open-access situation, and if ecosystem and resource degradation continue, there will be negative environmental, social and economic consequences.

FRs are of particular interest because their management objective is the sustainable use of natural resources¹⁰. Consequently, they should, theoretically, preserve habitats and species while contributing to local livelihoods and generate incomes for the state through fees. As FRs cover more than half of the Mlele District and as they are the first “belt” of protected areas surrounding village land that are subject to human pressures, they are of specific interest to our study. The FRs around Inyonga and Ilunde are national FRs¹¹, managed for productive purposes, which were gazetted between 1950 and 1954, (TFS, 2014). The FRs of Western Tanzania are particularly big compared to other FRs in the country. The creation of protected areas was facilitated by the resettlements due to the sleeping sickness because there were no village in the forests. Until 2011, the Forestry and Beekeeping Division under the Ministry of Natural Resources and Tourism (MNRT) was in charge of the FRs, but since 2011 its operational roles and functions are executed by the Tanzania Forest Service (TFS), a semi-autonomous government agency also under the MNRT. FRs are under the regulation of the 2002 Forest Act and are also influenced by the 2002 Beekeeping Act and the 2003 Fisheries Act. Moreover, Game Controlled Areas (GCAs)¹² overlap FRs and are specifically managed in regards to the

¹⁰ Since they were classified category VI of IUCN protected areas categories (FBD, 2006).

¹¹ The other type of FR is the Local Authority FR managed by district councils (Akida & Blomley, 2006).

¹² GCAs do not have protected area status as they only limit the use of the wildlife resource (leases hunting blocks to a hunting tour operator) and not human settlement or other activities. Furthermore, they can be established

wildlife resource by the Wildlife Division (WD) under the MNRT which implements the 2009 Wildlife Act. Beekeeping, fishing, selective logging, gathering (collection of fire wood and non-timber forest products (NTFPs)), mining and scientific research are possible with permits in FRs. Trophy hunting is allowed through the GCAs and implemented by private companies which have the lease of hunting blocks. Normally resident hunting is restricted to Open Areas on General Land (Wildlife Conservation Act, 2009), but it can also be allowed on GCAs not allocated to companies (which is not the case for GCAs in the Mlele District).

Akida & Blomley (2006) suggest that National FRs, by their management, contribute little to livelihoods and have a limited capacity to protect areas other than valuable forests such as mangroves or plantations. There is no specific data concerning the FRs of the Mlele District which are particularly remote and facing recent socio-economic changes. The only studies about FRs in the region are the ones by Banda et al. (2006) and Gardner et al. (2007) which respectively compare the structure and composition of vegetation and small fauna (small mammals, amphibians, birds and butterflies) between different protected areas. They concluded that the different protected areas are complementary because they harbour different taxon. Caro (1999), on his side, concluded that that FRs harbours a far lower mammal density than Katavi NP. Otherwise, wildlife and habitat surveys in the region were mostly concentrated in strictly protected areas (see for example Kiffner et al., 2009; Waltert, Meyer & Kiffner, 2009; Caro, 2008). The only large amount of data available concerns the Mlele BKZ but as its management is different from other FRs (co-management between IBA and the District formalized through a Memorandum of Understanding signed with the MNRT), we cannot generalize from this case. Several UASWS bachelor theses conducted studies about mammal population in the Mlele BKZ. Hausser et al. (2016) summed up the data collected between 2008 and 2010 and concluded that the Mlele BKZ still harbours an impressive species richness for a “low protected area” with a total of 49 species. They also call for further investigation of the ecological and social roles played by such areas. One study compared the Mlele BKZ with the Rukwa GR but did not reveal significant differences in terms of species richness and capture rates of medium and large mammals, except for the elephant (Mermod, 2012). Only one UASWS master’s thesis studied the wildlife population of another FR, Rungwa River (Stampfli, 2016), and found an interesting diversity of large and medium mammals with a total of 43 species, whereas she only inventoried 37 species for the Rukwa GR. Social studies about livelihoods have been conducted for the communities living in the proximity of Katavi NP (Borgerhoff Mulder, Caro & Msago, 2007), but do not focus on national FRs near Inyonga. Consequently, there is a paucity of data about the social and ecological dynamics of FRs surrounding the settlements of Inyonga and Ilunde.

To simplify the context we could say that FRs are spaces where there are natural resources, regulations and people. According to what we have described above, it seems that the regulations are not respected by the users and thus impact natural resources and ecosystems. Therefore, the initial question of this study could be: Why and under what circumstances do people not follow regulations in Tanzanian FRs and other protected areas?

on Village Land (like most of the GCAs in the North of the country). The particular situation in Western Tanzania is that GCAs have been established on existing FRs, which prohibit human settlement, agriculture and pastoralism.

1.3. COMMON POOL RESOURCE THEORY AND POLITICAL ECOLOGY

The common pool resource (CPR) theory attempts to explain why and how natural resources are sustainably managed or, on the contrary, face overexploitation. A natural resource is considered a CPR if it has low excludability (a difficulty to exclude other potential users) and high subtractability (resource units diminish significantly when one harvests the resource) (Ostrom, 1992). Common property is a management regime not an essential/inherent characteristic of natural resources (Bromley, 1992). For instance, a forest can either be under public, private or common management or even in open-access depending on the level of excludability that can be enforced. A CPR is managed by formal or informal groups of users who have defined mutual rules and rights on a resource and enforced them (Nelson, 2010).

CPR theory emerged in response to the “Tragedy of Commons” of Hardin (1968) who argued that a CPR leads to open-access and that they should thus be managed by the state or private entities. Many authors showed that some common property regimes are functioning very well, sometimes even better than state or privately managed regimes (Persha, Agrawal & Chhatre, 2011). CPR theory examines the links and convergences between resources, institutions¹³, individual choice strategies and outcomes (Oakerson, 1992). The sustainability¹⁴ of a resource’s use is heavily influenced by the maintenance of a collective governance, which itself depends mostly on the self-organization of users and the property-rights regimes (Ostrom, 1992). The property-rights regimes of Schlager and Ostrom (1992) define different bundles of rights, *de jure* or *de facto*, according to the positions of users (represented in Figure 2). They note that alienation rights encourage owners to invest for the resource but do not guarantee a sustainable exploitation. Moreover, some users can use and manage a resource well even if they do not have legal rights like Quinn et al. (2007) noticed for Isele villagers in Tanzania who consider a governmental GCA as a CPR.

BUNDLES OF RIGHTS ASSOCIATED WITH POSITIONS				
	Owner	Proprietor	Claimant	Authorized User
Access and Withdrawal	X	X	X	X
Management	X	X	X	
Exclusion	X	X		
Alienation	X			

Figure 2 Property-rights regimes. Source: Schlager and Ostrom, 1992

CPR theory thus analyses institutional arrangements with the aim of highlighting the context in which they are efficient and lasting. As institutions are the results of political decisions, one needs to understand the political processes backing management and governance if one wants to analyse natural resources exploitation and its outcomes (Nelson, 2010). Ingram et al. (2015)

¹³ “Institutions are the rules, both formal and informal, that govern society and which underpin human economic activities and social interactions [and] provide the substantive basis of governance” (Nelson, 2010, p. 7).

¹⁴ We can understand the sustainability as “ensuring human rights and well-being without depleting or diminishing the capacity of the earth’s ecosystems to support life, or at the expense of others well-being. It is a multi-dimensional concept encompassing environmental integrity, social well-being, economic resilience and good governance: each of these sustainability dimensions involves several issues and all dimensions need to be considered.” (FAO, 2015). Sustainability is often used as a normative concept in natural resources management. However, we do not use the sustainability as a normative concept in this study because it “requires concretisation through a reflexive, participatory and deliberative dialogue between all actors involved” (Rist et al., 2007, p. 26).

use the term “governance arrangements” to speak about the different configurations which govern the value chains of NTFPs in Cameroon. This term is broader than institutional arrangements as it also covers, in addition to institutions, the interactions between actors, principles, mechanisms, policies and processes of rule-making. The interdisciplinary field which could shed light on the political processes in order to understand the causes of environmental degradation is political ecology. This normative approach analyses the contextual and inextricable human-environment relationships within broader systems and at different scales (Robbins, 2012; Benjaminsen & Svarstad, 2009; Zimmerer & Bassett, 2003a). Political Ecology argues that environmental and social changes are produced by political processes and explores more sustainable ways to manage these changes, *“thus political ecology narratives typically track the historical processes, legal and institutional infrastructures, and socially implicated assumptions and discourses that typically make unjust outcomes the rule, rather than the exception.”* (Robbins, 2012, p. 87).

Political Ecology emerged in the 70s and became known in the 80s with a study about soil erosion which used a multiscalar chain of explanation (from local to global) and went further than the previous cultural ecology approach (Benjaminsen & Svarstad, 2009). The authors of the study (Blaikie & Brookfield, 1987, p. 17) explain that political ecology *“combines the concerns of ecology and a broadly defined political economy. Together this encompasses the constantly shifting dialectic between society and land-based resources, and also within classes and groups within society itself”*. Political ecology is a wide approach and its initial structuralist branch has evolved a lot since its beginning and that has led to division between structuralist and post-structuralist authors (Benjaminsen & Svarstad, 2009). The latter are more focused on the analysis of the narratives as objects and use concepts such as *governmentalities* and *environmentalities*. What the branches have in common, however, is that they are preoccupied by the environment and their related populations. That is why Blaikie (2012) argues that the goal of environmental justice is widespread among political ecologists. Additionally, Robbins (2012) claims that political ecology goes even further than the concept of justice by understanding to what extent the outcomes are not accidental but intentional and recurrent.

Political ecology refutes statements of “apolitical ecology” in regards to direct links between population growth and environmental degradation (neo-Malthusianism) and also refute the modernization explanation which declared that technology and modern management can solve environmental degradation (Robbins, 2012). Another pre-given explanation which should be avoided is the automatic and simplistic accusation of capitalism (Benjaminsen & Svarstad, 2009). Political ecology is a core integrated approach for empirical studies about the environment and/or development especially in geography (Benjaminsen & Svarstad, 2009). A geographical approach takes the politicized environment into account but puts a particular focus on biophysical and social components as well. That is why, as it aims to be at the edge between ecology and social sciences, it incorporates more ecological analysis than other political ecology approaches (Zimmerer & Bassett, 2003a). Concerning our domain of natural resources and protected areas, political ecology’s role is growing in the analysis of conservation strategies and their social and environmental outcomes worldwide. The political dimensions of conservation, especially protected areas’ strategies, are studied for different periods (colonial context, central state domination and the neoliberal environmental policies

with NGOs and the private sector) and from different perspectives (rights and access, power of state, narratives, role of natural sciences, conflicts, etc.) (Adams & Hutton, 2007).

International Union for Conservation of Nature (IUCN) defined a protected area as “*a clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long term conservation of nature with associated ecosystem services and cultural values*” (Dudley, 2008, p. 8) There are 6 categories of protected areas which correspond to the degree of human intervention¹⁵. Protected areas can thus be seen for their operational management aims, like IUCN does, or as a social production. Geographers see protected areas as a space¹⁶ (*espace* in French) involving a social dimension beyond the simple spatial area (because it includes notions of dimension, distance, extent and duration) (Laslaz, 2014). In the same line, Vandergeest and Peluso (2015, p. 162) made a substantial contribution to the study of forests when they coined the term of “political forest” which “*highlights the socio-political dimensions of forests*” which links a forest to its land use designation (by state) and not to ecological conditions. Consequently, a cleared land can still have the legal status of a forest and be managed accordingly, while, on the other hand, a land with trees could not be considered a forest if it is not legally classified as a forest or if the planted species do not correspond with a pre-established list. The aim with land categorisation is thus to clearly differentiate agricultural land from forest land and to not allow an overlap. This situation often leads to intersectoral conflicts among the states’ agencies (especially agriculture and forestry) and with the local population (Vandergeest & Peluso, 2015). Moreover, political forests have a long tradition (begun in colonial times and followed by independent states and non-governmental actors) of exclusive management by professional foresters who are considered to be legitimate due to their scientific knowledge and commitment to the “common good”.

1.4. CONSERVATION STRATEGIES IN TANZANIA

While there were only 10 million inhabitants in 1960, Tanzania counted some 51 million in 2014 for a terrestrial area of 883,749 km² (World Bank, 2016). Terrestrial and marine protected areas cover 26.1% of the 947,300 km² territory (including water areas). The core of the terrestrial protected areas network is composed of 16 NPs, 27 GRs¹⁷ and the Ngorongoro Conservation Area. These state-controlled protected areas foster a flourishing tourism industry in Tanzania (hunting and visual tourism) with international tourism receipts exceeding \$2 billion in 2014 and more than 1 million visitors (World Bank, 2016). In 2014, tourism indirectly employed 12% of the population and represented 5% of GDP (WTTC, 2015). On the other hand, most of the protected areas restrict the presence and activities of local communities.

¹⁵ Protected areas are categorized by IUCN according to their management objectives in order to use adapted tools, define the activities allowed and facilitate comparison between sites (Dudley et al., 2008). Categories I to IV are considered as strict protection because they are dedicated to nature protection and categories V and VI have a multiple use strategy. Protected areas are characterized according to their governance as well (governmental, shared, private or communities).

¹⁶ A protected space is a “*étendue socialement investie de valeurs, délimitée, bornée [...], pouvant comporter plusieurs “zones” indiquant un gradient de mise en valeur du territoire et au sein desquelles les pouvoirs publics [...], des particuliers ou des associations, décrètent des mesures de protection [...], en s’appuyant sur des législations et des réglementations*” (Laslaz, 2014, p. 11).

¹⁷ This number is not confirmed as there are frequent status changes and but no recent updates or maps.

This places an additional stress on local communities as 64% of Tanzania's population is considered poor by the Multidimensional Poverty Index and still relies substantially on these resources for its livelihoods (UNDP & URT, 2015). Social impacts of protected areas which began during the colonial era were largely confirmed in the 70s (Adams & Hutton, 2007) but, injustice through population displacement or restricted rights of access is still characteristic of many protected areas, especially in "developing countries" (Brockington, 2004).

Before colonial times, all of Tanzania's land was considered common property and managed by local communities. Natural resources, especially wildlife, were controlled and centralised since the beginning of the 20th century. The first hunting regulations were decreed in order to counter the massive wildlife decrease due to rinderpest epizootic and then the first reserves were established in 1905 by the Germans (Nelson, Nshala & Rodgers, 2007). The centralisation of the control over wildlife, for hunting, trade and asserting colonial power, was pursued under the British mandate with the first gazetted GR, Selous, in 1922. Then, NPs, where inhabitants and consumptive activities are not allowed, were established to match the Western vision of wilderness (Neumann, 2003). In 1923 all the land of the Tanganyika was declared public (Akida & Blomley, 2006). Customary land rights were still given to communities, but they vanished over the years, especially after Independence¹⁸. When most of the Sub-Saharan African countries gained independence, governmental control over natural resources and central management were reinforced. The maintenance of strict conservation and its expansion was largely supported by foreign donors to whom huge funds were allocated in order to conserve the wildlife after the departure of the colonists (Nelson et al., 2007). The expansion of protected areas owned and managed by the state with little or no rights for the local populations has created few incentives for them to manage natural resources in a sustainable way. As the state does not have enough means (even with donors funds) to ensure their management against a rising human pressure, this has led to open access conditions in many protected areas (Nelson & Blomley, 2010; Akida & Blomley, 2006). Moreover, resources are often exploited by outsiders and this can lead to the impoverishment and disempowerment of traditional local populations like those living in Kafue Flats in Zambia (Haller & Merten, 2006).

However, conservation theory and practice witnessed increased participation from the local population for the management of natural resources in the South which began in the 80s (Nelson & Blomley, 2010). The introduction of the community-based natural resource management¹⁹ (CBNRM) approach in conservation practices has been favoured by many different factors. First, ideological factors, which were perhaps the least influential for the implementation of CBNRM, made civil society aware of the poverty and social injustice provoked by protected areas and the replacement of the modernization theory by the sustainable development concept (Dressler et al., 2010). CBNRM was thus seen as a means to reduce poverty and injustice. Secondly, the conservation world ascertained that the management of the strict and centralized protected areas was a failure. They were influenced by the paradigm shift in ecology which recognised complex interactions between ecosystems

¹⁸ For more information about colonial politics in Tanzania, see Weber (2013, pp. 35-39).

¹⁹ "Community-based natural resource management [is] a term to describe the management of resources such as land, forests, wildlife and water by collective, local institutions for local benefit. CBNRM takes many different forms in different locations and different socio-political and bio-physical contexts." (Roe & Nelson, 2009, p.5).

and humans and the value of local knowledge (Dressler et al., 2010; Berkes, 2004). By highlighting the performance of local institutions in the management of natural resources, CPR researches also contributed substantially to the CBNRM (Nelson, 2010; Berkes, 2004). Biologists became aware that they needed to secure the livelihoods of local populations and, following the principle which claims that people use resources more sustainably when they have rights or financial incentives to conserve them (Kajembe, Nduwamungu & Luoga, 2005), include people in their conservation projects in order to minimize the failures (Adams & Hutton, 2007). Besides this, CBNRM was also seen by biologists as a means to extend and diversify the protected areas network which was insufficient to conserve biodiversity with the strict areas only (Nelson et al., 2007). Lastly, from a more political and economic standpoint, the neoliberal wave which followed the economic crisis of the 70s played a key role for the implementation of CBNRM, as it was in line with the structural adjustment programs imposed to developing countries (Nelson, 2010). The CBNRM approach was thus mainly supported by multilateral and bilateral donors, who pushed the government to undertake reforms.

In such a context, Tanzania had to diversify its conservation strategy. The first CBNRM initiatives appeared through pilot projects of bilateral donors and NGOs, and the first policies were implemented in the mid-90s (Kajembe et al., 2005). Currently, several configurations are defined by the laws, according to the sector (Wildlife, Forest and Beekeeping) and the land tenure (summarized in Table 1). Wildlife Management Area (WMA), Bee Reserve and Village Land Forest Reserve (under community-based forest management (CBFM)) consist of the creation of new protected areas on village land managed by local organisations. In regards to reserved land, the only possibility offered by the legislation is co-management between an association or local authorities and the central government for the FRs (national and local authority) under a Joint Forest Management (JFM) or the delimitation of a Beekeeping Zone. In 2008, 12.8% of the 34.6 million forested lands in Tanzania were under CBFM or JFM, which compose the Tanzanian Participatory Forest Management (FBD, 2008). This Participatory Management aims to improve the forest quality, the livelihoods and the forest governance at the village and District levels (Blomley et al., 2008).

Table 1 CBNRM configurations in Tanzania. Source: Nelson & Blomley, 2010; Beekeeping Act, 2002.

	Village land	Reserved land
Forest Act, 2002	Village Land Forest Reserve under Community-Based Forest Management	Forest Reserve under Joint Forest Management
Beekeeping Act, 2002	Bee Reserve	Beekeeping Zone inside Forest Reserve
Wildlife Conservation Act, 2009	Wildlife Management Area	N/A

Globally, after more than 20 years of implementation, many authors criticise CBNRM approaches and their outcomes in Tanzania. These initiatives are falling short of expectations when it comes to the amount of areas effectively managed under CBNRM regimes and remain unsatisfying in regards to socio-economic and political outcomes in terms of power transfer and revenue generation for local communities (Nelson & Blomley, 2010). The state gives back neither benefits nor land and resource ownership of currently protected areas to local communities and provides little guarantee of rights and access to resources (Nelson & Blomley, 2010; Kajembe et al., 2005). The objective of poverty reduction through CBNRM thus does not

seem fully achieved. Alden Wily & Dewees (2001) conclude that even if Tanzania is going further that its neighbours in terms of rights, there should be more incentives for the communities to be active managers and they should thus be fully involved in decision making. CBNRM principles are not completely implemented because natural resources revenues (especially wildlife) are very lucrative for the central state which does not want to leave them (Benjaminsen, Goldman, Minwary, & Maganga, 2013; Songorwa, 1999). Some authors even see a kind of recentralisation and reconsolidation of state control on wildlife under the cover of CBNRM because regulations place many new constraints on communities and involve many state decisions (Benjaminsen et al., 2013; Nelson et al., 2007).

National FRs owned and managed by the central government cover 35% of the Tanzanian forested lands, representing 12.3 million ha²⁰ (Akida & Blomley, 2006). Tanzania lost 8 million hectares (representing 19.4%) of forest cover between 1990 and 2010 and FRs are not spared by degradation (FAO & FFP, 2013). There are very few integrated studies about degradation linked to resource uses inside FRs harbouring miombo woodland. Most of the studies focus on coastal or mountain forests (such as Kimaro & Lulandala, 2013) or focus on only one aspect of the miombo like Sawe, Munishi & Maliondo (2014) who studied the physical degradation of miombo in Southern Tanzania. One study focused on two FRs in the neighbouring Tabora Region and found significant degradation due to encroachment which was influenced by socio-economic, political and biophysical factors (Majule et al., 2010). On their side, Lund and Treue (2008, p. 2794) "*believe that decentralized forest management generally constitutes a positive development for the villagers*". Blomley et al. (2008) found that forest conditions improved and that there were less destructive human activities in forest under participatory forest management, even for joint forest management which was accused of not delivering enough tangible benefits for communities. However, they call for more research about the achievements of participatory forest management objectives, especially concerning the livelihoods and local governance. Actually, miombo woodlands are of great importance for local livelihoods as they provide products (fuelwood, fruits, mushrooms, insects, honey, timber, etc.) which support rural means of living especially during food shortages in the dry season (Abdallah & Monela, 2007). Quinn et al. (2007) drew attention to the fact that there are few studies about the local (formal and informal) institutions in Tanzania managing natural resources and further investigations should be conducted on the CPR design principles and the ecological and social outcomes. After an outcomes analysis of the CBNRM project of ADAP in terms of power relations and *environmentalities*, Weber (2013, p. 76) highlights that "*To identify the group concerned and the reason for not participating or consenting in natural resources conservation and management would provide useful information on their perception of nature and the complexity of the local context.*" All these elements call for more research about conditions under which people harvest natural resources inside low status protected areas such as FRs and the links with the outcomes and broader politico-economic systems. Moreover, De Vries (2005) emphasises the need to have a more cultural-historical approach for baseline studies from conservation projects which only focus on ecological and social conditions and leave out the culture and politics. This study could thus provide some constructive elements that could serve as a foundation for a baseline study for ADAP's project.

²⁰ Or 14.3 million ha if one adds Local Authority FRs.

1.5. RESEARCH QUESTIONS AND HYPOTHESES

A sustainable use of natural resources depends on the balance and relations between the rules, the users and the resources. However, suitable regulations and their respect do not necessarily avoid degradation since broader economic and political contexts influence the conditions of the resources management. This master's thesis aims to answer the research questions: **1) What are the factors which influence the governance arrangements of the Mlele District FRs and 2) under which conditions could CBNRM approaches lead to more sustainable outcomes?** The following specific questions need to be addressed to answer them:

- Which strategies are used to generate incomes from the natural resources of FRs?
- What are the social and ecological effects of these strategies?
- What kind of internal and external dynamics influence the management of FRs?
- To what extent could CBNRM approaches allow for changes in the system and ensure social justice and sustainable use of natural resources?

According to what we have seen in the literature review, different hypotheses could explain the current regulations of FRs and their outcomes:

- * The FRs are degraded because of an open-access situation: *“when ownership is vested in the state unless there is adequate enforcement and monitoring of the rules, state property often ends up as open access with the resultant overuse and degradation”* Quinn et al. (2007, p. 101).
- * The local users cannot self-organise to manage resources because they do not have recognised rights and sufficient means to counter the high human pressures (Ostrom, 2009). Local users have no power in the current governance arrangements.
- * The existing Tanzanian CBNRM framework, as defined by policies and legislations, does not give enough rights and incentives to local communities to manage the resources in a sustainable way (Nelson & Blomley, 2010).
- * It is not the poorest who degrade the resources and benefit from it. There are underlying political processes which favour powerful actors at both the local and national levels (Robbins, 2012).
- * The introduction of CBNRM for Mlele District FRs does not guarantee legal certainty and central and local government bodies will resist letting go of power and its associated rent caption opportunities (Benjaminsen et al., 2013).

The objective of the present study is to understand the effective functioning of the FRs governance by studying relationships between resources, rules and users. The object of the study is the **National FRs** managed by the government which surround the village lands of Inyonga and Ilunde. As the Mlele BKZ is a specific area which was already documented by other studies, we will not focus on its management and ecological conditions and it will be used more for comparison. The same goes for village land, whose activities and governance will be taken into account in the analysis but not studied extensively, as it could be a single object of concern and goes beyond the scope of this work. The natural resources analysed for this study are **timber, wildlife, fish and honey** because they are the main harvestable resources authorised in the FRs of the Mlele District with significant social and economic stakes.

1.6. CONCEPTUAL AND ANALYTICAL FRAMEWORK

As this study seeks to understand the social and environmental outcomes generated by the FRs, it is undertaken within the **political ecology** field using a geographic approach which focuses on human-environmental interactions and the scales of analysis (Zimmerer & Bassett, 2003a). Moreover, political ecology seems particularly pertinent for a study with an objective of action, as it helps to build a bridge between conservation planners (natural science based) and social rights defenders (social science based) (Adams & Hutton, 2007). We use Vandergeest and Peluso's (2015) concept of "political forests" for the FRs because they are produced by politics and institutions which attribute to them a specific land use and a protected area category. Ecologically there is no difference between forests of a GR, a FR or a village land. It is only the legal status which changes their management, their uses and their perceptions. A strong post-structuralist focus does not seem to be relevant for our study if one wants to share findings outside the academic world and highlight practical changes to reduce inequalities (Blaikie, 2012). A critical realist political ecology approach is thus more useful in a development context and for the purpose of communicating with other actors. This study focus on access and control over resources, relationships among actors, power²¹ and the influences of global processes and structures in order to reveal the winners and the losers and the hidden costs of the governance system of FRs. Narratives at national and international levels about protected areas were not studied as they are well documented in the literature (Brockington & Igoe, 2006; Green & Adams, 2015; Neumann, 2001) and it would have been beyond the scope of the masters' thesis.

Since political ecology is not a theory in itself, we need to combine it with some related theories such as the **CPRs** theory which appears particularly adapted for understanding the dynamics leading to natural resource degradation by analysing institutions and their interactions with users and resources. CPRs theory is considered as "*one of the first and most essential contributions to a contemporary political ecology*" (Robbins, 2012, p. 51). The contribution is mutual as political ecology can also be useful to study conflicts in the commons. As main natural resources of FRs such as timber, wildlife, fish and honey have characteristics of a common resource²², the CPRs theory seems particularly appropriate for understanding how the outcomes are produced in these areas, even if the resources are supposed to be owned and controlled by the state. Moreover, Quinn et al. (2007) argue that many natural resources in Sub-Saharan Africa are still managed as common pool resources even if they are not common property and Nguingiri (2003) argues that the governance of protected areas is often made of legal and informal rules and that it is important to study both.

One of the useful concepts of CPRs is Ostrom's "social-ecological system" (SES) (2009) which aims to represent the complexity of human-environmental relationships. For this concept she proposes an interdisciplinary analysis oriented framework to organize the different findings in order to evaluate the sustainability. The key component is the emphasis on the importance of

²¹ Lachapelle, Smith and McCool (2004, p. 3, based on Agrawal and Ribot (1999)) define the power as "*the ability to influence processes by which individuals create rules, make decisions, implement and ensure compliance, and adjudicate disputes.*"

²² Resource units decrease when users harvest it and others users' access cannot be physically exclude.

relationships and interactions between different levels and scales (Bal, 2014). The SES framework takes over and completes CPRs findings, as, for instance, the analytical framework of CPRs (Oakerson, 1992), the users' organisation (Ostrom, 1992) and the property-regimes (Schlager & Ostrom, 1992). This framework is composed of first-level core subsystems (resource units, resource system, governance system, users, interactions, outcomes, related ecosystems and the social, economic and political settings) and their relationships. For each sub-system, there is a list of second-level variables (represented in APPENDIX 2). Among these, Ostrom (2009) highlights ten variables which affect the likelihood of users to self-organize because they impact the perceived benefits and costs of a resource's management.

According to Binder et al. (2013), variables of the SES framework conceptualise the dynamics of the social and ecological systems where each one is treated equally. The ecological system is represented from an anthropocentric perspective, from local to regional scales. The social system is characterised by governance and users at all hierarchical levels, with micro and macro interactions. Interactions between social and ecological systems are conceptualised by human activities which affect the ecological system and may cause externalities on the social system. The interactions go in both directions as rules impact and are impacted by the resources' conditions. The SES analytical framework is in line with political ecology's mode of explanation, described by Robbins (2012, p. 20), *"that evaluates the influence of variables acting at a number of scales, each nested within another, with local decisions influenced by regional policies, which are in turn directed by global politics and economics."* The concept of SES and its related analytical framework have helped us design and organize our analysis of FRs as a theatre of interactions between different sub-systems. However, we do not consider the SES framework as a blueprint because it is too general to explain outcomes (Bal, 2014; Epstein et al., 2013). Moreover, the system can be "sustainable" even if all the principles are not met (Quinn et al., 2007).

We have applied these concepts and frameworks to create an **analytical framework for the FRs**. We consider that the FRs of the Mlele District are political forests harbouring a social-ecological system and we have represented them with a diagram (in Figure 3) in order to understand how the current system works and highlight the main components to analyse. All the core subsystems of the SES framework will be examined but it is not possible to study them in detail because the subject is too wide for this study (requiring analysis about international politics, applied ecology, narratives, etc.). Moreover, some data are already available in the literature like the historical and external influence on Tanzania's institutions (Green & Adams, 2015) or the ecological characteristics of miombo woodland and its resources (Frost, 1996). Consequently, we focus mainly on local components of FRs: the conditions and uses of natural resources, the rules followed, the motivation of stakeholders and their interactions among themselves and with larger systems.

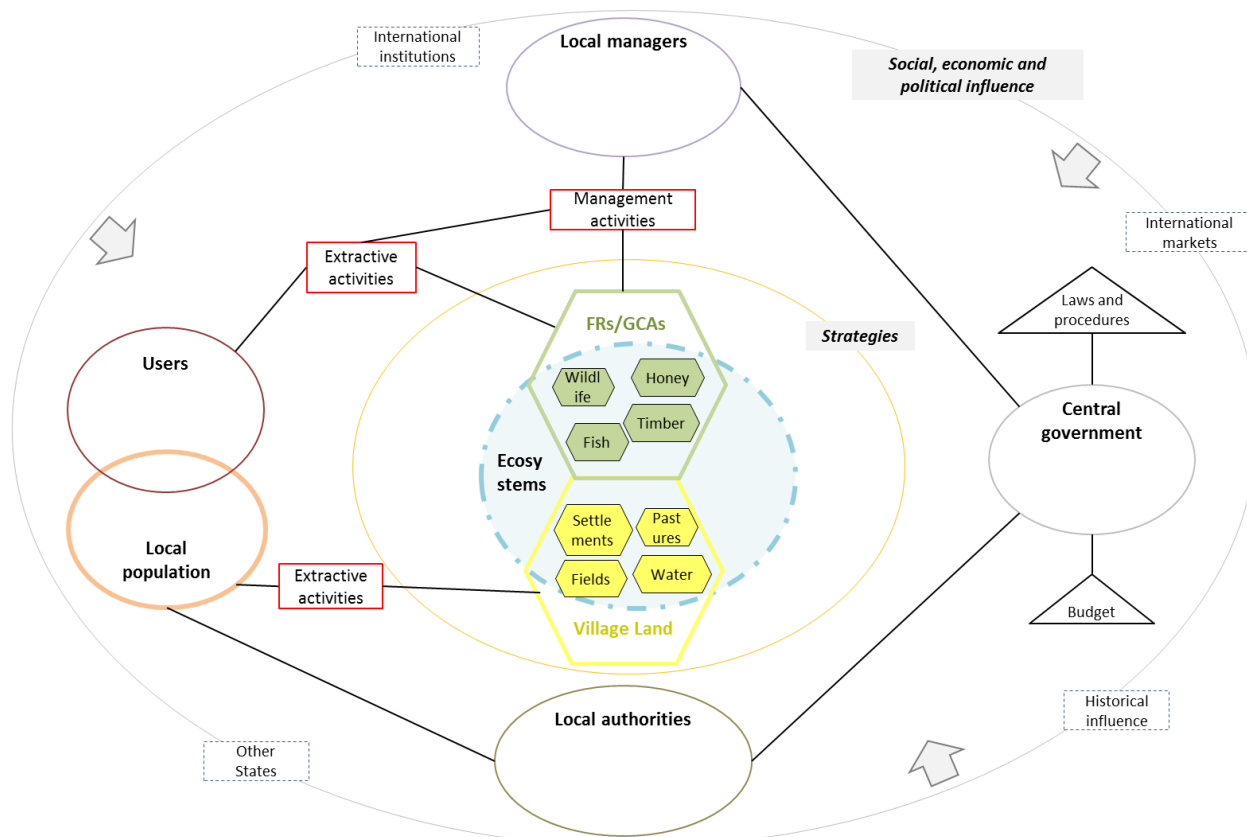


Diagram inspired by Ostrom, 2009; Robbins, 2012; Turner, 2003

Figure 3 Diagram illustrating the social-ecological system of the FRs.

The ecosystems which are politically and legally qualified as FRs or village land, each governed by *de jure* and *de facto* rules, are found in the middle of the diagram. Local populations and external people use the natural resources of these two features through extractive activities. Local managers undertake management activities and local authorities²³ supervise village land in its administrative divisions. These two bodies are of course linked to the central state through legal, financial and power relations. We added external influences that we found in the literature review, like international organisations, other states (bilateral cooperation, relationships, problem in neighbouring countries), international markets (tobacco, timber, ivory, mining) and the historical influence of colonisation (wilderness vision, laws, etc.). This diagram is only a way to present and analyse the use of natural resources in FRs, among many others, and thus is not exhaustive.

The FRs and the resources they harbour represent the resource system and the resource units defined by Ostrom (2009). The governance is illustrated through the relationships and decision making processes between users, local managers, local authorities and the central government. The interactions are represented by the different lines and the social, economic and political settings by the grey circle surrounding the whole system. The analysis of the interactions between all the sub-systems and at different scales will require contribution from political ecology. As Turner (2003, p. 164) points out for his study regarding the particular case

²³ Local authorities concern here the Village, Ward and District levels which consist of elected bodies (such as chairmen and village councils) and appointed executive civil servants. For more information see Brockington (2008).

of grazing, “by extending lines of causation through management practices to the broader political economy, political ecological analyses can identify a wider range of policy initiatives influencing grazing patterns than can conventional environmental assessment”. We could see in the diagram a kind of chain of explanation which aims to draw interactions between the components and contextual constraints (Robbins, 2012). However, as the chain of explanation of Blaikie and Brookfield was criticised because of its hierarchical pre-given scales from the local to the global, which do not allow us to establish causes (Rangan & Kull, 2008), we have tried to avoid a vertical diagram to show that elements are embedded instead of hierarchical.

In addition to the above concepts, the concept of sustainable livelihoods was used to describe the local population and its extractive activities. This concept is important in order to reveal the multi-dimensionality of rural means of living (Zoomers, 2008). “A livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a means of living” (Chambers & Conway, 1991, p. 6). The sustainability of a livelihood is assessed through its recovery (which does not impact assets or destroy natural resources) from shocks. One of the critics of this concept is that it neglects the structural limitations that poor people face (Zoomers, 2008). That is why we will only use part of the sustainable livelihoods framework to describe elements of the analysis and not the whole concept. The framework of the Department for International Development (DfID, 1999) is presented in APPENDIX 3. The most interesting part for our study concerns the livelihood assets which comprise 5 different types of capital which are all linked together. These are the human (health, skills and education), social (networks, leadership), financial (sources of incomes, savings), natural (land, water, natural resources) and physical (houses, goods, public infrastructures) assets.

The main **dimensions** that FRs’ analytical framework integrates are the institutional, social, ecological and political ones. This study uses a realistic approach of the rights since it focuses on what occurs in the field and does not analyse the legislation. We also have the spatial dimension which is represented by the geographical scales of the study. The scales used to analyse ecological and social changes and their effects are very significant and should be chosen carefully because a scale is socio-environmentally produced (Rangan & Kull, 2008; Zimmerer & Bassett, 2003a). Thus a scale is not static and should not be used as a method only because it has effects on the way one sees environmental problems and policies. Zimmerer & Bassett (2003b) suggest going beyond locally, regionally, nationally and globally pre-established scales to analyse human-environment relationships. They think that “*future political ecological research might consider how ecological scale interacts with socially constructed scales to produce distinctive environmental geographies.*” (p. 289). The present study takes the socially produced scale of FRs which is neither local nor regional but in between due to the large surface areas of FRs when compared to village scale. This FRs scale does not correspond to ecosystem scale as the boundaries were not fixed regarding ecological conditions. Even if the present study focuses on the FRs scale, we try to have a multiscale approach by taking villages, regional and national influences into account. The temporal scale should concern ecosystems, resources, uses and governance as the changes which have occurred are important to understand and assess the present situation.



Miombo woodland



Mbuga with the escarpment in the background.



Iloba River (semi-permanent river)



Rungwa River (permanent river)



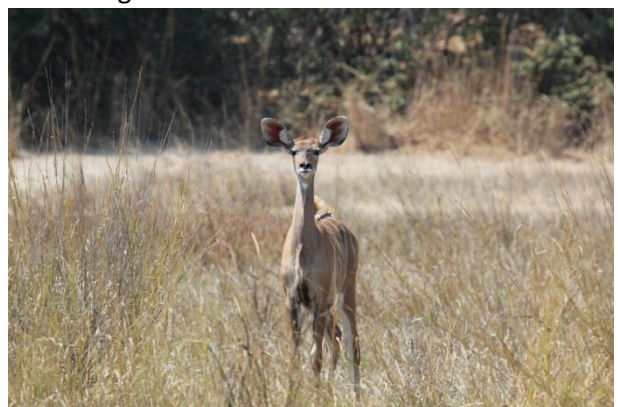
Bush fire during the dry season



Wooded grassland



Hippos in Koga River (permanent river)



Female of greater Kudu in the Inyonga FR

Figure 4 Pictures of the study area habitats.

2. MATERIAL AND METHODS

The physical characteristics of the study area and the methods used to collect ecological and social data to answer the research questions are presented in this chapter. The last section is devoted to describing and accounting for data collection problems.

2.1. STUDY AREA

The study area comprises 4 of the 6 FRs of the Mlele District, which are the Inyonga FR (6056 km²), the Mlele FR (2350 km²), the Rungwa River FR (2128 km²) and the Ugalla River FR (2095 km²)²⁴. The Mlele BKZ overlaps 850 km² of the Mlele FR and is thus included in the study. The FRs surround Inyonga, its twelve villages (Ipwaga, Kamalampaka, Kamsisi, Kanoge, Kaololo, Mapili, Masigo, Mgombe, Mtakuja, Nsenkwa, Utende, Wachawaseme) and Ilunde. These villages are the constituent units of the Inyonga Division²⁵ which had 34,698 inhabitants in 2012 (URT, 2013). The study area, which is circled in red in Figure 5, represents 13,270 km² (a full-page satellite image is available in APPENDIX 4.). Its central coordinates are -6.60, 32.20 decimal degrees. The refugees' camp of Katumba was not included in the study area as it is more linked to the villages on the Mpanda side and it would have required too far-reaching social research.

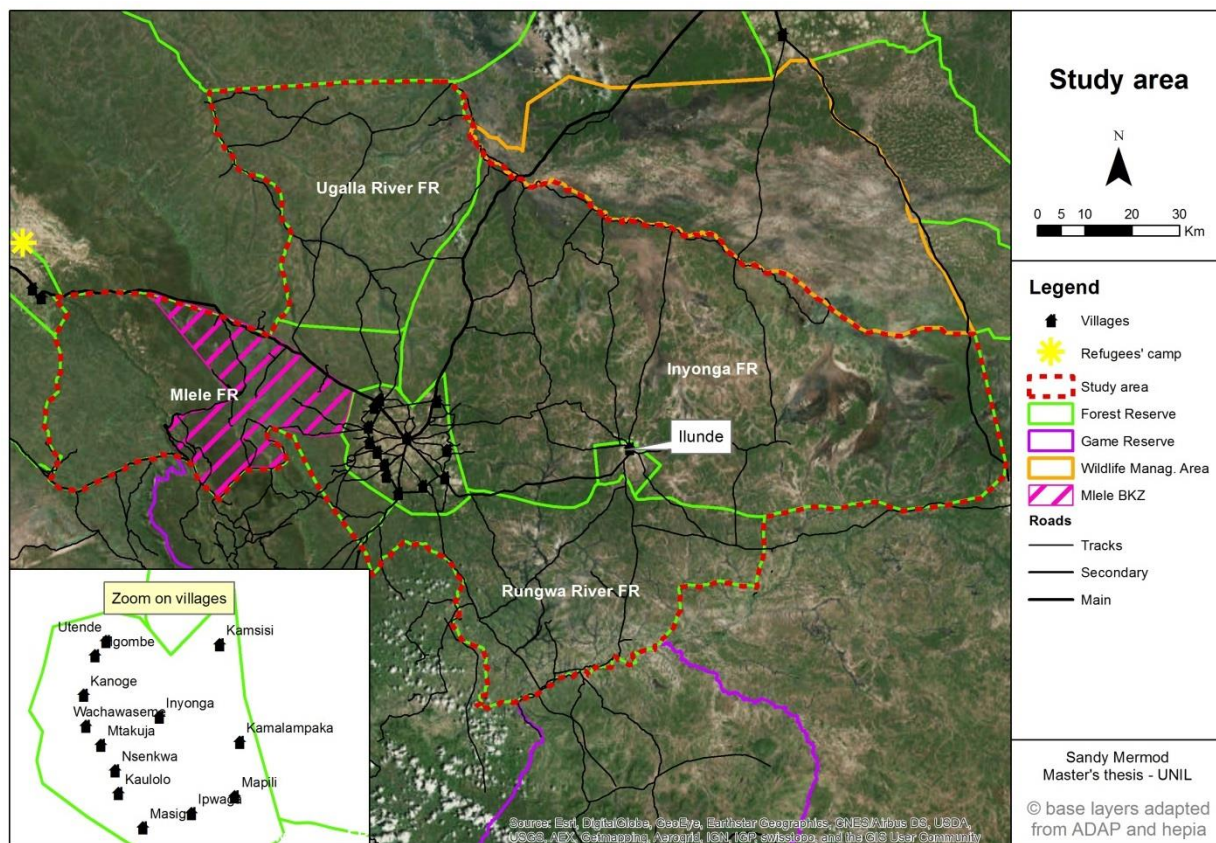


Figure 5 Map of the study area.

²⁴ The names of the corresponding GCAs are: Ugalla River FR->Msima East GCA; Mlele (Hills) FR -> Mlele North GCA; Inyonga FR -> Inyonga E, C, W GCAs; Rungwa River FR -> Rungwa River GCA.

²⁵ A Division is a part of a District. Inyonga is one of the three divisions of Mlele District, corresponding to Mlele council.

As this area is located in the Rift Valley there is an escarpment whose plateaus culminate at 1700 m, a high variation in altitude compared to the plains which are at 800 m (see topography and hydrography map in APPENDIX 5). The rainy season occurs from November to April (600-1200 mm of precipitation) and the dry season from May to October (Banda et al., 2008). Water resources decrease during the dry season which results in the drying up of temporary rivers. At the end of October water can be found only in the main rivers, like the Rungwa and Koga. The main habitat covering the study area is miombo woodland, a kind of dry deciduous forest with a high representation of the *Fabaceae* family. Other habitats comprise floodplains (called locally mbuga), mixed bushland, wooded grassland and riverine forests (Banda et al., 2008; MNRT & TANAPA, 2002). See pictures in Figure 4. Miombo woodland is not the most productive habitat in terms of biomass because vegetation regeneration is quite low due to the poor nutrient soils and limited rainfall (Frost, 1996). However, when there is a mosaic of habitats within it, miombo offers a high density of ecological niches for animal populations. If the conditions are favourable, the replacement rate of resources, such as fish, bee or small mammal populations, can be fast. Miombo harbours cohorts of large ungulate species adapted to miombo vegetation (elephant, buffalo, hartebeest, sable, roan) and large predators (lion, wild dog, leopard and jackal). There is thus a great diversity of species, but they are at low densities due to how difficult it is to find food and water during the dry season in pure miombo habitats. Fire is inherent to the miombo woodland and its impact depends on the time of year and the fuel material available: fires occurring at the end of the dry season are more damaging to trees than the ones earlier in dry season (Frost, 1996). Even if there are many dynamics occurring in miombo and some seasonal cycles, it is quite a stable ecosystem (when free from human disturbance).

Human infrastructures within the FRs are fairly limited (represented in the map in APPENDIX 6). They include the Mlele Headquarter, trophy hunting camps with their airstrip (named Msimu, Ipenyero, Shama, Mlele), IBA's camp, beekeepers' camps, primary roads (without asphalt; e.g. Tabora-Inyonga and Inyonga-Mpanda), secondary roads (without asphalt e.g. Inyonga-Ilunde) and hunting tracks. The four FRs are included in the Katavi-Rukwa ecosystem, an extensive protected area network for which the Katavi NP is the core area (see Figure 1). Katavi only allows visual tourism and is managed by Tanzania National Parks (TANAPA). The Rukwa GR is located in the west of our study area and is devoted to trophy hunting and villagers are allowed to practice a few activities in certain defined areas such as beekeeping or fishing. It is managed by the WD only. Two other GRs border our study area, Lukwati and Ugalla. Neighbouring FRs are Msaginia, Mpanda East and Ugunda. There is also Ipole WMA to the north of Inyonga FR.

2.2. METHODS

Due to the different types of data collected (ecological and social), the study combined methods and concepts from several fields such as conservation biology, geomatics, geography and social sciences. Such integrated methods borrowed from many fields are often used by political ecology researchers (Zimmerer & Bassett, 2003a). Even if it is essential to go over the natural sciences' analysis of conservation biology (Adams & Hutton, 2007), we considered it important to collect primary ecological data because most of the studies about SES collect

ecological data through interviews or secondary data only, and several authors deplore the lack of primary data and ecological knowledge (Epstein et al., 2013; Lund & Treue, 2008). The methods chosen for this study were based on different studies concerning community management and ecological effects of governance and combining qualitative and quantitative data (like Bottazzi & Dao, 2013; Ingram et al., 2015; Lund & Treue, 2008; Quinn et al., 2007). The methods are presented in the sections below, grouped by type of data, ecological or social. The data collection strategy prepared before the field work can be found in APPENDIX 7. The field document collection and literature review could also be considered part of our methods because they contribute to the results and analysis. Documents collected in the field are of varying types: local statistics about natural resources, grey literature, manager's internal documents or information posted on offices. Figure 7 illustrates the data collection.

Concerning logistical aspects of the data collection, nothing would have been possible without the supervision and support of ADAP during the field work. The association provided a car, Village Game Scouts (VGS) and camera traps for ecological data collection. For social data, the local staff (project supervisor and technical assistant) facilitated introductions to local authorities, helped to arrange meetings and interviews and made an office available. ADAP contributed to the funding of one trip in the bush (food, VGS salaries, fuel) that cost 370 CHF. Ingénieurs du Monde²⁶, an association funding internships and thesis field work for EPFL and UNIL students, participated in the costs of the international flight and part of the visa for an amount of 1252 CHF. The rest of the expenses, 4818 CHF, were covered by personal funds. The total cost of the field part of this master's thesis was thus 6440 CHF. A significant cost was due to the research and residence permits, 1550 CHF and 550 CHF respectively, needed to carry out a research in Tanzania and to enter into the FRs. The detailed budget is found in APPENDIX 8 with the calendar of the field work. Field work was conducted from the 14th June to the 10th September 2015, during the dry season, because of the inaccessibility of some parts of FRs during the rainy season and the fact that most of the villagers are busy with cultivation. The first and the last weeks of the journey were in Dar es Salaam and Tabora because of the necessary administrative procedures to get research permits and for the workshop organised by ADAP the 8th September 2015.

2.2.1. Ecological data

Considering the duration of the study and the available means, only three quantitative ecological variables were selected: mammal species richness and occurrence, forest cover and human activities. Mammal species were selected because they are one of our studied resources, wildlife, and forest cover because forests harbour trees for timber and honey production. It was not possible to measure the fish resource as it would require specific material for little added value. According to Li et al. (2012), large mammal species' presence, or absence, is often used as a proxy to measure the effectiveness of protected areas management. Moreover, they play a key role in ecosystems and are easy to detect and to identify. Forest cover analyses go beyond the assessment of timber as *"the decline of forest cover is an environmental issue of great concern, due to the negative impact on biodiversity as*

²⁶ More information on: <http://idm.epfl.ch/>.

well as on local ecosystems. Forests are crucial too, for the livelihoods of those who dwell in them” (Jacobs, 2008, p. 337). Human activities are used as a proxy of human disturbance which impact the naturalness and ecosystem functions. They are not as elaborate as the Human Footprint Index of Leroux et al. (2010) but they still give us an idea of the intensity of human natural resource use. Field work began with the collection of ecological data in order to get an overview of the conditions in the field before conducting interviews.

Mammal species data collection combined two methods: camera trap surveys and opportunistic observations. A predictive list of 64 mammal species which could be found in the FRs was made in advance based on the literature. This list gives the order, family, French, English and Latin names and can be found in APPENDIX 9. The four FRs were prospected over a length of 1030 km, mostly by car and a bit by foot to set up the camera traps in the field (trips and camera sites are indicated in Figure 6). Observations were recorded throughout the time spent inside FRs. Journeys in the field required a 4WD car, a driver, four armed VGS, two GPS, food and camp material for cooking and sleeping (out in the open). One VGS was speaking English and ensured good communication with staff who only spoke Kiswahili. All of them were living in Inyonga or in the villages around and knew the bush very well.

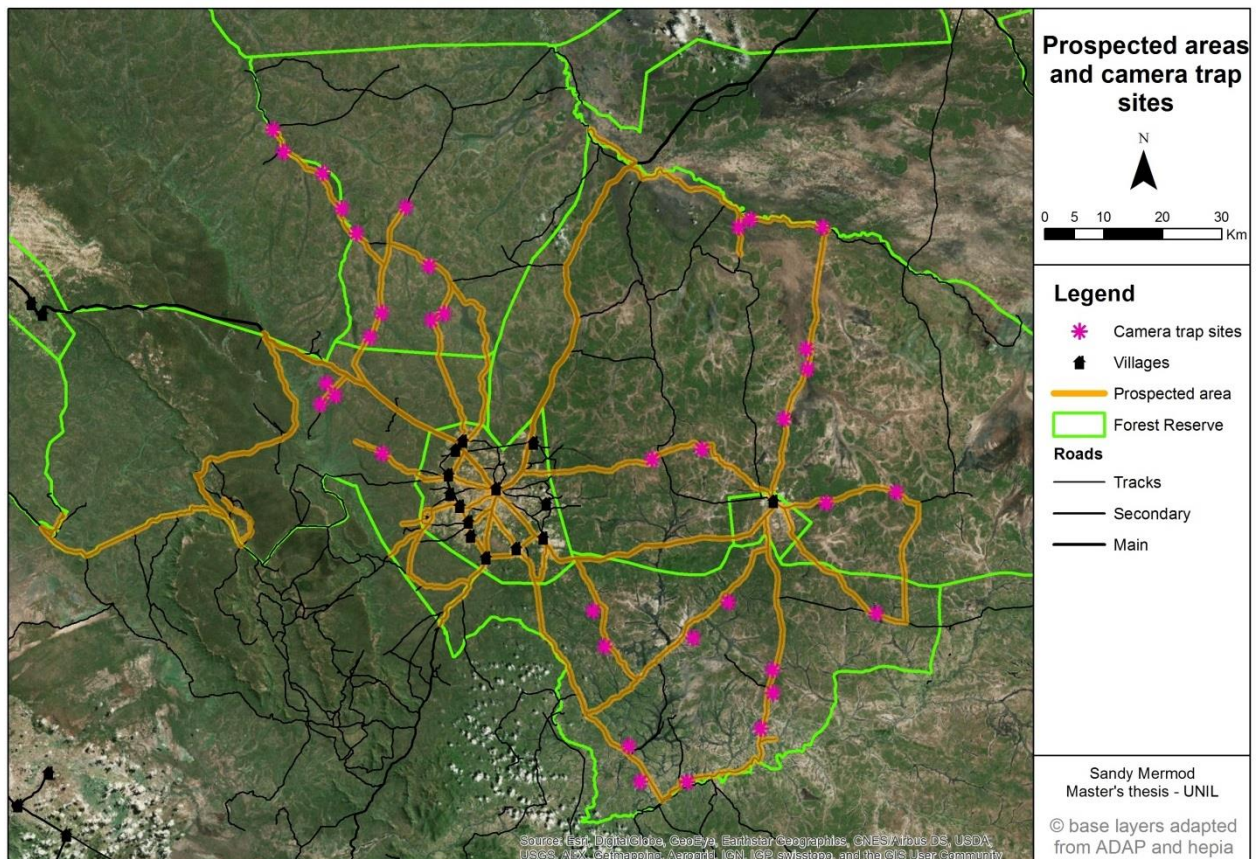


Figure 6 Prospected areas for the study and camera trap sites.

Camera traps are a reliable and efficient method for sampling a substantial amount of species, especially mammals (Li et al., 2012). This method performed particularly well with 31 of the 49 species detected during monitoring in Mlele between 2008 and 2010 (Hausser et al. 2016) and 27 of the 39 species inventoried in the Rukwa GR in 2012 (Mermod, 2012). Camera traps are particularly applicable to the vegetation of miombo which is not suitable for line transects due

the low visibility. They are also ideal for identifying nocturnal and elusive species which cannot be detected easily by other methods (Pettorelli et al., 2010).

As the Inyonga FR, the Ugalla River FR and the Rungwa River FR had never been inventoried with camera traps, we wanted to do a first rapid assessment in order to know if it would be useful to monitor them with a systematic sample design²⁷. Moreover, since the users were supposed to be numerous in the FRs, it was more cautious to try with a few cameras to check if theft was prevalent. The sites were chosen according to the proximity to tracks (less than 2 km to save time), the habitats, the space between each camera and the distance from the first farms. The camera traps were set up (favourable location for animal trapping, height on the trees, camera parameters, field work tables, etc.) according to the methodology used in UASWS bachelor's thesis (Mermod, 2012). The cameras were left out in the field for 21 days, being operational 24 hours a day with a time lag between two pictures set to 1 minute. Camera trap stations were not baited or lured. The camera mark was the Bushnell Trophy Cam with infrared. 26 camera traps²⁸ were set up for this study between the 23rd June and 6th of August 2015²⁹. Rungwa River was not targeted because it was the object of study of a UASWS master's thesis between the 12th August and the 6th October 2015 with 4 squares of 36 camera sites (Stampfli, 2016). 10 camera traps sites from that study were selected for the present study in order to have comparative samples with other FRs. The sampled area was very limited for huge surfaces such as the four FRs and it gives thus a global overview and some trends rather than a precise assessment.

The data collected were analysed (field work tables and 30,550 pictures, including only 1,431 pictures with animals in them) using Excel sheets. The species were identified and their pictures were divided into dependent and independent categories in order to only use the independent ones for the statistics³⁰. Data were produced for each camera trap site (habitat, CT days³¹, number of species, names of species, capture rates³² for each species, species/CT days and independent pictures/CT days) and pooled for each FR. The files were transformed into shapefiles in order to spatially represent the different parameters with ArcGIS.

²⁷ Like the Mlele BKZ and the Rukwa GR which are monitored with squares of 100 km² each having a 2 km by 2 km grid layout sampling strategy representing 36 points.

²⁸ 11 in Ugalla River, 10 in Inyonga and 1 Rungwa River (the only camera set in Rungwa is due to a field mistake because the boundaries are not marked). As Mlele has been monitored since 2008, a huge quantity of data is available and thus it was not the purpose of this study to collect more data. 4 cameras were set up only for comparative purposes with FRs at the same time.

²⁹ This is more than 21 days because the inventory was completed during two separate time spans (see 2.2.3.).

³⁰ Pictures were considered dependant when the same species with no sexual dimorphism or no individual marking is recorded several times in the span of 30 minutes. For gregarious species, only the picture with the most number of individuals was recorded and considered independent, regardless of the length of the sequence to prevent overrepresentation of species spending time foraging in front of cameras (Hausser et al., 2016).

³¹ Camera trap days (CT days) are the number of days during which the camera was functioning and are used to measure the research effort (Hausser et al., 2016).

³² Capture rates are a measure of occurrence and are obtained by pooling independent capture events per species (for each site or among all sites of a FR) and dividing this number by the number of CT days. Capture rates are often used as a surrogate index for species abundances and are common in camera trap studies where reliable abundance indices are not available (Tobler and al, 2008).

Additionally, Kruskal-Wallis tests³³ were done on the different variables to assess if the differences between the FRs or between the habitats were significant. All the statistical tests were done with the Statistical Package for the Social Sciences (SPSS) software.

Camera traps data were completed by **opportunistic mammal observations** made during all the trips into the FRs by car, by foot or at the temporary camps. Observations consisted mostly of direct animal sightings (dead or alive). Indirect signs such as tracks, dungs or screams were recorded only for IUCN Red List threatened species³⁴. The data from the tables were transcribed onto an Excel sheet. Observations of Stampfli (2016) in the Rungwa River FR were integrated as well. A Kruskal-Wallis test was done on the number of observations and the number of species to assess if there were differences between FRs. Then the inventoried species were pooled with camera trap data to make a species inventory per FR. As we lack baseline data on the FRs, we tried to compare our results with neighbouring areas. We also used user perceptions concerning the evolution of the wildlife population to assess changes.

Human activity observations were also reported on a table during the trips into the FRs. The pictures of users taken by camera traps were added to the data as well. Every sign of use or the presence of people was reported with an assessment about the type of activity and its legality. For this latter parameter, it was not so easy to determine if people were engaged in legal or illegal activities. For instance, if someone has a beekeeping permit, he could also poach animals or fish illegally. Additionally, it is impossible to know if a pit-sawing was done by legal or illegal loggers. We were sure that people were engaged in illegal activities when they saw us and started to run (some because they did not have a permit or some because they did not have the right material, like nets with too small meshes for example) or when we saw carcasses with bullet holes or riddles to dry the meat nearby. Some observations remain undefined, like motorbike tracks or old fire places. Users on main roads (Tabora-Mpanda) were not taken into account as we did not know if they would go into a FR or not. Hives were not recorded as they are numerous and linked to beekeeping camps which are already registered. In order to have a sample of recent uses, only the pit-sawings less than one year old were recorded. Stampfli's (2016) observations were also integrated. A Kruskal-Wallis test was done on the data to assess if there were significant differences among activities and their legality between FRs. We have to bear in mind that one observation does not mean the same impact on natural resources according to the kind of activity. A carcass means the death of an animal, a pit-sawing implies that many trees were cut whereas observations of cows mean that pastures were temporarily affected and that wildlife was disturbed. This kind of information however gives an idea of the intensity of activities.

The analysis of forest cover changes was done in Switzerland using **satellite images**. The methodology was based on previous individual work on remote sensing and image treatment at the University of Geneva (Mermod, 2014). Landsat images from 2002 (the oldest year available) and 2015 were downloaded from Earth Explorer³⁵ and treated with ArcGIS to

³³ Kruskal-Wallis is a non-parametric test which is used to compare means between several samples. It is an alternative to ANOVA when data are not normally distributed (Lehmann, 2014).

³⁴ Like Wild dog (EN), elephant (VU), hippopotamus (VU), lion (VU) and leopard (NT), Puku (NT). See IUCN (2015).

³⁵ U.S. Geological Survey (n.d.) Earth Explorer. Retrieved from: <http://earthexplorer.usgs.gov/>.

produce the band combination *vegetation analysis*³⁶ (the detailed procedure is available in APPENDIX 10). This combination allows for good differentiation between cultivated fields and forest. Polygons were drawn following the perimeters of the fields for the 2002 and 2015 images and let us conduct a visual and statistical comparison. In regards to the analysis we had to be very careful because such a method shows the quantity of forest and field and not the quality of forest cover. That is why it was beneficial to complete GIS information with field surveys and local knowledge. Moreover, we should not forget that land cover categorization is a social construction and that degradation depends on the people's perceptions (Robbins, 2012).

2.2.2. Social data

Qualitative data collection combined semi-structured interviews, focus groups and direct observation. The topics studied were the livelihoods of local population, the natural resources use, their management, the governance of the FRs and the stakeholders' perceptions of ecological conditions. An interview guide for each topic was prepared before the field work and adapted after the first interviews and observations (see final interview guide in APPENDIX 11). Social data were collected in FRs (during the ecological data collection) and in villages of the study area. Some interviews were also done in Tabora. The list of the interviewees is found in APPENDIX 12, where only their occupation is given in order to preserve their anonymity and guarantee their safety. Codes are thus used to mention the interviewees in the document (according to the method and kind of stakeholder, e.g. *S_GM01* for semi-structured interview government manager)³⁷. The interviews conducted have allowed a diverse representation of the different stakeholders, with perhaps a lack for the Wahutu refugees, the loggers and the District employees. A translator was necessary for the interviewees who did not speak English (it was the case for half of the semi-structured interviews and almost all the focus groups). A 45-year-old VGS who has been living in Inyonga for 20 years translated the semi-structured interviews and some focus groups. ADAP/IBA staff (30-year-old urban men) translated the other focus groups as they happened after IBA's meetings. The translators implied a certain bias as they were linked to ADAP and IBA. However, the VGS enabled the access to stakeholders who are difficult to reach, such as old poachers or fishermen, as he has settled in the region for many years. Some interviewees would not have been met if the translator was a student. Moreover, it is very difficult to find people who speak English in Inyonga.

Semi-structured interviews are considered a good means to collect qualitative data about opinions and allow the space for extended topics according to the interviewees (Quinn et al., 2007; Suristat, n.d.). The discussion is guided through the interview guide but ensure certain flexibility as the questions are not pre-formulated and their order not pre-established. The topics were chosen and formulated according to the interviewees' profile. The aim was to interview all kinds of key-informant stakeholders in order to have a broad view, from the

³⁶ *Vegetation analysis* was used in Margono et al.'s study (2012) about forest degradation in Sumatra.

³⁷ **S_** for semi-structured interviews, **F_** for focus group followed by **GM**: government manager, **LU**: local user, **FS**: field staff, **CM**: community manager, **CO**: company, **KR**: Konongo representative, **SR**: Sukuma representative, **VS**: Village natural resources stakeholders, **WG**: women group, **DE**: district employee or **NE**: NGO employee. No distinction was done for personal comments (PC) and ADAP's meeting (AM) which are only followed by numbers.

villagers to the government managers. They have different knowledge of the resources, the drivers of changes or the regulations and their motivations of actions vary greatly (Quinn et al., 2007). It was possible to conduct a total of 20 semi-structured interviews with direct and indirect stakeholders of natural resources use in FRs (women, farmers, cattle keepers, beekeepers, fishermen, loggers, traditional healers, traditional chiefs, hunting companies, tobacco companies, District employees, local and regional managers). Some interviews were done inside offices and others in front of houses with children or passer-by who observed. Villagers' interviews were kept for the end of the field work in order to be more used to the context and interviewing practices. Milner-Gulland & Rowcliffe (2008) recommend not paying the interviewees in order to not alter their behaviour. Thus, the interviewees were never proposed to be paid to accept an interview. Nonetheless, a soda was offered during the interview and, at the end, a small tip was given to farmers to thank them for the time taken and the transport for some cases.

A **focus group** aims to reap a collective word which comes from interactions between members of a group. Even if there are some inhibitions, it provides some data which would not be collected in individual interviews (Combessie, 2007). A focus group is very close to a semi-directed interview in regards to the way it happens with an interview guide and the space for discussion and other topics. A total of 10 focus groups were undertaken with villagers, village' authorities, managers and users (Konongo elders, Village Natural Resources Committees, women, cattle keepers and IBA). The list is available in APPENDIX 12. Women were interviewed separately as they do not dare to speak during the meeting with men or do not say the same things (Quinn et al., 2007). Two persons which interact were considered a focus group (such as the TFS managers) and one person accompanied by one or several passive people (who observed but did not speak) were considered semi- structured interview. Village authorities expect to receive per diem when they come for a meeting. Having limited funds and not wanting to pay people to collect data, some focus groups were done after ADAP/IBA's official meetings to take advantage of the presences of people. At the end of some focus groups, tea was offered and once money was given to the collective account of a women's group who produce batiks.

Direct observation concerned the daily life in villages, the stakeholders' behaviours, the different narratives, etc. in the villages and in the bush. According to Milner-Gulland & Rowcliffe (2008), direct observation is a good complementary method which allow for data triangulation. Nonetheless, this requires that the observer understands what happens. In addition to the three methods, **informal discussions** were a valuable source of information. Some people were more talkative during informal meetings in bars, restaurants or in the street. Additionally, it was sometimes the only chance to speak with some stakeholders since they were not available or present the rest of the time. Informal discussion happened with a total of 34 persons. Some persons had been already interviewed but gave additional information during these informal meetings. Journeys in the bush were also very instructive because people are more confident and speak more openly around the fire. **ADAP's meetings** were also a source of information. There were a meeting with local managers of natural resources, another one with the District Executive Director and the workshop held in Dar es Salaam which gathers local and national natural resources management stakeholders together.

During the field work, data of semi-structured interviews, focus groups, personal comments, ADAP's meeting and personal observations were written in a notebook and recorded (for semi-structured interviews and focus groups). In Switzerland these data were organised into a chart divided by the nature of information (semi-structured interviews, focus groups, etc.) and by topics (views of environmental degradation/threats, FRs management, land and government, activities, conflicts, livelihoods). The final chart (extract in APPENDIX 13) allowed for a comparison between the different stakeholders and to link their words with ecological data and observations. Some annotations were done on a printed version in order to highlight contradictions (between stakeholders or with field observations), to rank the threats, to underline the causes mentioned or the different conflicts. The data analysis was done by topic, which mirror the different parts of the results.

2.2.3. Problems encountered in the field

As it was expected, the initial calendar was not respected and the meetings did not happen like it was planned. Local inertia was substantial in regards to the preparation of journeys in the bush and the planning of interviews with the local team. There were often delays and sometimes some meetings were cancelled in the last minute. The meetings had thus to be planned again which modified the initial program. Seven meetings were not rescheduled because people were no longer available or there was not enough time at the end of the field work. One interviewee was questioned by e-mail (because it was impossible to meet him in the field) but he has never replied. One meeting with a supposed Hutu settled in Inyonga was not convincing. He said that he did not remember about his life in refugees' camps and he did not know about the current uses of natural resources by the refugees. He perhaps wanted to hide his past. The number of village natural resources committees was reduced because of a lack of time. Thus three villages were selected according to their proximity to the FRs: Kanoge which is near the Mlele BKZ, Mapili which is close to the Rungwa River FR and Ilunde which is remote and surrounded by the Inyonga and the Rungwa River FR. Four semi-structured interviews and four focus groups were not recorded for technical purposes (empty batteries, recorder forbidden) or because they were unexpected meetings. The District stakeholders (elected, executive or employees) were the most difficult people to meet because they were busy with the elections. Generally, it was difficult to work during pre-elections because all civil servants were busy and they did not dare to take or to communicate decisions.

The work in the bush was not easy due to cars in poor conditions and bad roads which resulted in several breakdowns. The journeys were long and had to be well planned because there was no network in the FRs. A specific problem happened to the camera traps survey. Half of the memory cards had a virus (from the computer of IBA employees) which hindered the record of pictures on it. Thus, at the supposed end of the survey 21 day later, 15 cameras had nothing on the memory card and had to be installed again during 21 days, which implied a third trip to remove them.



Temporary camp during the FRs survey



Breakdown in the Mlele BKZ



Visit of FRs (on an airstrip near a hunting camp)



Camera trap installation



Wasukuma focus group



Wakonongo « observers » during an interview



Interview with a fisherman



Focus group with village NR stakeholders

Figure 7 Illustrations of ecological and social data collection.

3. RESULTS

This chapter presents the data collected during the three-month field work in order to provide a basis for the analysis of human-environmental relationships. It is organised into three different sections. The first one gives an overview of the links between livelihoods, natural resources and the local population's culture. The second section presents the ecological data collected. The third section focuses on the effective management of FRs implemented by the government organisations. Finally, the fourth section offers some insights on possible solutions considered by interviewees to ensure a better use of natural resources inside the FRs.

3.1. WHEN LIVELIHOODS AND CULTURE ARE LINKED TO NATURAL RESOURCES

This section presents the main findings of the study which concern the livelihoods, the importance of natural resources and some cultural aspects of the region's main two tribes, the Wakonongo and the Wasukuma. The presentation of these socio-cultural and politico-economic parameters is not exhaustive but it provides key figures for understanding the context and the drivers of natural resource use. The first small subsection describes the conditions in which the villagers live so that the reader can get an idea of the situation and the atmosphere.

3.1.1. Setting the scene

After many hours in a bus, you arrive in Inyonga totally dust-covered because of the road's laterite soil. People are watching you when you leave the bus and the children call "*Mzungu, mzungu!*" which means the white person. The world around you is orange and brown because of the hard-packed soil and the brick houses, contrasting with the blue sky. There are many people in the streets but it is not crowded. There is only a main street, which seems quite "urban" with shops, restaurants and traffic, but as soon as you walk in the perpendicular streets, it is more an atmosphere of village with family houses, chicken wandering and children playing outside. Other villages of the study area have the same conditions except that they do not have the "urban" street of Inyonga and there are not as many inhabitants. Ilunde is more rural and remote as the village is 60 km east from of Inyonga in the middle of the bush and there is no phone network. As an illustration of this remoteness, there is only one guest house with two rooms in Ilunde, versus more than ten with several rooms in Inyonga.

Most activities in Inyonga belong to the primary sector, with farming which concerns 85% of the population (URT, 2015). All the villagers interviewed practise at least two activities to earn a living. The main one is always farming, labour intensive with low economic returns, which employs people during the rainy season. The most cultivated crops are maize, groundnut, rice, beans and tobacco, to be sold except a part kept for own consumption. Besides these, farmers cultivate vegetables, sweet potatoes, cassava and other cereals for their own consumption or for local markets. The common secondary activities are livestock keeping (goats, cows, poultry, and pigs), beekeeping, fishing, logging, poaching, shop keeping or manpower selling. There are other less common secondary activities such as traditional healing, motorbike driving, VGS, or carpentry. There are some employees in Inyonga who are paid by cooperation projects, companies or who are civil servants. They do not need to cultivate at all and behave like elite.

These people do not easily mix with the perceived “lower” farming classes except for their professional duties. Even professional relationships are not so good and farmers do not dare to ask them questions or to request help because of the “inferiority” they feel.

The typical meal is ugali (maize or cassava flour) with a tomato sauce and beans. One can add some vegetables like spinach or cabbage. Most of villagers eat meat once or twice a week, generally cow meat. Meat can be replaced by fish during the dry season. Chicken and rice are quite expensive and are mostly cooked by the small restaurants for employees who have lunch out of the office. Local population eat few fruits except during “mango time” or when they have papaya or banana in their garden. Food from the forest includes fish, honey, mushrooms and bushmeat. Some people also eat wild fruits, leaves or termites. Bushmeat is illegal but there are black markets in the villages and many women asked us if we had brought back buffalo meat from the bush because they like it a lot. To give an idea of the costs of living, here are the prices of some common products. A typical meal (rice, beans and meat) at the restaurant is 1,500 TSH, 2 kg of tomato are 4,000 TSH, a big bag of charcoal is 10,000 TSH, a live chicken is 15,000 TSH, a soda is 1,000 TSH, a beer is 2,500 TSH and a bus ticket Inyonga-Tabora (200 km) is 15,000 TSH. Figure 8 presents some pictures of Inyonga and other villages.

3.1.2. The local population’s livelihood assets

This subsection concerns the population’s means of living and the difficulties they face in everyday life. The elements will allow us to understand the livelihood strategies implemented by the local population and their outcomes. The local population is not homogenous as there are different socio-economic “classes” of inhabitants. However the farming class, which represents the majority of inhabitants, has the same standards of living and it is on it that we focus the livelihoods overview presented below. We evaluated the livelihoods assets (presented in Table 2) according to the interviews and observations and based on the Sustainable Livelihoods Framework (DfID, 1999). The most crucial assets supporting local livelihoods seem to be natural assets, followed by social, financial, human and physical ones.

Table 2 Evaluation of the local population’s livelihood assets

	Physical	Social	Human	Natural	Financial
Assets evaluation (max. 5+)	+	+++	+	++++	++
Positive assets	District infrastructures, communication	Strong family links, associations and groups	Traditional knowledge	Soil, forest, rivers, wildlife	Selling raw products, selling labour and services
Negative assets	Bad roads, poor water supply, basic housing	Little government help	Limited education, Sicknesses	Competition for resources, sanctions	No credit, few bank accounts, low prices

The **physical assets**, mostly represented by infrastructures, are quite limited in the village of Inyonga. There are two District buildings, one police station, an office of the village government, two primary schools, one secondary school, one football field (consisting of hard-packed soil and poles for the goals), one open building used as a tribunal, one place in the middle of the village for the daily market, one place outside the village for the monthly market

and an unused airstrip (only a flat area with grasses and no buildings). Electricity has been available since 2014 but it is only for people who can afford because it is produced privately held generators. Moreover, it is only available during certain hours. In the periphery, there is a mix of brick and mud houses. Half of the houses still have roofs made out of grasses. In the centre, most of the houses are made of brick and have iron sheets on the roof. Some “modern” houses for the District employees have been built by the government in the village periphery and they contrast greatly with the other houses. The neighbouring villages have far less infrastructures than Inyonga. Village councils’ buildings are brick houses with a table and chairs inside. There is no tarmac road in our study area. The Inyonga Division has no hospital, only one health centre and 5 dispensaries (URT, 2015). There are 12 primary schools (7-13 years old), including one in Ilunde, and 3 secondary schools, of which none are in Ilunde (URT, 2015). The toilets are traditional pit latrines or improved pit latrines and some households do not even have their own toilets. All the households of the region cook with wood or charcoal. There is no permanent river in the area and the water used by the population is underground water. There is no tap water available; only wells and pumps, more or less maintained. Two village focus groups and many villagers told us that they need more clean water which they could get by repairing the well or installing more pumps. The situation is especially critical in Ilunde where most of the pumps are broken and the water is very dirty. Moreover, the Ilunde population deplores the poor infrastructures like roads, no phone network and the lack of a government presence (police, natural resources managers, etc.) (F_VS08).

People use bicycles to practise activities outside the villages, or motorbikes for the luckiest ones. Bicycle limits the amount of things one can carry, is tiring and the journey can take a lot of time. For example, one woman (PC28) needs two hours by bicycle to go to her field and she has to come home every evening because of her children. Some beekeepers cover 150 km round trip on bicycles to harvest honey in the bush (without gears). A limited number of private owned vehicle, including 4WD are owned by private traders and some governmental officers. There is no agricultural mechanisation and the main tool is the hand held hoe. There are no irrigation schemes for cultivation. The rice is cultivated in mbuga, naturally inundated during the rainy season. Lastly, there is no bank, no post office, no specialised shops and a poor internet network in Inyonga. This limits available services and activities and forces people to make regular trips to Mpanda or Tabora by bus. There are about ten buses per day that cross Inyonga in both directions.

In the region, the **social assets** still rely strongly on the extended family (parents, children, uncles, aunts, grandparents). Close relatives often live in the same household or in the same neighbourhood. The average household size in the District is 5.9 people which is higher than the average for the mainland of Tanzania which is 4.8 people (URT, 2013). However, this is only an average and we met many women with 7 to 12 children during the study. There is strong intragenerational and intergenerational solidarity inside the family, even if they do not live in the same households. The sisters and brothers of a family work or do daily tasks together, even if they are married and have their own households. When someone is sick, family members help him by doing his daily tasks or providing money for medicine if needed. The family, even the distant relatives, are always present for events such as funerals, births, and weddings and they contribute to the financial costs. All the family members help in the field during seed beds

preparation or during the harvest. Elders never really retire, even if they have some physical difficulties, because they still need to earn money as they do not have social insurances. They are often assisted in their activities by their children or they help their children with their own activities. During the study we met an old couple (more than 65 years old) fishing in the middle of the bush. The man was a retired policeman who was still farming and fishing. Thus, even some civil servants need to work once they are retired since they receive only a limited income from social insurances.

Life is quite difficult for women because they have to work a lot and most of the time the men do not help them or they are engaged in their own activities (F_WG07). F_WG06 think that women are discriminated in comparison to men in terms of power and education. This probably explains the presence of substantial mutual assistance between women. Most of them belong to groups to practise secondary activities like cooking for small restaurants, keeping small shops, handcraft production or providing services such as traditional dances for celebrations. Thus they join forces to earn money and can share the tasks. Young people who are lucky enough to get an education usually do not come back to their village to live or work. They just come greet their family from time to time and they work for small companies or the government in towns. Tanzanian employees generally send money to the family that has stayed behind in the village or in another town, especially if the family is taking care of their children. However, according to Ellis & Mdoe (2003), the amounts sent are not consequential for households, representing less than 4% of their incomes.

Traditional leadership is decreasing and village authorities do not have the means to assist or empower the local population. Moreover, Tanzanian public sector seems to hinder the rural poor more than they support them because of the formal and informal restrictions or violence in taxation (Brockington, 2008; Ellis & Mdoe, 2003). For instance, 90% of the Sumbawanga District's taxes come from villagers (who are farmers) but only 1% of the expenditures concern agriculture (Brockington, 2008). There is one Community Development Officer for the Mlele District but he is held back by a lack of funds and a lack of means to work (motorbikes and no car, only four staff) (S_DE06). It is difficult for them to collect data about livelihoods and calculate statistics for the District level. Instead, they measure life improvement with data on water, health services and loans provided³⁸. Some women are quite satisfied by local governments because they provide infrastructures like roads, secondary schools and dispensaries (F_WG06), some others think that the local government does not take care of inhabitants' lives at all (F_WG07) or that they require more support, especially for women's groups (F_VS10).

In regards to **human assets**, modern health care and education capabilities are fairly low among the local population. The enrolment for primary school is between 45 and 60% and less than 400 pupils go to secondary school. Most of the adults do not know how to read and write. Many children who are selected for secondary school are forced to work by their parents in order to earn income for the family (URT, 2015). However, secondary school enrolment is increasing and no difference between boys' and girls' enrolment was observed. The District is

³⁸ If people repay the first loan and obtain a second one, the District considers that there is development (S_DE06).

aware that improving education is a real need, and that it could reduce the poverty level, and thus they want to invest more resources in this sector (S_DE06). We learned from interviews that the main preoccupations of women are the education and health of children. They do not have enough money for their children's education, especially secondary school. If they had more money, they would invest in their children's education (F_WG06). The knowledge and skills concerning traditional activities (like beekeeping, traditional medicine) are still important and useful. However, knowledge and skills concerning modern activities (agriculture, business) are insufficient and not adapted to current needs.

Severe sicknesses still hinder daily activities and this is quite costly for the households. Nonetheless, even if health centres are expensive, the women do not hesitate to go there, especially for children (F_WG07). The main sicknesses causing death among the District population are acute respiratory infections, malaria, pneumonia, diarrhoea and anaemia (URT, 2015). HIV is difficult to estimate as some people die before going to the hospital and others die from linked diseases such as tuberculosis. The District estimates that 4.1% of people have HIV. However, informal data suggest that this percentage is far higher. The District has noted the presence of child malnutrition due to the undiversified food, especially in Ilunde (URT, 2015). In regards to women's health, contraceptive injection is available and free but women use it only after having 6 to 7 children and not for prevention (F_WG06). Women and child security is fairly high as the social nets are still substantial. However, some categories of people, such as albinos, are more threatened than others. One woman from a focus group (F_WG07) is very afraid for her albino son as albinos are often killed or amputated in Tanzania for witchcraft purposes. One man had his ear cut off in Kanoge, a neighbouring village, and therefore it is very dangerous to leave him alone. Moreover, he needs special care like protection against the sun and there is no government help for that.

In regards to **natural assets**, there is still an abundance of natural resources that the local population can use for their own consumption or to earn incomes. One important natural asset is the soil, which is needed for farming activities and cattle keeping. Although fairly restricted by protected areas, the soil needed for cultivation is still available and not too degraded. However, the use of soil by the local population is regulated by formal and informal rules, which are not equal for everybody. Land was fairly available until the 2000s because the human density in the Division was low. Today most households "own" between 1 and 1.5 ha (PC10). The only landless households are the ones living in the centre of Inyonga doing business or working as employees. Thus, unlike in other Tanzanian regions, land is primarily owned by the farmers here, which is a big advantage when it comes to coping with shocks. However, not all the people have title deeds or a Certificate of Customary Rights of Occupancy³⁹ for their lands, whereas these documents allow for easier access to loans. With the migration and population growth, land has become a scarce resource, and moreover is not well managed by local authorities (F_VS10; S_NE14). Local authorities (District and village) are corrupt when it comes to plot attribution and allow massive immigration into village land and FRs (for bribes or political purposes, e.g. to get votes for local elections). There are also some

³⁹ The delivery of such titles was possible thanks to the Planning and Land Use Management conducted by the Land Use commission supported by ADAP. However, the process is not finished yet.

contradictions as some chairmen claim that land is no longer available while the District invite newcomers and advertise the availability of land on its blog (Mlele District, 2014).

NTFPs (plants, leaves, insects, dried wood, straws, etc.) are probably the only forest products which are still partially found in village land, wild or planted. Since forests within the village land have been decreasing, the local population use now mostly the natural assets of the FRs to improve food security and earn more incomes. Beekeeping is a traditional Konongo activity which is widespread among the local population. This activity is practiced by groups of relatives who have a camp in the bush. Beekeeping is seen as a good income generating activities. It requires little material when it is traditionally practiced but particular skills learnt mainly with fathers. Its importance in regards to household incomes varies greatly with some beekeepers who have 30 hives and some others more than 200. Beekeeping is a suitable secondary activity for farmers as the harvest occurs in the dry season. Honey and wax can be sold locally and regionally (buyers come themselves in Inyonga). Fishing is also practised by farmer during the dry season but is less common than beekeeping because the main rivers are very far from Inyonga or Ilunde. Since this activity requires few skills and no permanent camps, some villagers engage in it only when they have a lack of incomes in the household budget.

Some villagers are also engaged in local hunting, or “poaching”. Although it is a traditional activity, the practices have changed over the years. Spears, arrows and traps have been replaced by weapons and many outsiders come in the Mlele District FRs to kill animals for commercial purposes (meat or added value products such as ivory). Some villagers are still hunting with muzzleloaders to their own consumption but most of the poachers work in organised groups (of local and outsiders people) which use semi-automatic weapons. Elephant poaching is more complex as it requires contacts with businessmen who are in charge of the exportation. Only the group’ leaders (who carry the weapon) and businessmen earn substantial incomes. Wildlife resource is also “used” by foreign clients of the trophy hunting companies. The staff of these companies comes from other Tanzanian regions, which provided few incomes for local livelihoods. However, trophy hunting activity provides significant funds for the District through taxes. Another activity practised by outsiders with small salaries for the local population is the logging activity, which is led by individuals or companies coming from the North of the country. This activity has massively increased the last few years and occur in all the FRs. For the moment, only few hardwood species are targeted by the loggers. These are *Pterocarpus angolensis*, *Afzelia quanzensis* and *Pterocarpus tinctorius*. Nobody uses GPS except the trophy hunters. The different activities are described with more details in APPENDIX 14 and their main characteristics are summarized in Table 3.

Some villagers are engaged in several of these activities based on natural assets. Moreover, most of the users of FRs also gather and bring back some traditional plants or mushrooms (found only in the forest) in the villages for self-consumption. Livelihoods of the Mlele District are strongly linked to natural resources and this was confirmed by the District community officer (S_DE06). However, one cannot consider natural assets as “owned” because most of these natural resources are inside government protected areas and villagers can use them (in theory) only under certain conditions (taxes, practices, season, etc.). The livelihoods of the local population were quite satisfied in the past even with the restrictions of the FRs because the degradation was low and the management not too restrictive. However, this is not true

anymore. The local population is in competition with several external stakeholders in regards to the natural resources of the FRs.

Table 3 Characteristics of activities practised inside the Forest Reserves .

Activities	Location in FRs	Kind of stakeholders	Organisation	High season	Importance for local livelihoods
Beekeeping	Everywhere but not far from water (holes, rivers)	Local villagers	Small family groups	June-July	+++
Fishing	Permanent rivers	Local villagers, outsiders	2-3 people, not always family members	June-September	++
Logging	Everywhere	Outsiders, local villagers	2-3 people, not family members	May-November	++
Poaching (local hunting)	Everywhere but focus on main rivers and mbuga	Local villagers, outsiders	Groups from 3 up to 40, not family members	Every time, but easier at the end of the dry season	+
Trophy hunting	Everywhere but focus on main rivers	Foreigners	Companies with staff	July-December	-

The **financial assets** come from different sources of incomes. The main financial assets of the households come from raw material that is cultivated, kept or collected and sold. This raw material is crops, cattle, timber, honey and fish. Other assets can come from services like selling manpower, cooking, keeping a shop, etc. Only people who are doing business (of agriculture products, hardware stores, guest houses, etc.) do not need to cultivate crops (some of them are Wakonongo but most of them are outsiders). Even witchdoctors, who receive money from their clients, cultivate crops. However, it is common to be jobless for part of the year in this region (S_FS09).

Farmers have few financial assets in the form of savings because they do not have a sufficient margin to save money. Furthermore, access to credits are limited and for the moment credits proposed to villagers come from the private sector like tobacco companies. The government implemented Savings and Credit Co-operative Societies throughout the District. However, the Mlele District only provides small loans to groups⁴⁰ of women or young people for the moment to allow them to develop a secondary activity (URT, 2015). According to S_FS17, few villagers have bank accounts. They instead make transfers and use accounts with mobile phones (such as M-PESA). As it is difficult to get credits, farmers buy expensive things at the end of the harvesting season (May to June) or when they receive money for tobacco (September). Some farmers are able to build a house with the money received in one season but few can do this. The situation of cattle keepers is different as having a herd is a means for them to save money. Farmers therefore have few opportunities to invest in a better life. The investments that they would like to make are not for big houses or cars but rather to be able to buy hives to produce more honey. Many parents would invest more in their children's education because they are aware that education is a means of accessing better jobs, which, in turn, improves the life of the whole family. Farmers envy company employees or civil servants who receive a salary each month (S_LU08).

⁴⁰ According to S_DE06 loans are always attributed to groups because they manage better the funds.

The incomes earned by the household members are used for the household's needs. However, it is the men who manage the money and they can take it to satisfy personal needs like drinking or smoking (S_LU07; F_WG06, F_WG07). Women can keep money from their own activities, like working in restaurants or beekeeping, but when they need money for the household's expenses that exceeds what they have, they are forced to ask their husbands. We noticed that local people, like VGS, have a hard time managing the money they receive. They do not have the foresight to keep it for later, when there will not be a salary, but instead they spend it in 1-2 days. The Wakonongo were not prepared to deal with market and to manage money.

We can now try to assess the **vulnerability** of livelihoods. Since sources of income are based primarily on natural resources, they vary according to the seasons, weather and ecological conditions. Consequently, if a household relies on one resource and the season is not good, it would affect their income for the whole year. That is why it is safer to have a diversification strategy involving two or three activities in case one is not fruitful. Furthermore, farming, even tobacco farming, is often not enough to earn a sufficient income with which to live. A woman (S_LU07) explained that without beekeeping, there would be a gap in her household's revenue. Natural assets are considered the security net in this region by Borgerhoff Mulder (2007) because they reduce the vulnerability to seasonality as local population use them to cope with bad farming seasons and to fulfil some basic needs with natural resources such as food, fuel and medicine. Consequently, natural assets are very important to local people's strategies for avoiding vulnerabilities but they are not secure because they are subject to degradation and are regulated by national laws, be it on village land, FRs or other protected areas surrounding the villages. The sanctions or dangers associated to use natural assets in protected areas can even be a threat to livelihoods.

Even if natural and social assets help local population cope with shocks and trends, they are insufficient to reach the population's desired outcomes and improve their standards of living. With their tight budgets, local families cannot face unexpected events like severe sickness or afford investments. This is the case for a beekeeper (S_LU08) who is unable to invest in new hives because his wife died and he does not have enough money as they already invested in a house a few years before. Even if the District found that the development level is not among the worst in Tanzania and that it has even been improving for 2 years (S_DE06), local populations still face several problems in order to meet their basic needs. People interviewed mentioned three main things with which they have difficulties: capital, water and education. Villagers find it difficult to earn enough income with their activities in order to buy what they need for their basic needs, like medicine, hospital consultations, diversified food and education fees for the children. Moreover, it is a vicious circle because if they have no money, this impacts their health and education. Having little or no education keeps them in poverty and can directly impact their health as well, as with the example of this old fisherman who tried to cure his diarrhoea with poisonous battery powder.



Inyonga centre



Secondary street in Inyonga



Periphery of Inyonga



Ilunde



Restaurant of a women group in Inyonga



Water pump in Masigo



Ugali, fish and cabbage, quite typical meal



Market of Inyonga

Figure 8 Pictures representing some aspects of the life in Inyonga.



Demonstration of traditional flour grinding



Place to pray the spirits in the bush



Sacred graves near Ilunde



Old pottery found in Rungwa River from an old Konongo settlement of the end of the 19th century



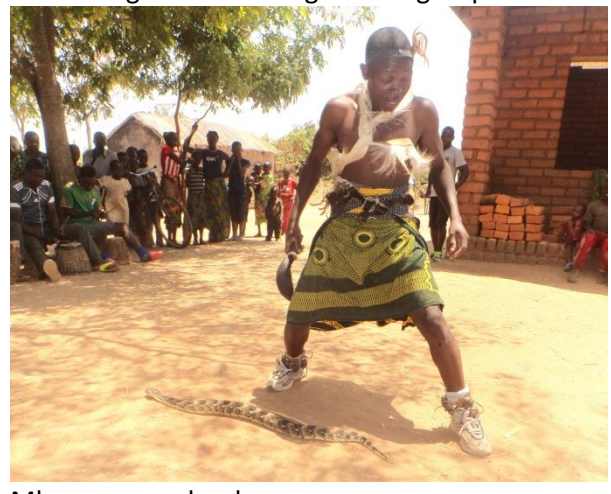
Demonstration of traditional blacksmith



Wakonongo elders during a focus group



Traditional chief, Mtemi Mbaula



Mkonongo snake charmer

Figure 9 Pictures concerning Konongo traditions.

3.1.3. The Wakonongo and their interactions with the environment and people

The Wakonongo were originally a tribe living as different clans in nomadic settlements and led by a gerontocracy and traditional chiefs (Singleton, 2009). Nature was embedded in Konongo culture due to their hunter-gatherer lifestyle and slash-and-burn agricultural practices (Singleton, 2010). Rules and rituals were thus governing their relationships to natural resources and involved figures such as chiefs, traditional healers and witchdoctors. Since natural resources were abundant until the end of the 20th century, it seems that the traditional management was not too restrictive. In regards to wildlife, it was the abuse which was problematic and not the fact of killing. For instance, in 2003, two men left Ilunde and killed a lot of elephants. When they came back, villagers told them to stop because it was too much but the men did not listen to the advice and continued. Few weeks after, they were killed with machetes. According to PC06, these kinds of collective sanctions probably stopped when outsiders from Katumba started to kill elephants with AK-47. Even today, an old poacher thinks that a poacher who kills 27 hippos in one day should be arrested because it is excessive (S_LU04).

As we have seen in the introduction, the Wakonongo have faced several socio-economic changes that modified their traditional organisation and beliefs. Today, the traditions of the Wakonongo such as the chiefs' power, royal rituals, procedures for funerals, natural resources regulation or family greetings seem to disappear. Even their language, the Kikonongo, has difficulties to survive faced with the Kiswahili, first national language. The interviewees do not all agree about the factors that have contributed to the decline of traditional rules. Growing external influences since the beginning of the 20th century are pointed out such as the European Catholic missionaries, the German and British colonists, the socialist government of Nyerere, newcomers, District's establishment, globalisation or technology (see APPENDIX 15). It is probably the combination of all these elements, with different roles at different moments in time, which explains the increasing loss of Konongo culture. It also seems that the traditional rules were already starting to disappear in the 1970s at the time Singleton (2010) was there. The same assessments about vanishing culture have been done for the Wapimbwe living on the other side of the Rukwa GR (Seel, Mgawe & Borgerhoff Mulder, 2014). Like the Wakonongo, the Wapimbwe traditional chiefs have been replaced by village councils and most traditions and celebrations of the past have gone. Nowadays Wapimbwe share its territory with many other tribes and locals favour dispensaries instead of traditional healers. Only some rituals in honour of ancestors' spirits have been maintained.

The remaining Konongo rules and traditional organisation were **difficult to assess** during the field work because the different information obtained from interviews was fuzzy and some statements were not consistent. For instance, the old Wakonongo said that it was a German colonel "Makren" who resettled them in Inyonga. However, the field notes of Singleton (n.d.) mention a Scottish Doctor, Maclean, who diagnosed the sleeping sickness in the region in the 1920s and consequently resettled them. People said about traditional chiefs that one can recognize them easily by their black dress and a hat with shells. However, the big chief of the region wore pants, K-way and an Islamic hat. In addition, it is strange that six interviewees told us to be chief, *Mtemi*, or from a family's chief while there are supposed to be only a few in the region. There was also some inconsistency about the differences between traditional chief,

traditional healers and witchdoctor status. One chief said to be also a traditional healer but not a witchdoctor (S_KR10) and one supposed traditional healer said he was witchdoctor and a traditional chief at the same time (S_LU05). It is therefore difficult to determine what the people call being a "chief". It seems that people reinterpret the traditions and the past because they are not strongly connected to it anymore. Hence we have to be especially careful with the interviewees' statements about the traditions as they could be only vision of what Wakonongo were or are supposed to be. It is thus a bit difficult to know what exactly remains from Konongo traditions. After cross-checking information, it seems that the only remaining practices concern the symbolic power of chiefs, the beekeeping rules, the rituals in honour of spirits and traditional medicine.

The only **traditional rules** outside the family structure are related to hives location in the bush as beekeeping camps are inherited places. When a new beekeeper arrives, he has to take the beekeepers already present into account and to avoid putting his hives in sacred places where there are spirits (F_FS03; S_LU08). Most of the people engaged in a legal or illegal activity in the bush still ask the spirits for good luck. However, it is difficult to know how many and what kind of rituals they celebrate. The place to ask the spirits can be in the village near the houses or in the bush at the camps. Most of the time it is a tree in branches on the ground laid out in two squares (see Figure 9) where people put flour for ancestors and where they prey (F_FS03). The fishermen, beekeepers and poachers who were interviewed confirmed this practice (S_LU20; S_LU08, S_LU04; S_FS17) and they also said that it were not only the Wakonongo who celebrate such rituals. However, the ritual seems smaller than the ones in the past (S_FS09). In addition, some very active poachers go to see the witchdoctor to become "invisible" (PC25). It seems that the Wakonongo who still believe in traditional spirits and follow some traditions mix them with Christian practices (S_KR03), like one ex-poacher who uses both a traditional talisman and a Christian cross to protect him (S_LU04) or a traditional healer who trusts in the Christian God (S_LU05).

Sacred places are still known by the Wakonongo and they respect them. Common sacred places are mostly chiefs' graves or special places endorsed with a myth and can be found in the village land⁴¹ or in the bush, in current GRs and FRs. Each chief has his sacred place with the graves of his ancestors but now when one chief dies, he is buried south of Ilunde (picture of grave in Figure 9) because it is where more traditions are kept alive (S_KR03). In addition, each clan has its own sacred place in the forest (S_KR03). As newcomers do not respect these sacred places (F_VS08 reported that The Wasukuma feed their cattle among the graves), some Wakonongo would like to protect them better with the help of the government (S_KR10; F_VS10). Large parts of traditional chiefs' territories are inside FRs and other protected areas where chiefs need a permit to enter (S_KR10). Their power over land attribution, which was present until the early 2000s, is now totally replaced by governmental ruling. The only thing for which traditional chiefs are solicited is to implore the rain (F_VS09). In some exceptional cases, villages can use traditional authorities to solve land conflicts, like they did in Ilunde (F_VS08), or when government fails to solve some problems (F_CM04).

⁴¹ Singleton (2010) visited about six graves outside the villages.

Regarding **traditional medicine**, knowledge remains at the household level as most of the Wakonongo know how to heal themselves with plants or have a relative who knows (S_KR03; F_WG07; F_FS03). Other tribes living in Inyonga such as Wafipa Wanyamwezi or Wasukuma also know how to use plants of the forests. Most of the time only one plant is needed without complicated mixes. Some plants are still available on village land, others are in the bush only (S_KR03; F_WG07). The situation is quite different for traditional healers or witchdoctors who are seen by the local population as impostors looking for money. The villagers find the drugstore cheaper (S_LU08). However, some traditional healers receive many clients from all over the country (S_LU05). One traditional healer explained us that people come to see him to cure diseases, to receive love potion, wealth potion to acquire invisibility and protection in the bush, etc. (S_LU05). Therefore his position has changed quite a lot since the 70s. At that time, the traditional healer was an advisor of traditional chiefs and whose help was sought after in all kinds of matter such as disease, drought or a stolen bicycle (Singleton, 2010).

Several Wakonongo think that their life has improved as compared to 20 years ago because now they live in brick houses, have a many clothes and a better education (S_LU04; F_WG07). Nevertheless, old and adult people regret that nothing has really improved for the population except the possession of more material things. Moreover, there are negative changes in society and in the behaviour of young people who do not respect the elders anymore and who do not follow the traditions (S_KR10). Additionally, modernity has arrived with different behaviours, criminality and prostitution for which traditional societies appear particularly defenceless. With all the changes that Konongo society faces and with the weak transmission of traditions from generations to generations, the local population is quite **pessimistic about the preservation of Konongo cultural values**. Some elements may probably remain such as traditional medicine (as long as modern medicine is expensive or hardly accessible) or the belief in spirits beliefs but they may be more or less hidden and become weaker (S_FS17). Old people find this sad and problematic for society because of the loss of social control since the local government has not enforced its laws properly (F_VS09). Contrary to this statement, some women do not think that the disappearance of traditions is sad because women had no power previously and were discriminated (F_WG06).

Only the members of the Inyonga Ecotourism Association think that the culture could be maintained if some actions are taken. They speak as if Konongo culture is still strong and pretend that traditional chiefs still have power, even over newcomers (S_KR03) but their views are likely influenced by their position in the association. This association, which receives support from ADAP, aims to conserve some practices and traditional groups (drummers, snake charmers, traditional weapon makers, etc.) and promote them for tourism or celebrations of weddings. As parents do not transmit traditions to their children anymore, they have decided to build a museum about Konongo culture and think as well about a seed bank to maintain floral species for traditional medicine.

As the **Wasukuma** are establishing massively in the region, it is essential to speak a bit about their culture, habits and relationships with the Wakonongo because they are important stakeholders in the village land and for the FRs as well. The Wasukuma have been arriving in the region since the 1970s but first at a low rate and they were quickly integrated into the local population (S_SR19). The migration intensified in the 2000s and has reached a very high rate

since 2010. They come to Inyonga because of the bad ecological conditions (little rain, bad pastures) and scarce lands in their regions of origin (Mwanza, Shinyanga, Tabora) (S_SR18) and because they were pushed by the government to move because of conflicts with the farmer population (URT, 2015). Most of the time, the men come first to find a place and then the family follows (S_SR18; F_SR05). As they have cows, they settle outside the villages. The Wasukuma are not only cattle keepers, they are good farmers and have big fields. They generally do not cultivate tobacco because they do not consider it an interesting crop (primary societies cheat the farmers and there is too much pesticide involved) (S_SR18). Village and District authorities welcome them because they pay to have land, especially in mbuga to cultivate rice. Some Wasukuma ask authorities where they can settle and others settle without asking in village land and even in FRs (F_VS10; F_SR05). A village leader asked a Msukuma for 1,500,000 TSH to let him settle in a FR (S_SR18). The Wasukuma are known to have funds for bribing local authorities (Brockington, 2008). Bribing can also be done with game wardens like was recently the case in the North of Tanzania with a bribe of 4.7 million TSH to allow grazing inside a GR (The Guardian, 2016).

The Wasukuma have their own language (not so different from Kikonongo) and their own traditions but they do not seem to face the same cultural degradation that the Wakonongo do. They have difficulties with teaching their traditions to their children as well and do not follow all their past rules. They still, however, do rain rituals, wear typical clothes and jewellery, speak Kisukuma rather than Kiswahili and use traditional medicine (S_SR19). Some explanations mentioned for this strong culture were the facts that they do not go to church, they are the largest ethnic group in Tanzania (more than 16% of the population), they are still doing what they have always done (cattle keeping and farming) and they are wealthy because of cattle.

It seems that the relationships between the Wakonongo and the Wasukuma are not good, especially with the newcomers (S_LU07; S_SR18). The Wakonongo accused the Wasukuma of destroying their lands, damaging their crop with the cows, hating them, and being aggressive and not respecting traditional places (S_LU04, S_LU07; S_KR10). The Wasukuma see the Wakonongo as lazy people who do not cultivate the land well, are jealous of them and only wait for money from tobacco (S_SR18). According to S_SR18, there are few marriages between Wakonongo and Wasukuma and when there are, they do not work well because of the different mentalities. There are frequent conflicts between Konongo farmers and Sukuma cattle keepers because the cows damage the crops (S_CO13, S_FS17). A farmer of Kanoge had his maize eaten by cows and went to see the Village Chairman but the latter did nothing (S_LU08). There are rumours about the Wasukuma who bribe village leaders but at the same time, Wasukuma are never invited to village meetings. A Msukuma who arrived 5 years ago finds it difficult to be a newcomer here because everybody tries to ask them for money (S_SR18). On the other hand, the Wakonongo buy food (milk, potatoes, rice or vegetables) or charcoal from Wasukuma and some even welcome them. Two focus groups of women (F_WG06; F_WG07) told us that the relationships with the Wasukuma are good. F_WG06 is quite happy because Wasukuma have brought new food into the villages and they can do business with them.

This section, about “When Livelihoods and Culture are linked to Natural Resources”, has allowed us to gain information about the diagram components of **local population, users** of natural resources and qualitative data about their **extractive activities** in the FRs and village land. We would like to emphasize that the situation of the local population is still precarious due to the small amount of physical, human and financial assets available for facing shocks and due to the lack of support from the government. Farming is the main activity but alone it is not enough to satisfy basic needs and secondary activities are needed to generate additional incomes. These secondary activities, such as beekeeping, fishing, logging and poaching, are often linked to natural resources (especially for the men) and are practised in the FRs of our study area. Natural assets are significant for the livelihoods of the local population and can reduce their vulnerability. However, these assets are not secured because of the regulations and the competition with newcomers and outsiders which is stimulated by market incentives and their own livelihood strategies. Thus, the number of users in FRs is increasing and the practices are changing, as in the Konongo society. Some traditional rules which were respected in the village and in the forest a few years ago are no longer respected and the traditional chiefs do not seem to have power anymore. Only some of the beliefs and traditional medicine knowledge remain. On the other hand, the Sukuma society is stronger and is less subject to traditions decrease. The Wasukuma were better prepared to deal with the market and socio-economic changes due to their long-standing agricultural and livestock keeping skills. Their herds represent financial assets which allow them to invest in new economic strategies and cope with unexpected events.

3.2. IMPACTS ON ECOSYSTEMS AND CONSEQUENCES

This section presents the results of ecological and social data concerning the FRs and their natural resources. We will first speak about the evolution of forest cover as measured with satellite images. Next, we will present and comment on the results of the large and medium mammals' survey and the activities observed in the field. This will lead us to the stakeholders' perceptions about the evolution of ecological conditions, the problematic activities threatening natural resources and how the stakeholders think the situation could evolve.

3.2.1. Changes in forest cover

In 2002, on the 640 km² of village land, the cultivated and inhabited surfaces represented 375 km²: 336 km² for the Inyonga area and 39 km² for Ilunde (represented in yellow in Figure 10). We can see that cultivated areas are fragmented. There are isolated patches inside the forest like in Mapili, Ipwaga or Kamsisi. In 2015, cultivated lands covered 929 km², 762 km² for Inyonga and 167 km² for Ilunde, which represent an average increase of 248%, 227% and 428% respectively (the 2015-state is represented in orange in Figure 10). The largest area of extension for Inyonga is in the east of Kamalampaka with an extension of up to 15 km in length, probably because of favourable habitats. We observe a massive increase in the north of Utende and the south of Masigo and Mapili as well. Two new villages have been created, Namba Moja (north of Utende) and Songa Mbele (East of Kamsisi), represented in blue on the map. In Songa Mbele, there are already 1500 inhabitants and 1700 cows and no more land is available (PC05). The only side where there were few changes in forest cover is the west of Nsenkwa. This is perhaps due to the fact that this place was already quite far from the villages and farmers preferred to extend cultivation into forests closer to the villages. Extension to the west of Kanoge was limited and people from this village think that it is thanks to the BKZ and patrols of VGS (F_VS09). In regards to Ilunde, the extension was quite concentric, with a tendency to spread towards the North-West. The FR the most impacted by encroachment is the Inyonga FR. Inyonga villagers can attest to this massive reduction because they remember that the forest was very close to the village in the 1970s (S_SR19) and even in 1994 (S_FS17). According to the last interviewee, a high rate of deforestation only began 3 years ago.

Between 2002 and 2015, the population of the Inyonga Division increased by 181% (see Table 4), which is far less than the deforestation growth of 248%. This discrepancy could be explained by two combined elements. First, the 929 km² of cultivated land are not all intensively exploited. There are some wooded grasslands and one can still find small patches of forest, especially North of Ipwaga, East of Kanoge and West of Ilunde (see satellite images in APPENDIX 16). Consequently, this reduced the impact of the extension a little. Secondly, the land cultivated per inhabitant could have increased between 2002 and 2015 due to the cultural practices of the Wasukuma (even if we do not have official figures). They use a lot of land for cultivation and for livestock, more than the Wakonongo, which implies an unproportioned growth of cultivated lands. Nonetheless, regarding Ilunde, the disproportion between land and population growth is enormous: 428% of cultivated land versus 164% of population growth. As many Wasukuma are settling in the periphery of Ilunde, they were perhaps not counted by the 2012 census or they have come in a massive way since 2012, at a rate greater than the official 3.2% annual growth. We can also add that the density of the fields is lower in Ilunde than in

Inyonga, as they still have important forest patches. This can relativize the huge land conversion. One Ilunde village leader (PC02) told us that the ward consists of about 8000 people, which is double that of the official numbers. Another leader (S_KR11) thinks that Ilunde was better preserved than Inyonga because of its remoteness and its unique tribe. However, these conditions are no longer present and Wasukuma arrived massively 5 years ago.

Table 4 Evolution of the cultivated land and population between 2002 and 2015.

Year	Inyonga Division		Inyonga		Ilunde	
	Total cultivated land (km ²)	Population*	Cultivated land (km ²)	Population*	Cultivated land (km ²)	Population*
2002	375	21,111	336	18,613	39	2,498
2015	929	38,137	762	34,049*	167	4,088
% of increase	248	181	227	183	428	164

*Based on the 2002 (URT, 2015) and the 2012 Census (URT, 2013) with a 3.2% annual growth rate for the District.

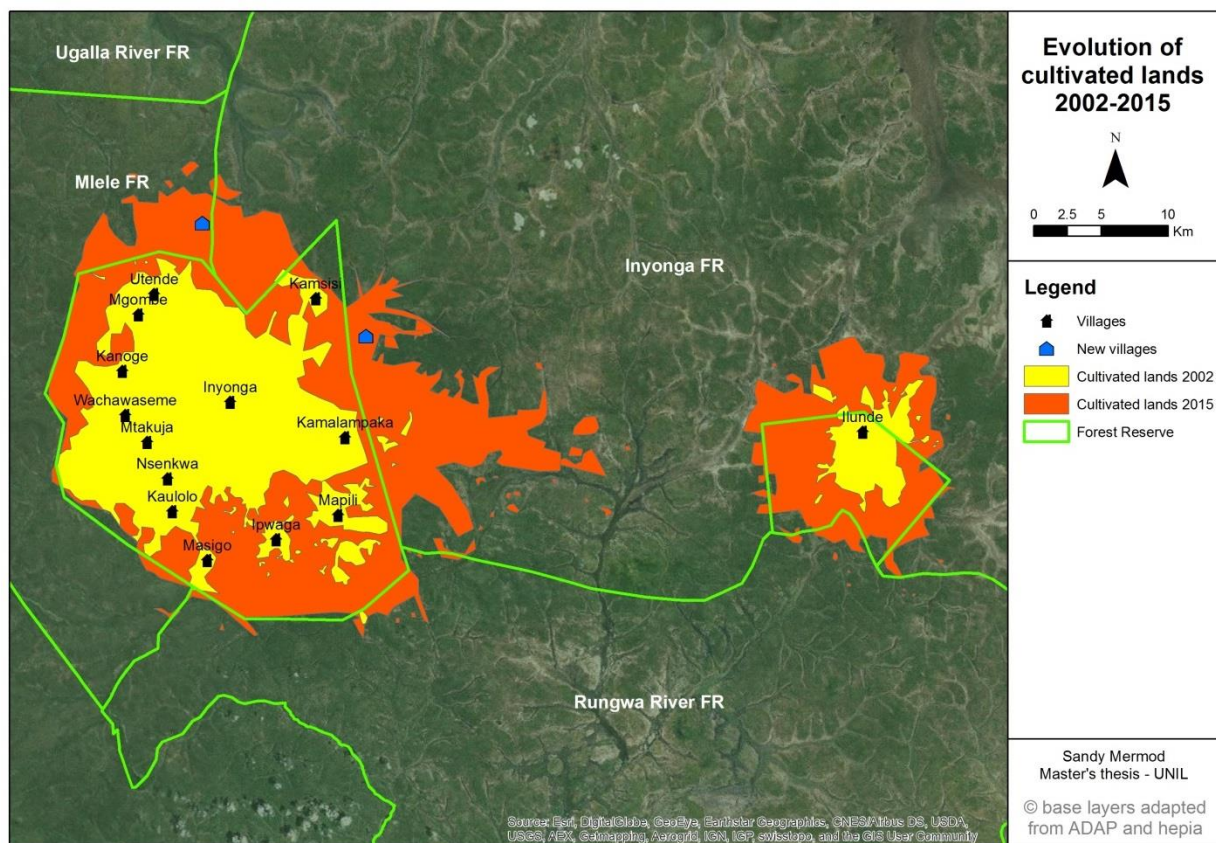


Figure 10 Map representing the extension cultivated land between 2002 and 2015.

To analyse the cultivated land extension from a legal perspective, we need to see how it is linked with village land boundaries and Land Use Plans. The village land delimited for the Inyonga area is about 540 km² and that for Ilunde 100 km². However, it seems that current maps do not take section 15 of the 1995 Village Land Act n°5 from 1999 into account. This section stipulates that former ownership stopped when government settled in an Ujamaa village during Operation Vijiji between 1973 and 1974 and that the radius for village land should be 5 km for agriculture and 2 km for livestock (F_GM01). If we try to draw a radius of 7 km for each village (except the new ones, Namba Moja and Songa Mbele because they were established after 1974) we have an approximate idea of where the new village land boundaries

should be (represented in APPENDIX 17). In the East of Kamalampaka, these boundaries have already been exceeded by the deforestation and accordingly most of these new village lands would be inside the FRs, like for Masigo, Kamalampaka, Kamsisi and Ilunde. As a proposal for degazettement was submitted by TFS for these issues (F_GM01), we still do not know what will be approved by the government and enforced. Thus, for the moment, we suppose that the current boundaries on the maps represent the village land. The same boundaries are used by the Land Use Plan (available in APPENDIX 18), except for Ilunde where the Land Use is planned inside 45 km² of the Inyonga FR.

In regards to this Land Use Plan, a land use officer (S_NE14) explained that although it is relatively recent, it is already outdated. The villages and the District have neither respected nor followed the plans for the land planning and newcomer accommodations of the last few years. There are many rumours about land mismanagement and Villages and District leaders inviting and settling Wasukuma in exchange for bribes (S_GM01; F_VS10). Some village forests do not exist anymore or have reduced dramatically (confirmed by several villagers) and as we have seen, the settlements extend far over the village land boundaries. The only place where the cultivated fields do not go over the FRs boundaries is in the west and south-west of the Inyonga area, probably because of the enforcement of the BKZ boundaries and the Rukwa GR patrols on the western side.

3.2.2. Large and medium mammal species

Camera traps and opportunistic observations allowed us to identify a total of 43 large and medium mammal species in the study area, 37 with camera traps and 6 by observation only. Among these 43 species, 4 are considered threatened by the IUCN Red List: elephant, hippopotamus, lion and leopard. The research effort and the areas sampled were not sufficient to get an inventory of all the present species (we identified a potential of 64 species, see APPENDIX 9). For example, after 6 years of monitoring, we know that the Mlele BKZ harbours 52 species of large and medium mammals and that Stampfli (2016) needed 2471 CT days to inventory 41 species in the Rungwa River FR. Thus, we should not forget that the non-detection of a species does not confirm its absence, especially for a small survey. Nevertheless, our survey allows us to make a first comparison between the different FRs and would be a useful guide for future mammal surveys. We will now present results for each method.

Camera traps is the method which gave us the most details to analyse. Camera traps captured a total of 37 large and medium mammal species in 618 CT days with 649 independent pictures. The FR with the highest species number is Ugalla River with 31 species, followed by Rungwa River with 29, then Inyonga with 25 and finally Mlele with 14. However, we need to report these numbers alongside the CT days, and complete the analysis with the capture rates if we want to compare the FRs. The table with the parameters for each CT site is found in APPENDIX 19 but Table 5 gives a summary of the total data per FR. Figure 14 presents some of the pictures collected with camera traps.

CT days vary a lot between the FRs; hence it is interesting to divide the number of species and independent pictures by the number of CT days to make a coherent comparison between the FRs. This reorganizes the rank of the FRs. First comes Mlele with 0.183 species/CT day, then

Inyonga with 0.178, Ugalla River with 0.151 and lastly Rungwa River with 0.149. We can also compare the independent pictures/CT days, and this gives us a new ranking. Ugalla River is first (1.361), then Inyonga (0.976), Rungwa River (0.949) and lastly Mlele (0.614). The results of the Kruskal-Wallis test, using data at the CT site scale, show that there is no significant difference between the means of the FRs for the different variables (in APPENDIX 20). If we look at the boxplots, we see that Ugalla River data are generally more spread out than other FRs and that Mlele has the lowest mean of all the FRs.

Table 5 Camera traps data summarized by FRs.

FRs	CT days	Nb pict total	Indep mamm pict	Nb. mamm sp.	Species/CT days	Indep./CT days
Total Mlele	77	4039	47	14	0.183	0.614
Mean Mlele sites	19	1010	12	3.5	0.046	0.153
Total Inyonga	140	15440	137	25	0.178	0.976
Mean Inyonga sites	14	1544	14	2.5	0.018	0.098
Total Ugalla River	206	11071	280	31	0.151	1.361
Mean Ugalla sites	19	1006	25	2.8	0.014	0.124
Total Rungwa River	195	16880	185	29	0.149	0.949
Mean Rungwa sites	18	1535	17	2.6	0.014	0.086
Total FRs	618	47430	649	37	0.060	1.051

Capture rates of each species were calculated for the different CT sites (APPENDIX 21) and we did a Kruskal-Wallis test to see there were differences between FRs. The only species for which the kind of FR is significant are the hare, the common duiker and the greater Kudu (see results in APPENDIX 22), but it does not seem to be the result of management or human disturbance (see argumentation and distribution map in APPENDIX 23). Some species that should be more abundant in this ecosystem, have a really low total capture rate or were not captured at all. This is the case for the buffalo, the topi, the leopard, the elephant and the lion and is indicative of a high poaching/hunting pressure on these species or of the loss of prey basis for the lion.

As the different FRs do not seem to influence the species or independent pictures, we can try to see if other variables, such as the natural habitat, influence them. According to the Kruskal-Wallis test (in APPENDIX 24), habitats have significant impact on the number of independent pictures, on the species/CT days and on the independent pictures/CT days. Mbuga and edge habitats (between mbuga and miombo) have the highest number of independent pictures, followed by riverine forests. For the species richness, there are no significant differences between the habitats, but open woodland and wooded grassland have the highest species richness/ CT days. The miombo has the least amount of independent pictures/ CT days. These results make sense as we sampled during the dry season, when the miombo has little water and few available pastures, both of which are available in more open habitats. As some FRs like the Rungwa River or the Mlele had many CT sites in miombo, they could have influenced the results a little in regards to independent pictures because the wildlife was less abundant and thus would relativize the ranking made above. The edge habitats are the best for capturing different species and independent events as they harbour two kinds of habitats and animal paths often follow the edges.

Besides the influence of habitats, we can look to see if the proximity of human infrastructures has an influence on our results by CT sites. In Figure 11, we notice that areas with the greatest number of species are not close to main roads or villages but that they do not seem to follow a gradient. The proximity of the water like the Msima River (to the west of Ugalla River) and the Rungwa River (south of the FR) seems important but not determinant. The CT sites near the Koga River (north of the Inyonga FR) do not have more species than other parts of the reserves, probably because the Koga River is highly frequented on both sides the fishermen, beekeepers, poachers and staff of hunting companies, as we observed during field exploration. In the Inyonga FR, almost all the area sampled are found along roads/tracks linking different places (Ilunde-Koga, Ilunde-Rungwa) and frequented by many users, and not only users of natural resources. This creates disturbance for wildlife and makes it easier for potential poachers to come in.

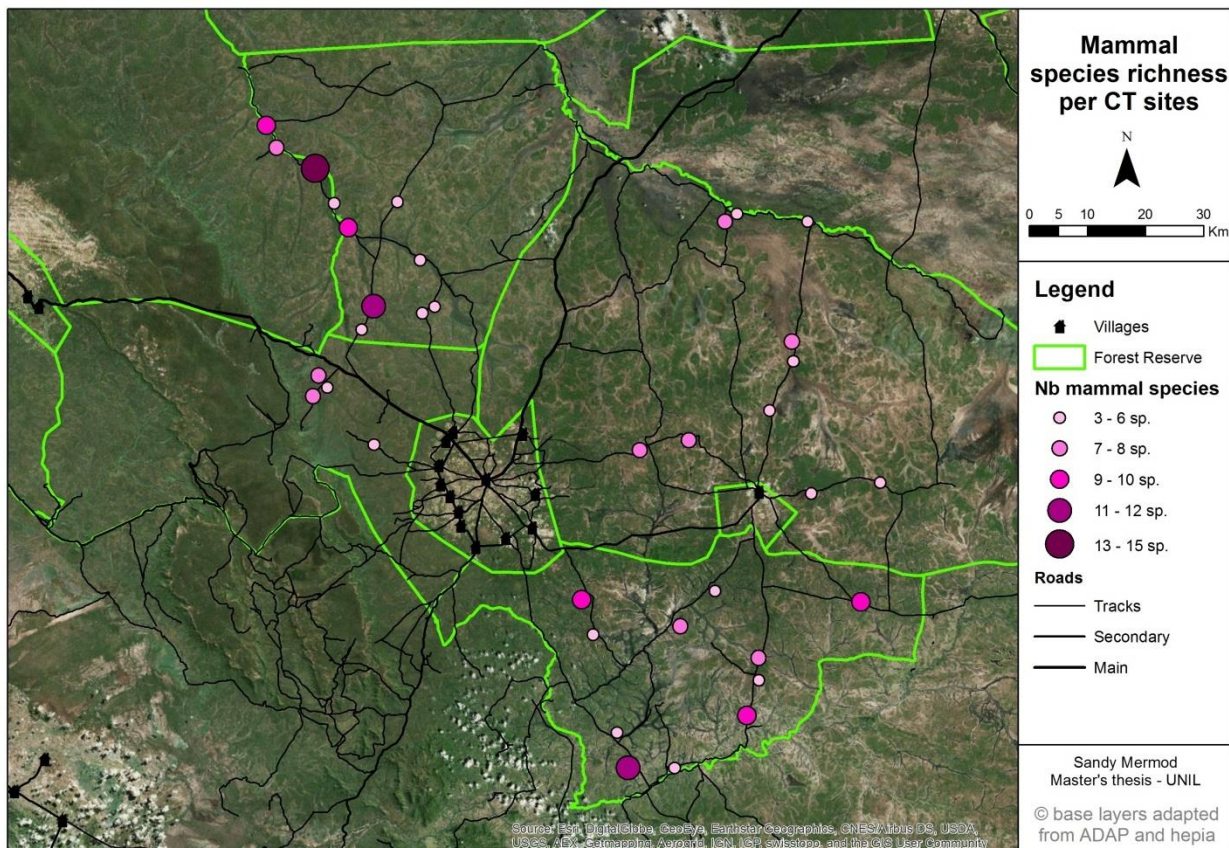


Figure 11 Mammal species richness per CT sites.

To close this camera traps part, we can highlight that Mlele appears to be rather poor area in terms of species and independent pictures. However, this is mainly due to the low sampling. Initially, 6 cameras were planned only because of the high sampling done the past years by UASWS. On the 6 cameras planned, 2 had a virus on the memory card and it was decided not to put the cameras again to save time. Moreover, not all the Mlele FR was sampled. If some cameras were set along the Iloba, a semi-permanent river, the results could have been far different. As there were many biases in the sampling of CT site, it was good to combine this method with opportunistic observations in order to make the results more representative.

The **opportunistic observations** modify slightly the results because they add new species that were not captured. In Mlele, the area covered for observation was bigger than the one for the camera traps. The table which present the species detected in each FR, for each method and with the frequencies can be found in APPENDIX 25. The total data are summarized in Table 6.

Table 6 Mammal species results for camera traps and opportunistic observations.

	Mlele FR		Inyonga FR		Ugalla River FR		Rungwa River FR	
	CT	Obs.	CT	Obs.	CT	Obs.	CT	Obs.
Species for each method	14	13	25	22	31	10	29	25
Frequency for each method (capt. rates for CT and numbers of independent sights for obs.)	0.614	26	0.976	76	1.361	30	0.949	120
Total species	22		34		34		37	
Red List species	2		4		1		4	

Rungwa River has now the highest species richness with 37 species, followed by Ugalla River and the Inyonga with 34 species each and Mlele with 22 species. The 120 observations done in Rungwa River might be due the presence of a lot of water and to the greater presence of the teams, which implies that some animals were perhaps counted more than one time. We can see on Figure 12 that there are more wildlife observations near the water. With about 50 observations, the Koga River influences strongly the total observations of the Inyonga FR. The places without observations are situated around the villages and along the main roads, especially the Inyonga-Tabora one. This indicates that species tend to avoid areas with high human presence. Some interviewees think that the wildlife does not come anymore inside the village land because there are too many people and poachers (S_FS17, S_LU04). Some women were used to see giraffes, lions and elephants near Inyonga in the past but now they do not even see baboons (F_WG07). Ilunde seems to have still wildlife around the village likely because there are far less people over there. Some “holes” in the observations map could also be due to the time of the exploration as midday is really not good for animal’s observations. However, the trips were done many times and not at the same hours, which should reduce the bias of hot hours.

In regards to the spatial distribution of some groups of species (camera traps and opportunistic observations), large ungulates (size from the waterbuck to the giraffe) are fairly widespread (see map in APPENDIX 26). They avoid only the mains roads, the villages and the escarpment. However, the buffalo was very rare during this study with only two sites in Ugalla, along the Msimba River, and one site in the Rungwa River FR. Bones were also observed in Rungwa River and PC05 saw some buffalo dungs in Mlele in the middle of August. The few buffalo observations could indicate the decrease of the populations in the region. This was confirmed by the fact that the WD did not find any buffalo to shoot in the Rukwa GR or other FRs for the Uhuru Torch celebration (PC05). In addition, very few buffalos were observed in Katavi NP in July. This phenomenon is likely to show a high poaching pressure on buffalo for its meat. The situation appears especially worrying for the FRs because Stampfli (2016) had 21 independent pictures of buffalo in the Rukwa GR and only 5 for the Rungwa River FR. Trophy hunting represents also a substantial pressure because the buffalo was the most heavily harvested species in 2014 with 10 individuals shot in the Ugalla River and the Inyonga FR (see APPENDIX

27). In regards to the carnivores (distribution map in APPENDIX 26), we notice a widespread distribution except along the main roads or around the villages. Ecosystems are thus still healthy to harbours species at the top of food chain, but with very few large carnivores such as lion or leopard. The hyena was observed near the water points and where there were many others species, but some villagers (S_SR19) told us that they regularly hear them at night at the periphery of the villages and that they kill goats, as the leopard does sometimes.

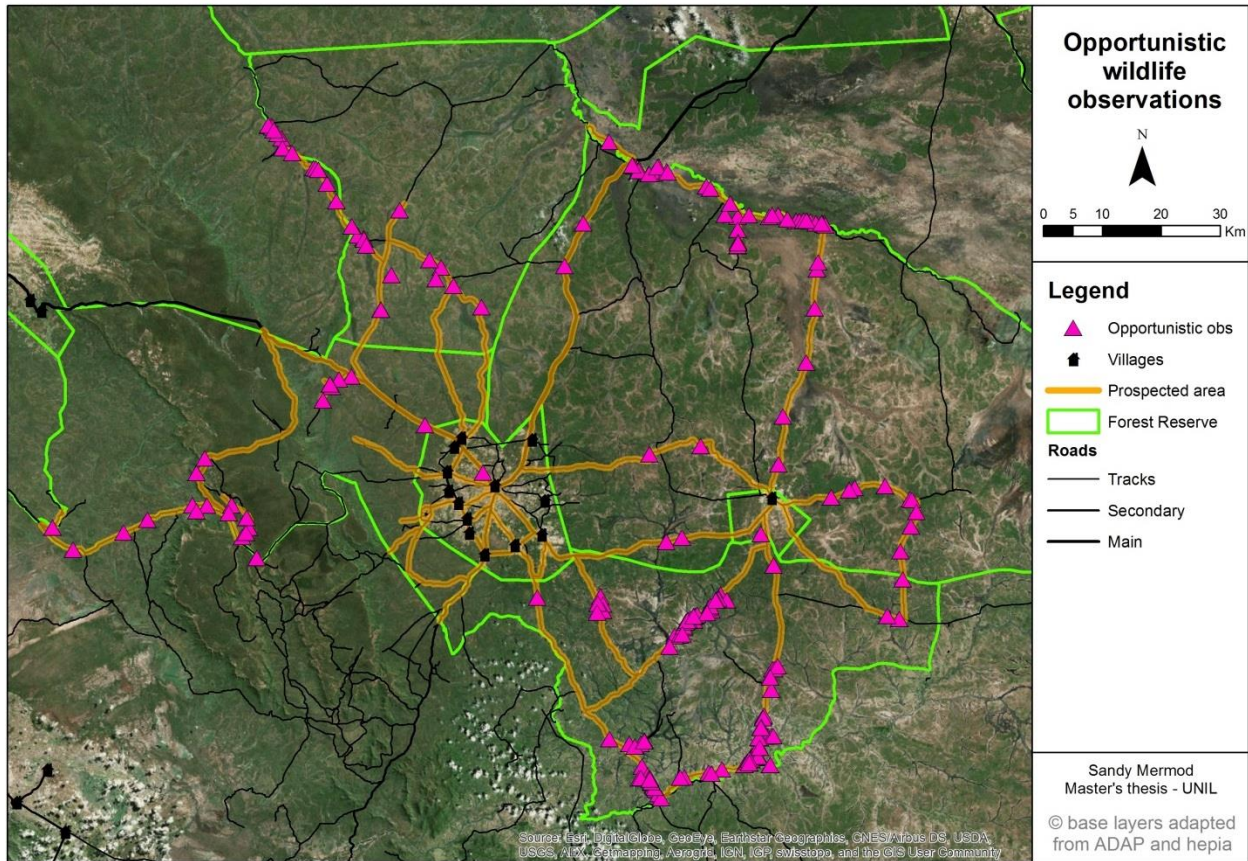


Figure 12 Locations of opportunistic observations of wildlife

Inyonga and Rungwa River are the only FRs to harbour the four threatened species (elephant, hippopotamus, lion and leopard). We know that the wild dog is present in the region but it was not detected in this survey or in the one of Stampfli (2016). Threatened species were observed mostly along rivers or in mbuga (see map in APPENDIX 28). There were less hippopotamus in the Koga River than in the Rungwa River but this is not because a lack of water. According to a fisherman (S_LU20) and our observations, hippos and crocodiles are almost finished by poachers in the Koga River and now they begin to go in the Rungwa River. Lion is surprisingly widespread and fairly close to human infrastructures. One individual was heard at less than 15 km of Ilunde and tracks were observed along the main road Mpanda-Inyonga. They do not seem to be in packs but alone or two-three individuals together. In the 70s, lions caught a lot of cows (S_SR19) but now they are not seen as a danger anymore by the villagers, especially cattle keepers, because they are in low densities (S_SR18). The ritual killings of lioness by Wasukuma do not occur anymore because there are no more lions and this tradition decreases. One Msukuma thinks that it is population growth which is guilty of the disappearance of lion and another one thinks that it is trophy hunting because they overkill it.

This fact was mentioned as well by F_CM04 who told us that there is no more lion in the Rukwa GR near Lukima because of the hunters.

Elephants were not seen directly, only tracks or dungs in two areas: Shama (Inyonga FR) and Ipenyero (Rungwa River FR). VGS reported to have seen elephants in Mlele along Iloba one night in August. In the past, elephants were used to come in the maize fields next to Inyonga (S_LU04). Now they are very elusive and move a lot, which might be an indicator of a high poaching level. This phenomenon is not specific to our area but occurs in all Tanzania which faces a high poaching wave. The country has lost 60% of its elephant population in 4 years (Kideghesho, 2016) due to the poaching of ivory for Asian countries like China or Thailand. The areas the most concerned by poaching are the Selous GR, the Ruaha NP and the Katavi-Rukwa ecosystem. Since poaching also occurs in NPs, the GRs and FRs are the first impacted because they are less managed and patrolled. In Katavi NP, it was alleged that some game wardens were involved in elephant poaching with 7 elephants killed near the headquarter of the park in January 2015 (PC05).

3.2.3. Activities observed in the Forest Reserves

The number of people encountered during the trips into the FRs was impressive. As many activities are allowed, it is quite normal to meet people inside the forest but there were also numerous people engaged in illegal activities. Moreover, this high frequentation was possibly due to the beginning of the dry season, when the activities overlap. Table 7 summarizes the **observations** by type and by legality. Out of 152 observations, 49% concern logging activities, 13% cattle keeping, 12% poaching, 9% beekeeping, 7% undefined, 5% fishing, 4% management and 3% clear cutting. The logging activity seems to be intensively practised but it is likely due to the observations of pit-sawings which are seen easily and last over time (which is not the case of other signs such as carcasses). The second and the third activities observed are illegal activities, cattle keeping and poaching, whereas management signs (mostly represented by staff) are the second to last activity. Agriculture was not recorded as it was treated in 3.2.1. Figure 15 gives an overview of the different activities with some pictures of the field work.

Table 7 Human activities observed in all the FRs.

	Observations	% of total	Nb of confirmed legal observations	Nb of confirmed illegal observations
Logging	74	49	3	3
Cattle keeping	19	13		19
Poaching	18	12		18
Beekeeping	13	9	5	8
Undefined	11	7		1
Fishing	7	5	4	3
Management	6	4	6	
Clear cut	4	3		4
TOTAL	152	100	18	56

Out of 152 observations, 56 were illegal, 18 legal and 78 were undefined. The rate of illegal activities is rather high and is due to the numerous observations of cattle keeping and

poaching activities. A particular poaching event occurred along Rungwa River. We saw a large amount of recent hippo carcasses in Ipenyero and we learnt from fishermen (PC15) that a group of 49 people (from Mapili, Mtakuja, Kamsisi, Ipole and Sikonge) killed 27 hippos and wounded 8 others the 17th July 2015. They harassed the fishermen to have food. The leader, a well-known poacher with one hand only, carried the AK-47. In regards to the legal activities, such as logging, fishing or beekeeping, their practice is subject to many irregularities. Some people fish with mosquito nets, which are very damaging for fauna and flora, and many fishermen do not have permit. S_LU20 estimates that 50% of the fishermen along the Koga River do not use proper nets. Some loggers do not have license, some use expired license, while others have photocopies from friends. S_NE14 heard that half of the timber is illegally cut in the surroundings FRs.

The **spatial distribution** of observations is not widespread and equal along the prospected area (see map on Figure 13). The roads Tabora-Inyonga and Inyonga-Mpanda have few users as people on the road were not taken into account. Permanent water bodies (especially where there is still some wildlife) attract many users who have to share the space and coexist. There are a concentration of sights in the south of the Inyonga FR and overall the Rungwa River FR, mostly due to pit-sawings. The data confirm that poaching activity occurs along the big rivers and even along the small ones like the Iloba River. Four poaching signs were observed around Ilunde, including a weapon shot. Inside the FRs, management activities were seen at the hunting camps and at the WD headquarter only. The research permit for this study was controlled only twice by hunting companies at their camps. In addition to the cultivated areas, cattle were seen in the north of the Rungwa River FR, near Ilunde and on the road Mapili-Illunde. Furthermore, the Wasukuma are used to cross the Inyonga FR with their cattle. In the bus Tabora-Inyonga, some Wasukuma stopped in the middle of the bush with provisions, they probably wanted to join fellows with their cows. Cattle keepers enter inside the FRs because it is difficult for them to find good pastures in the village land (S_SR19; F_SR05). Forest clear-cutting is never far from the cultivated front and was not observed in the middle of the forest. Generally, the deforestation is progressive, which reflects the slash-and-burn practice: some trees are cut for timber or tobacco curing, then farmers cut many trees to cultivate and remove the others years after years. That is why we find, in many places, a continuum from “clear cut” near the fields to “some trees cut” after 500-2000 m from the last fields. There is nothing particular to say about beekeeping, except the fact that they were many trees cut to harvest wild honey in the Rungwa River FR.

No charcoal production was seen perhaps because, for the moment, it is still produced in the edges of the village land by the Wasukuma. We only heard about a large charcoal production near the Katumba refugees’ camp and Urawira village (to the west of the study area). It was observed that users do not enhance the natural resources they use (legally or illegally). For instance, some Wasukuma clear cut and burn the trees to cultivate instead of using the trees to product charcoal or to sell them for fuelwood, the loggers take only the standard length of planks and let the rest of the tree in the bush whereas it could be used for other purposes such as houses framework or fuelwood and poachers take only ivory from elephant and let the meat in the bush. One particular observation was the remains of an old village, Mfuluro, inside the Rungwa River FR. This village was still inhabited in 1890, before its displacement by the British.

We found a human tooth, old potteries and a stone to saw mill (see Figure 9). Lastly, it is not possible to affirm that activities inside the FRs (other than permanent settlement and encroachment) such as logging or beekeeping, affect the wildlife distribution since wildlife is also present in places with a high rate of activities.

People were met regularly inside the FRs (see map in APPENDIX 29). However a higher intensity of illegal people was observed around Ilunde and along the main rivers. Out of 34 people met in the FRs, 16 were legal and 13 were illegal (we did not know for 5 people). Only four women were seen in all the FRs (3 fisherwomen and 1 game warden), which highlights the fact that the bush is still a place for the men. In addition to the activity they are engaged in, all the human beings have an impact on the habitats and the natural resources because they need a camp, water, firewood and they use material such as batteries, radios, torches, buckets, etc. The camps of others users are far more rudimentary with only a hut, a fire place and latrine. Most of the time, the users leave their rubbish (batteries, plastics) at the camp site. Hunting companies should normally remove all the material from their camp when they finish the season. However, in Ipenyero the company abandoned its camp and now one can find old toilets and pipes in the middle of the bush. This phenomenon could be seen as marginal but as there are many registered and temporary camps in the FRs, it could have a substantial impact on the resources. Moreover, users start bushfires, intentionally or not, which can be harmful to the vegetation and the wildlife if they occur at the end of the dry season (Frost, 1996).

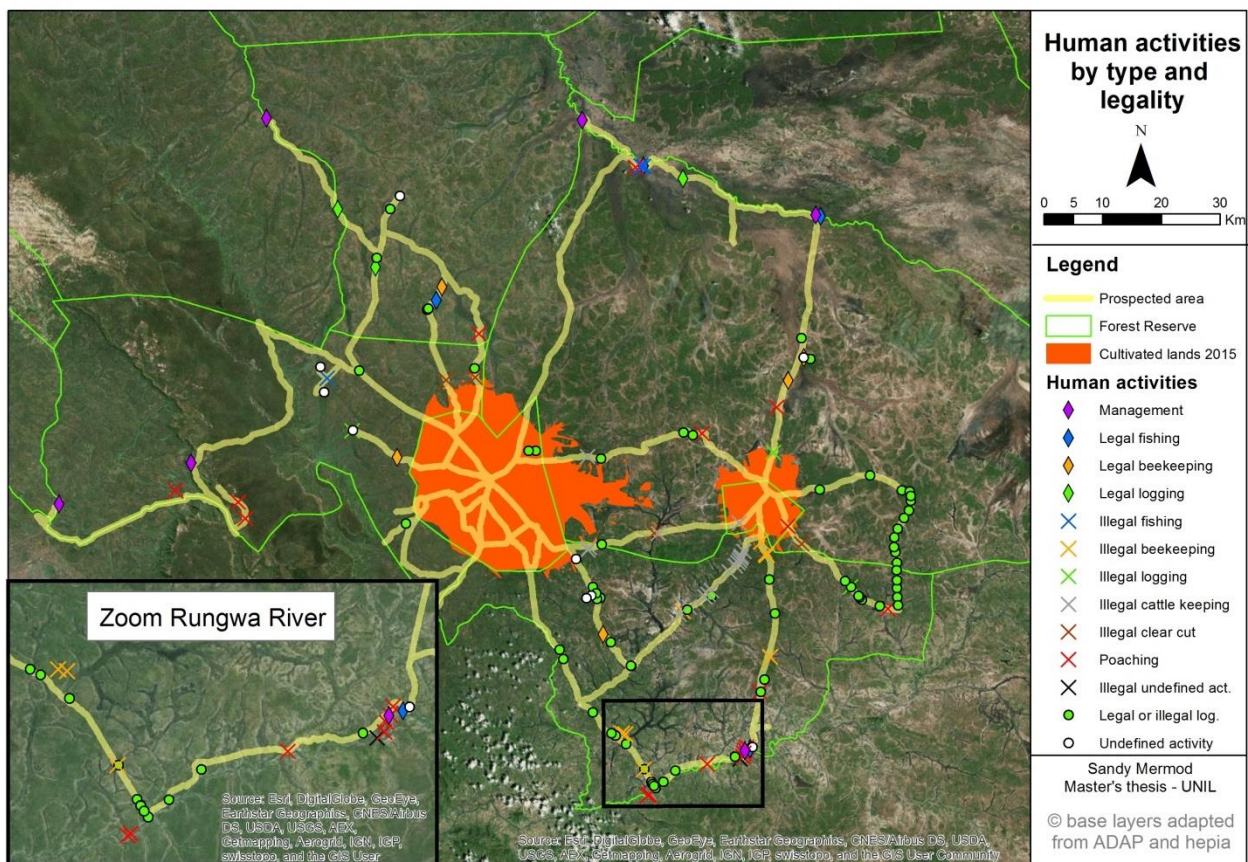


Figure 13 Map of human activities observed in the FRs.

There are no significant differences between the FRs regarding the total of observations, their legality, the people met or the type of activities. However, if we look at the data per FR (in

APPENDIX 30) we notice that the FR with the greatest number of human activities is Rungwa River with 86 observations. It is followed by Inyonga with 36, Mlele with 16 and Ugalla with 12 observations only. The high number of observations in Rungwa River is due to the pit-sawings seen and the cattle encountered. This might be explained by the fact that the hunting company does not operate anymore and therefore no anti-poaching patrol is conducted in the area. The south of the Inyonga FR is highly concerned by logging as well and it was where many loggers (legal and illegal) were seen. Thus logging and poaching pressure seems to be very high in the Inyonga and the Rungwa River FR.

3.2.4. Stakeholders' perceptions of resources evolution and its effects

The landscape of our study area has undergone substantial modifications, with an increase of cultivated areas and a high rate of activities which use natural resources, the last 15 years. Most of the interviewees confirm this **evolution** and mention the decrease of natural resources over the past years. The forest was closer to the villages, as wildlife did, and there were less timber and wildlife poachers (S_LU08). Elephants were seen around the village 25 years ago but nowadays the villagers do not even see one (PC20). Traditional healers go ever further to find plants for preparing medicine (F_KR02) and loggers harvest in the GRs because timber reserves have decreased in the FRs or some parts of the forest are totally destroyed (PC23; S_GM01). Two interviewees confirm that they have already seen some changes in rainfall patterns for 25 years with a decrease of water in the rivers⁴². One of them thinks that this decrease is linked to the reduction of forest cover and the traditions which die away (S_SR18). The large quantities of water consumed by Sukuma cattle cause some scarcity problems in the periphery of villages since some springs were destroyed. According to a fisherman, the fish stocks have decreased for 15 years due to the use of wrong nets (S_LU20). In regards to the honey, it seems that the quantities have decreased in the forests close to the villages because they are degraded (S_LU08). However, the honey quantities at the study area level have not decreased yet and there are few differences between FRs. Nevertheless, a change could come fast. For instance, some beekeepers of Tabora come in Mlele District FRs because their activity is almost finished in their region (S_GM16; F_CM04). Most of the interviewees confirm that grazing has exploded inside the FRs and an ADAP's employee (PC05), present in the region for 20 years, is impressed by the high number of people inside the FRs. Some interviewees such as beekeepers or VGS think that the only place where few resources have decreased, except the elephant, is the Mlele BKZ (S_LU08; S_FS09; F_CM04). One game warden and one villager think that the resources are more preserved in GRs than FRs because there are more patrols (S_LU20; PC23).

There is an agreement in interviewees' views about the worrying situation in regards to the forest and natural resources loss and their **predictions** about the future are quite pessimistic. Out of 30 people interviewed, 12 mention clearly that if no measures are taken to curb down illegal activities, almost nothing would remain of the forest and its natural resources in 10-20 years. Most of the others mention fears concerning the future of natural resources. The local managers do not refute such pessimistic analysis (AM02). A hunter (PC12) thinks that large

⁴² However, Caro (2008) observed no rainfall decrease for Katavi NP between the 1980s and the 2000s.

mammals and reptiles could disappear from FRs before 2025. In his view, the situation is similar the one in Central African Republic 10 years ago, when it lost most of its savannah wildlife (Bouché et al., 2012). A logger is afraid of an imminent scarcity of timber species in the region. No one mentions hope or confidence for the future of the FRs of the District. However, some interviewees reported that some villagers think that there are enough trees in the forests and do not care about environmental issues (S_GM16; S_LU04). Fishermen met in Koga told us that if everybody fished like them, it would remain nothing for the children (PC13). The old Wakonongo are afraid for their natural resources and the current degradation are new for them. They know that their traditional powers cannot avoid them (S_KR10; F_KR02). Several personal comments confirm the worry and feeling of helplessness also for the natural resources at a national scale. Some interviewees are optimistic for the Mlele BKZ but only if the VGS patrols are maintained (S_LU08). The decrease of natural ecosystem would affect the forest, its functions and the natural resources, which would **impact the local population**. The elements that would be problematic for people are summarized in Table 8 below.

Table 8 Consequences of forest degradation for the local stakeholders, with the number of mentions.

Environmental impacts	Social impacts	Economic impacts	Cultural impacts
Modify the rain patterns 8	Unavailability of forest products for daily uses 4	Reduce incomes of the District 1	Loss of culture (knowledge on wildlife and forest, rituals, traditions, ...) 5
Land will become a desert 3	Nothing will be left for next generation 3	Loss of incomes related to wildlife for the country 1	Spirits will be very angry 1
Degraded sources of water 1	Degradation of means of living 2		
Lack of good pastures 1	People will die 1		

The rain is the first mentioned element. The villagers know that when the forests are clear cut, there is less rain. They heard about examples in other parts of Tanzania such as Shinyanga or Dodoma or Urambo. Some Wasukuma have already experimented a decrease of rains and soils fertility in Tabora Region, which pushed them to migrate. Villagers know that without rain and without trees the soil would not be fertile. A decrease of water and fertility would induce less harvest and less pastures which would reduce the food and incomes of the households. That is why two people said that their means of living would decrease. That is why some people think about a desert and one person thinks that they would simply die (S_LU05) in the eventuality of a massive loss of forest. This image might be felt as excessive, but since most of the miombo soils are nutrient-poor, sandy and ferralitic, the run-off and erosion would be significant without vegetation cover (Frost, 1996).

The second fear is the loss of culture (5 people mentioned it). According to a beekeeper, traditions and culture have better chance to survive if they are still forests. The Konongo culture is strongly linked with natural resources, especially for rituals and traditions. Moreover there is an important knowledge about forest and wildlife which could be lost if people are no longer in contact with natural habitats. The wildlife knowledge has already decreased

significantly because most of the villagers, especially the children, do not live in contact with wildlife anymore, The children do not know how the wildlife they sometimes eat looks like and some adult do not make the difference between buffalo and hippo meat (S_FS09). Only one person thinks that the spirits will be very angry if they destroy the natural habitats.

The unavailability of forest products is the third people’s worry. No more forest products would mean the end of some activities, such as traditional healer or logger, and a crucial production decrease for beekeepers. Moreover, all the households are more or less concerned by gathering and if the products are not available close to the villages, it will represent a loss for medicine and food supply (F_WG06). The lack of fertile land and forest products would impact the future generation. As a focus group said: *“We need forests for our lives. Houses and fields are not enough.”* (F_VS10). Lastly, it is interesting to see that even if natural resources degradation would have indirect impacts on local and national economy, only two interviewees spoke about economic impacts. During the interviews, the villagers often mentioned the lack of financial funds they face in the daily life but they did not say the word “money” to speak about what they would miss if the natural habitats disappear. Perhaps it is due to the way the question was asked, that did not explicitly link the forest to their incomes.

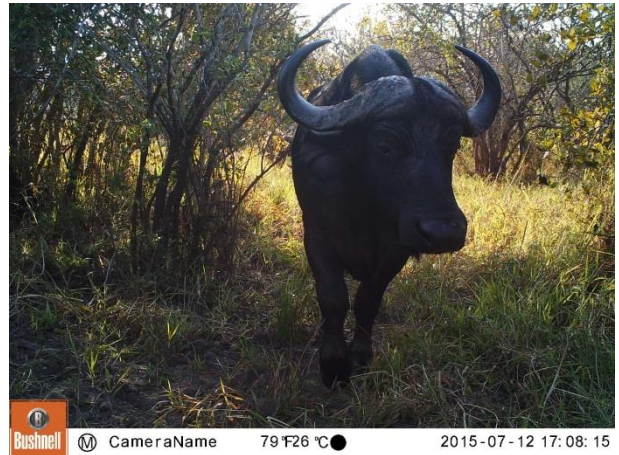
The **problematic activities**, which are the most harmful for the forest and natural resources from the views of interviewees, are compiled in Table 9. The Wasukuma are considered the worst activity since they were mentioned by 11 interviewees (including one Msukuma). It is interesting to see that people speak about a tribe instead of an activity, which shows how the Wasukuma are perceived. This tribe is accused to settle inside the FRs, to clear cut large areas to cultivate, to exhaust pastures and water with their cattle and to product charcoal. Some villagers think that the Wasukuma are not afraid to violate traditional or legal laws (F_VS09). A FR manager said that *“The Wasukuma are flowing in the District and it is not sustainable the way they cultivate”* (S_GM01). The Wasukuma are accused to exhaust natural resources before shifting to another place but not all the members of this tribe behave like this (S_SR18).

Table 9 Assessment of problematic activities by interviewees.

Activity	Number of mentions	Kind of impact
Wasukuma (settlement, farming, livestock keeping)	11	Destroy forest habitats and could bring diseases to the wildlife with cattle.
Logging	5	Select some species only but need to open new roads inside the forest.
Livestock	4	Could bring diseases to the wildlife and make disturbance.
Tobacco	4	Destroy forest habitats and consume a lot of wood for curing
Farming	3	Destroy forest habitats
Charcoal	2	Destroy the trees
Poaching	2	Kill wildlife only but which can have impacts on ecosystems balance
Mining	2	Destroy forest habitats and engender pollution
Tree debarking	1	Kill some trees only
Settlements	1	Destroy forest habitats
Tarmac road	1	Disturb habitats connexion and new ways for activities
Wahutu	1	Heavy wildlife and timber poachers



Common eland



Buffalo



Leopard



African civet



Bushy tailed mongoose



Lichtenstein's hartebeest



Warthog



Female of sable antelope

Figure 14 Overview of some camera trap's pictures.



Encroached area near Songa Mbele



Clear cutting near Namba Moja, a new village



Sukuma cows in Ilunde



Hippo carcass along Rungwa River



Pit-sawing for timber logging (Stampfli, 2016)



Fishermen with forbidden net in Koga River



Control of illegal users



Trophy hunting camp inside Inyonga FR

Figure 15 Illustration of activities observed inside the four FRs.

Logging is the second problematic activity people's view. One forest manager and one partner of a timber company confirm that the current logging activity is unsustainable. The focus on few tree species provokes a massive decrease in these populations whereas there are other suitable timber species (S_GM02). The third level problematic activity is livestock keeping due to the massive arrival of the Wasukuma with their cows over the past years. The damages made by the cows and by their keepers to the forests are seen as a disruption by local population. Farming is also seen as a very problematic activity for the forest. Tobacco growing is a problem in itself because of its responsibility in the encroachment front, soils impoverishment, use of chemicals and fuel wood consumption for curing the leaves (S_NE14; S_FS17). Some women also spoke about health problems due to chemicals and smoke during the curing (F_WG07).

Activities mentioned twice are charcoal production, poaching and mining and activities mentioned only one time are tree debarking, settlements, tarmac roads and Wahutu refugees. The tree debarking was mentioned by a forester who thinks that without this practice, the beekeeping could be fully sustainable (F_GM01). Settlements concern the illegal Sukuma houses inside the FRs and not all the villages in general. There is no tarmac road in our study area yet but this threat was mentioned since there are some projects of tarmac roads in Western Tanzania. The Wahutu are blamed for forest and wildlife degradation because they poach with automatic weapons, cut a lot of timber and steal honey. An interviewee thinks that previously the Wahutu refugees were problematic for wildlife but now the biggest problem is the Wasukuma because they destroy the forest with their swidden agriculture and then move to other regions (S_GM16). The village representatives of a focus group (F_VS09) did not agree about who were the worst between the Wahutu and the Wasukuma. Fishing was not mentioned as a problematic activity by the interviewees, perhaps because they thought more about the forest (in the way they were questioned) and the permanent rivers are far from the villages (50 km). However, a fisherman (S_LU20) explained that fish populations are exhausted in Koga in two months because there are too many fishermen over there (due to the easy access by bus). Nevertheless, according to him, the biggest problem of fishing activity is not the number of users but the nets which are used (mosquito nets) and the way they are put in the river (across the width of the river).

This section about “Impacts on ecosystems and consequences” gives us information about the components **ecosystems** of FRs and village land, with a focus on wildlife and forest cover, the effective **activities** practiced inside FRs and their presumed effects on ecosystem functions and **local population**. To summarize we can highlight the fact that the cultivated land has grown faster than the population, encroaching on the FRs and not respecting the Land Use Plans. The encroachment front is progressing fast from Ilunde and Inyonga and is accompanied by high rate of cattle grazing and progressive forest degradation. Out of the encroached area, the forest is still substantial but some timber species are cut massively and large mammals are heavily poached along the main rivers. Fish of these main rivers are overexploited due to numerous fishermen and incorrect practices. There is thus a significant proportion of illegal activities occurring inside FRs. There are no significant differences between FRs however, the Inyonga FR is the most affected by encroachment and has to face several illegal activities in its Southern and Northern parts. We also notice a high rate of activities in all the Rungwa River FR, especially logging and poaching. Some activities and impacts, for example farming, are easily seen with satellite images, but others, such as logging or poaching, are more insidious because they do not change the land and forest cover sufficiently to be noticeable. However, they affect importantly the natural resources and ecosystem, particularly forest structure and densities of exploited timber, showing the need to assess the situation in the field. Regarding mammal populations, there are no significant differences between the four FRs in terms of species richness and capture rates. There is still wildlife but not in high densities, except for the habitats near water and with good pastures. Some patrimonial species, such as the elephant, the buffalo, the lion and the leopard seem to have a very low occurrence; this is not linked with the habitats or other ecological variables but with human pressures, such as poaching, hunting, habitat degradation and disturbance. The periphery of the villages and the main roads are avoided by all the wildlife, indicating a negative impact of these infrastructures on it. Unfortunately, baseline data are lacking making it difficult to compare the current results and confirm a decreasing trend. Nevertheless villagers attest a population decrease and the disappearance of wildlife from areas where they were used to be in the past.

Consequently, the FRs are still harbouring important natural resources and biodiversity but they are weakening every day because they are under pressure both from the peripheries and from inside. Rungwa River is the FR with the highest number of species but with the greatest number of human activities as well. According to interviewees the situation is likely to become worse in the coming years if nothing is done to ensure a more sustainable use of natural resources. Local population is afraid for the future because a loss of forest habitats and natural resources would have harmful impacts on their activities. A recurrent preoccupation is the lack of rain linked to the decrease of forest which could impact strongly agriculture. The Wasukuma’s activities are seen as the most problematic for the ecosystems because they provoke a high encroachment due to agro-pastoralism and settlement. The other preoccupying activities are logging, cattle rearing and tobacco farming. The large encroachment and the numerous illegal activities observed question the efficacy of the state to manage the FRs, whose activities represented only 4% of the observations.

3.3. EFFECTIVE MANAGEMENT OF FOREST RESERVES

In this section, we present the management as it occurs in the field in order to see what is done to manage and control the four FRs of the study area. Firstly, the effective organisation and the interactions between the different government managers and stakeholders, such as companies or NGOs, are outlined. Secondly, we present the planning and regulation activities of FRs, followed by control and sanctioning activities. Finally, examples of conflicts between managers and users are highlighted.

3.3.1. Government managers and their organization

Local government managers⁴³ of FRs are TFS Inyonga and the Mlele District, represented by District Land and Natural Resources Officer (DLNRO) and District Forest Manager respectively. The DLNRO is under the MNRT to advise the District, and the TFS manager is under a zonal office which is under TFS headquarter (the one defining the strategic management). National FRs should be managed by central government through TFS in collaboration with the District (Msemu, 2013) but in Mlele, the District level is still strongly involved in the management because it was the only one present in the past. One should not forget that TFS is fairly new in the landscape because this agency was created in 2011 and it has been present in the Mlele District only since 2015. Before TFS' creation, the FRs were under the Forest and Beekeeping Division represented at the District level by a District Forest Officer and a District Beekeeping officer. It seems thus that these two institutions have overlapping authorities and there is a conflict between the decentralisation laws and the creation of TFS. Moreover, the Mlele District is new and is not fully established yet and some tasks are still done in Mpanda (where everything was done before). Even some current harvesting data (2014-2015) are still in Mpanda and this complicates the current management.

As the FRs have also the status of GCAs, the WD is involved in the management of these areas through the District Game Officer and the regional unit. However, they manage only the wildlife resources and all related activities. At the end of 2015, a new parastatal semi-autonomous agency will be created for the wildlife, the Tanzania Wildlife Authority, which will share the wildlife management with the current WD. We still do not know what kind of impacts it will have on the local management of FRs/GCAs in the Mlele District. Lastly, another extra level of management exists with the superposition of the Mlele BKZ in areas of the Mlele FR. IBA is responsible of the BKZ management (from the planning to the controls) in collaboration with the District and the villages.

As the reorganisation of institutions is new and not fully implemented, the different managers are not clear about who is entitled to do the different management tasks. Thus for outsiders and villagers it is quite difficult to understand what are the missions of each organisation and the limit of their duties. Even the difference between IBA and ADAP is not clear as some villagers think that the BKZ is owned by ADAP (F_VS09). Moreover, there are other stakeholders involved, directly or not, in the management of the FRs/GCAs such as hunting companies which have anti-poaching and road maintenance tasks. Some NGOs, like ADAP⁴⁴,

⁴³ We use the term "manager" for the institutions which are legally in charge of the FRs/GCAs' management.

⁴⁴ ADAP is the only NGO dealing with natural resources which is based in Inyonga for many years.

influence the local management as well, by providing supports or trainings. Currently, there is also a 4-year project from UNDP “Mainstreaming Sustainable Forest Management in the Miombo Woodlands of Western Tanzania”, or Miombo Project, which covers our study area.

All the government managers are based in Inyonga. The leaders of Ilunde deplore the absence of managers and police in their villages while they are surrounded by forest. Thus, chairmen have to supervise and solve the problems alone, a situation worsened by the fact that there is no network to communicate (S_KR11). Table 10 sums up the local managers of FRs, their typical profile, their authority and their working tools.

Table 10 Management rights for the FRs (including their status of GCAs and the BKZ).

	Managers	Typical profile	Authority	Means
FRs	TFS, through DFM	Bachelors in natural resources management (forestry mostly)	General management of FRs, supervision of logging and beekeeping	6 staff, 1 car, 1 GPS, no weapon
	District, through DLNRO	Bachelors in natural resources management (forestry mostly)	Supervision of beekeeping, logging and fishing	11 staff (for land use too), no car and no weapons
GCAs	WD, through regional unit and District, through DGO	Diploma in wildlife management	Supervision of hunting activities only	Same means as District. Regional unit has certainly 1 car and weapons.
MBKZ	IBA, village councils, District	No specific qualification except secondary school diploma for some	Management of the Mlele BKZ only	30 VGS, 1 car, 1 weapon and 3 GPS

With regards to the means of the managers, TFS has an office in Inyonga, one road checkpoint in Kamsisi, one car, one motorbike, one GPS, all acquired recently (after May 2015). The staff for Inyonga consisted of 6 people in June 2015 (including 2 at the checkpoint). There is no road maintenance planned in the budget and no ranger post inside the FRs. TFS zonal office also faces a lack of staff and means. According to them and with regard to the amounts collected through the logging activity, problem of TFS is not really a lack of funds but the complicated procedure to obtain budget for the field. When it comes to the District, it has even less means to work with, although it should supervise all the resources activities. There are 11 staff for land use and natural resources issues (which represent about 1% of the District staff (URT, 2015)) and they have no car and no weapons (S_GM01). They do not have budget for roads or infrastructures inside the FRs. The District sectors which have vehicles are administration, agriculture, health and civil engineers and most of the District staff are dedicated to the education sector. In comparison, IBA have 30 VGS, one car, one shot weapon and 3 GPS to manage the Mlele BKZ. They have budget to maintain the roads, train beekeepers and build infrastructures like a camp or beacons for boundary. They also have 80 camera traps to monitor the wildlife. However, we should not be too optimistic because IBA is financially supported by ADAP and, for the moment, it could not cover the management costs with their current revenues without its support.

Even if material is not the most essential requisite to manage an area, and actions and skills are more important, the means available to government managers hinder the possibility of good management. Their means are very poor, especially for material and infrastructures needed in the field. Most of the management offices visited consist in a table, two chairs and a wardrobe

stacked with papers. There are no current maps on the walls, which are most of the time empty. When there is a computer, there is no data available on it and no GIS software to treat the data. Consequently, they lack basic tools and equipment required to ensure sound management of the areas and resources. Another problem is the remoteness of Inyonga and the motivation of employees who do not want to work there. Employees originating from other regions, are always looking to travel into towns (for banking, meetings, networks, services, etc.) in order to escape Inyonga. Government managers are often out of office and the vehicles are used for administrative tasks first.

3.3.2. Planning and regulation of resources harvesting

Regulation of access and harvesting aims at limiting the pressures on natural resources to the capacity of the ecosystem. It results from the management plan of an area, itself based on resource inventories. However, no inventory has been done recently for the four FRs, neither of wildlife nor timber. The only data available concern the Mlele BKZ: mammal surveys from 2008 up until today and botanical surveys done in 2004 and 2013 (Kayombo, Mpinga & Natai, 2013). The FRs' boundaries are often contested with village land as there are no natural boundaries like rivers or hills, no panels and most of the beacons of the 1950s cannot be found anymore. The Mlele BKZ is the only area with a management plan (which has to be adopted formally). For other FRs, management plans were reported to exist but neither the District or TFS were able to provide them for this study, even if the TFS Zonal Office (F_GM01) said that without management plans, it is not possible to harvest timber. The only management plan they had was the one of Inyonga East FR but this plan was not applicable because it comes from a copy-paste of a FR in the Tabora Region and there was a lot of incorrect information inside regarding maps, context and statistics. The TFS recognised this lack of management plans, maps and resources (human and transport facilities) in its annual report (TFS, 2015a).

The TFS provided us with the **timber** harvesting plans from 2014 to 2019 for the four FRs. They are fairly basic documents and are based on a partial inventory from 2005 and other secondary data which represent a 0.01% sampling intensity (TFS, 2014). APPENDIX 31 presents the allowable cuts⁴⁵ from these harvesting plans. The allowable cut per year is 151,932 m³ for Rungwa River, 502,352 m³ for Inyonga, 142,307 m³ for Ugalla River and 732,885m³ for Mlele. Mlele has the largest harvestable volume but its area represents only 40% of the Inyonga FR and the habitats are not so different. Moreover, the Mlele FR includes the BKZ where logging is not allowed. What is strange is that the surface areas of FRs given in harvesting plans do not correspond to the GIS data. As the harvesting plans do not include maps, it is not possible to check where the differences are. We asked the TFS for maps but they were not available in Inyonga, neither as hard copies nor as soft copies. This absence of maps shows that loggers never receive information about the precise locations where they can harvest. Some other documents also had mistakes: there were differences between allowable cut summary and the harvesting plan and between volumes from 2014 to 2015 per month and per FR. Moreover, some charts do not have dates. The total volume cut for the Mlele District from 2014 to 2015 (from June 2014 to May 2015) is between 4,600 and 4,800 m³, very far from the allowable cut.

⁴⁵ Term used by TFS to designate the volume it is possible to harvest in a FR.

As it was admitted during the meeting with local managers (AM02), allowable cuts are too high and there are no recent inventories.

The price of the licence depends on the volume of timber harvested. The cost of one cubic metre of *Pterocarpus angolensis* or *Afzelia quanzensis* is 204,800 TSH and the licence validity is 30 days. The license is only one of the documents required to cut trees⁴⁶. Currently, it is still the TFS in Mpanda which issues timber licenses because the TFS Inyonga office is new and the District Harvesting committee⁴⁷ is not operational (S_GM02). This is a big problem because the Mlele District does not control license issuance and does not receive the money from Mpanda. Licenses were not issued between July and November 2015 because the District Harvesting Committee (a new system) did not organise a meeting because of the coming elections (PC11; S_GM01). The District receives 20% of timber license and transit pass fees and the TFS receives the remaining balance (S_GM01). F_GM01 explained that in 2014, a District Commissioner did not want to issue harvesting permits but the TFS officer told him that he should deliver them if he wanted to keep his car and his salary. The TFS is accused by other stakeholders of issuing too many timber licenses in order to generate more profit (S_NE14; F_VS10). TFS argues that if they do not issue licenses, they open the door for illegal harvesting (which happens even when they issue licenses). Currently, the village councils also have to approve the licences and, as they do not receive their share from the central government, they ask for additional money from the businessmen in exchange for the licenses (S_CO12). A logger thinks that the system is not good because village authorities are forced into illegal practices and they cannot refuse the licenses if they receive bribes. The harvesting places inside the FRs should be indicated and the trees should be marked by the TFS before being cut down but managers do not do this and they just come at the end when the work is done (PC07). A local TFS officer acknowledged this poor supervision of cutting (S_GM02).

In regards to **wildlife** management, no plan exists except for the quotas established by the WD in Dar es Salaam. There is no wildlife population monitoring data for GR or GCA, except for the data from UASWS' bachelor or master students. As the Rukwa GR has no valid management plan, the GCAs are not likely to have one either. Even the hunting quotas are not known by the District Game Officer because they are directly sent to hunting companies (PC17). The officer only accompanies the clients during their hunt to check the species shot. Thus, the District knows only the number of animals shot (which frequently differs from the allocated quota). The data from 2013 to 2015 for the Msima and Inyonga GCAs are in APPENDIX 27. The animals shot per year are decreasing, from 119 in 2013 to 65 in 2014 and 49 in 2015 (but the data were until October only). For some companies, it could be due to a decrease in the wildlife population and to a lack of clients because among the 4 blocks of the study area, 2 have had no clients since 2013. As the District keeps 25% of the taxes (supposed to be used for anti-poaching), it receives less incomes. Nonetheless, the amount received from block allocations (25%) is the same every year (\$25,000 per GR and \$7,500 per GCA). A hunting company's employee told us that the hunting quotas are not adapted to hunting results (PC27). The same

⁴⁶ Companies also need a business license to operate in the timber industry, a registration at the District level and a Transit Pass from TFS which indicated with checkpoints they have to use with the volume (S_CO12; F_GM01).

⁴⁷ The District Harvesting Committee is composed of the chairmen of Village Councils, District Councils, secretary of DED, Water engineer, DFO, DLNRO, VEO, TFS manager (AM01; F_GM01).

report was given for the Rukwa GR where the hunting quota do not change over the years and some species which are part of the quota are not even found inside the area (Stampfli, 2016). It seems that quotas are issued without any information regarding existing wildlife populations and without taking hunting results of previous years into account. Another important event which occurs but which is not regulated is the killing of animals to feed the WD staff and anti-poaching units of some hunting companies. There are no quotas and they kill according to their “needs”⁴⁸, which are qualified as excessive by some hunters (S_CO15).

There are no quotas for the **beekeeping** activity. The beekeepers come at the District office, pay 5,000 TSH and receive the permit for one year. They are supposed to go at TFS office to collect an entry pass but they do not do it (perhaps because they do not know it). A total of 3,397 beekeeping permits were issued for Mlele District in 2014⁴⁹. Since a permit can be valid for 5 beekeepers, the number of beekeepers is far higher than 3,397. There were some contradictions between the managers regarding the tasks of permits issuance and the sharing of incomes. A District Officer told us that from now, TFS is supposed to issue the beekeeping permits but shares 50% of the fees with the District. Another District Officer refuted this statement and said that it is the District Beekeeping Officer who issues the permits and the District keeps 100% of the amount, like for fishing incomes (S_GM01; S_FS17). Moreover, several beekeepers with permits from Sikonge District were met in the field whereas this practice should not occur. In regards to the **fishing** activity, there is no inventory but a theoretical limit of 50 permits per year, 25 for Rungwa River and 25 for Koga River (PC17). Mpanda District issued 39 fishing permits for the Mlele District in 2013, (Stampfli, 2016). However, there are more permits in the field because Sikonge District also issues fishing permits for Koga River as it is the boundary between the two regions. The authorities which issue the different licenses/permits are summarized in APPENDIX 32. We have to pay attention that the authorities which issue the permits are not necessarily the ones which plan the activities because, most of the time, the quotas are done by upper or central institutions. The resources which guide the management are timber and wildlife because they involve central institutions (TFS and WD) and generate high revenues. Fish and honey are managed by the District level only and are considered “side” activities. District does not issue mining permit as it is the prerogative of the central government. However, there is currently no legal mine in the District (S_GM01). The permits for spirituals ceremonies or gathering inside FRs are free but it seems that many people do not ask them (PC30). For example, only one permit for spiritual ceremonies was asked for the Rukwa GR in 2014 (Stampfli, 2016).

3.3.3. Control of access and resources use

Even if quotas of all resources are not based on scientific data, permits and licences are issued and managers should ensure that users respect the rules by controlling and sanctioning them if necessary. To control the activities inside the FRs, managers need several things: infrastructures (buildings, roads), material (car, GPS, radios and weapons), staff, funds (to pay

⁴⁸ In 2012, some species killed during a bachelor’s thesis field work were hartebeest, roan, sable, warthog and buffalo. Game wardens declared to kill an animal once a month (Mermod, 2012) but it seems that they tried to minimize this practice.

⁴⁹ 2,925 permits for FRs, 113 for Rukwa GR and 359 issued from Mpanda District for the Mlele (Stampfli, 2016).

the staff and put fuel in the car) and a planning. And the most important thing, but not always the evident one: they need to go out in the field and patrol the protected areas. Subsection 3.3.1. treated the subject of the means, here we will analyse the actions of each institution supposed to control the activities in the FRs. **TFS** Inyonga has a staff of 6 for 25,000 km². A big recruitment is planned for August 2015 and TFS Inyonga hopes to receive 10-20 staff for its office but it will still be far from what is needed (PC11). Because of its set up, TFS Inyonga was not able to patrol before June 2015. A logger informed us that he never saw a TFS patrol in the bush, sometimes the WD only (S_CO12). Between June and September 2015, the TFS did 17 days of patrols where 273 logs were confiscated and 7 people penalised (TFS, 2015b). Some stakeholders deplore that people caught by TFS have only penalties or are warned (S_NE14; F_VS10) while they should receive stronger sanctions. The illegal logging may be stopped but the perpetrators are never brought to the police (F_GM01). Moreover, there is a rumour that TFS Mpanda is legalising illegal wood (S_GM02; S_GM01). On another hand, TFS also accuses the District to legalise wood. The **District** lends one car to other District sectors and weapons to the Mpanda District to go in the bush. They are supposed to patrol once a month but according to the data they provided to Stampfli (2016), they patrol only every 4 months. There are between 10 and 20 poachers arrested per year in the Mlele District (Stampfli, 2016) but it is not clear who arrested them: the District staff, the WD or the VGS. Each time poachers are arrested, a file is opened at the police office and lawyers of the District follow the case (S_GM01). The follow-up is really needed if one wants to ensure the court judgement (S_NE14). VGS of **IBA** conduct patrols inside the BKZ 14 days/month by car and by foot. They carry out some opportunistic controls as well during the trips outside the BKZ.

Rukwa GR is not in our study area but it is interesting to have an overview on its management because a GR is supposed to have more means and be better protected than FRs/GCAs. Even here, the means and the staff are insufficient. They have 1 game warden/160 km² while by rule it should be 1/25 km² (Stampfli, 2016). They have two cars but only one is devoted to patrols (the other one is for administrative tasks). As there is no network at Rukwa headquarter, the administrative staff always go in Mpanda to work and communicate, spending a huge amount of fuel and monopolising a car. They do not have a budget to repair roads which are in poor conditions and difficult to pass during the rainy season. There is a permanent patrol (30 days per month) along Lake Rukwa and another one depending on information they receive on poachers. They also have several semi-automatic weapons. During the patrols, they walk about 20km/day (PC23) but an old game warden told us that the new generation does not like to walk nor to sleep in the bush and this demotivates the old ones (PC31). The patrols performed in the region seize all material and resources of illegal users (timber, meat, bicycles, axes, etc.) and the institutions sell them in auctions. This provides an interesting amount of money but it is sometimes a bit ambiguous as these items go back to the "market". Moreover the practice is not well regulated and there are some disagreements between the different sectoral managers about who can receive the money. Normally, the users do not get back the material seized.

In regards to tobacco **companies**, even if farming is not allowed inside FRs, tobaccos fields are present and encroach on them. When a tobacco company representative was asked how they manage this problem, they replied that they were not responsible for where the tobacco they buy was planted. It is the duty of the cooperatives and government who should enforce the

laws (S_CO13). Because of the lack of control on the duties of the hunting companies, these have varying implication to the anti-poaching patrols and infrastructures maintenance. One company has opened tracks, built camps and applies anti-poaching measures in all its areas (even if it is only one team for 3 blocks). Another company, which has 2 clients per year, has opened only some tracks and built 2 camps for the 4 blocks it has in the region (PC16). In addition they do few patrols as its anti-poaching unit is affected to other tasks. This company collaborates with Tabora Regional anti-poaching sometimes but they have poor equipment, no maps and stay in the car during the patrols. Consequently, the poachers know that if they avoid the roads/tracks, they have little chance of being caught.

Sometimes the different local **managers collaborate** as for the eviction of people from Msaginia FR where there were TFS, WD, District Security Committee and the Police. TFS does not have the same prerogatives as the police and needs the DLNRO to take people to court. Moreover, TFS staff cannot be armed whereas DGO and game wardens can (PC11). Thus they need to collaborate for the patrols as well. They share information about poachers too (S_GM01). However, it is difficult for them to catch poachers even when they have information because of the lack of means and the remoteness of the areas, especially the staff of Rukwa GR which is far and has no network. We noticed it in July, when we heard that the poacher who killed 27 hippos, was selling the meat in villages and drinking in bars. The District was not able to act because of its lack of means and the VGS had only a shot weapon and did not want to have problems with their relatives. So ADAP staff called the anti-poaching unit from WD but it took a long time for them to arrive and information about the precise location of the poacher was got from many different sources, which is time consuming. When they decided to act it was too late because the poacher had left after he heard about the operation. Another example concerns a poacher seen in a neighbouring village. The VGS asked the police of Inyonga to come with them to arrest him but the police wanted to be paid first whereas it is their duty. Actually, few stakeholders trust the police and some hunting companies go straight to the towns with the poachers because they know that they can be easily released in Inyonga (S_GM01; PC23; S_CO15). In addition to this lack of control, all the governmental institutions were in stand-by because of the coming elections. In the better cases they just do not take decisions and in the worst cases they do not work at all and do tasks for the campaign.

During the three-month stay, anti-poaching units were seen in the bush (and not in villages) only once and it was one from a hunting society. Moreover, we noticed that game wardens of WD and hunting companies like to be in the villages instead of patrolling in the bush. They felt guilty because they tried to hide from their boss and were ashamed when we saw them. VGS endure social pressures from others villagers who are unhappy with their arrests or ask them for information. Even in a village focus group (F_VS09), the people asked if IBA could inform them about the date of patrols. Seven VGS stopped their activities because the social pressure was too high and some were threatened (F_FS03). Another VGS knows that if he stopped being a VGS, he could not go in the bush anymore. He might be killed because he has arrested too many people during both his previous job, in a hunting company, and in the current one as VGS (PC08). Recently 6 VGS were fired by IBA because they accepted bribes from illegal loggers to turn a blind eye on their harvesting in the BKZ (PC10).

The details of **arrests** observed in the field are presented hereafter. As the field team of this study was composed of VGS (allowed to arrest people and armed), they apprehended all the people encountered in the bush to check their permits. Some fishermen, loggers, a man on a bicycle with a small bag (supposed to be ammunition) and the Wasukuma settled inside a FR, all ran when they saw us. This means that they know they are engaged in illegal activities and that they can be punished. Consequently, they are still afraid of the sanctions even if the controls are very low and the police fairly corrupt. The culprits who could not escape tried first to lie about their presence. For example, one guy told us he was engaged in beekeeping while he was an illegal logger or another one said he was only carrying food while he was carrying an illegal fishing net. When VGS or game wardens catch doubtful guys they do not hesitate to push them on the ground and beat them with sticks to force them to speak and intimidate them. Even if users are legal, they feel obliged to give honey or fish to the game wardens. Some game wardens even threaten to kill poachers if they did not stop their illegal activities (PC08). The social status of users determines the way they are controlled. For instance, Indian businessmen who were hunting without permits in the Mlele BKZ in December 2013 were not beaten by VGS. Anti-poaching patrols find cows everywhere inside the FRs or GRs but do not kill them even if they are allowed because the Wasukuma are protected by politicians, who promised them land (PC16). Moreover, the ones who keep cattle are not always the owners of the cattle as some businessmen invest in herds and pay employees to keep them (S_CO15).

3.3.4. Stakeholders' conflicts

The current management of FRs engenders conflicts⁵⁰ of interests, and cognitive conflicts between the different managers, the managers and users and between users. The conflicts between **managers** are not physically violent. It is more a question of complaints about the presence and the work of others which undermines efficiency and opportunities of collaboration. The District has lost part of its authority on forests with the creation of TFS and perceived its arrival as a kind of recentralisation. TFS feels superior to the District in terms of authority because it represents the central government while the DLNRO places himself at the same level than TFS (S_GM01; S_GM02); all these sentiments show different perceptions. In addition, TFS thinks that the District is too much involved in politics, working for the main party's interests which is bad for managing natural resources because they are easily corruptible and do not have their priorities on natural resources (S_GM02). The District and TFS accuse each other of mismanagement and of seeking profit only (PC17; S_GM02). It seems that TFS does not like when District arrests loggers for minor infractions because they are considered "customers"⁵¹. The double status of FRs/GCAs complicates the management and creates bad relationships between the WD, hunting companies and TFS as they do not have the same objectives and prerogatives on these areas and irritate each other. A logger (S_CO12) thinks that wildlife and forest officers do not have the same power because WD can arrest loggers but TFS cannot arrest poachers. TFS sees the hunters as untouchable because their

⁵⁰ According to Hausser et al. (2009, p. 2685), "*conflict is a common feature of natural resource management and conservation (Balmford et al., 2001) and generally arose from competing interests of various stakeholders in the use of the resources of a defined area*".

⁵¹ This term was used by the TFS during the interviews. This could be seen as a form of patronage because TFS employees use their authority to avoid sanctions to loggers.

licenses are issued straight from the MNRT (S_GM02). Moreover, the companies never come at TFS office to announce their presence and complicate its management. TFS representative deplores the harassment of game wardens and hunting companies on their “customers” (F_GM01), and wildlife managers regret the disturbance of loggers on wildlife and habitats. In addition, the WD is accused of doing business with the wood seized (S_CO12). Some hunting companies do not recognise the status of FR and claim that it is GCA only. The TFS officer sees FR status as more legitimate than GCA because they were gazetted earlier (before Independence) and are protected areas (S_GM02)⁵². A TFS officer thinks that this intersectoral conflict should be solved by a strong MNRT board, which currently does not exist, and perhaps they should choose between GCA and FR status. The WD representative does not have the same opinion and thinks that both statuses should be assumed (AM03).

Regarding the associations’ side, TFS contests the IBA’s management plan and its Memorandum of Understanding with MNRT. TFS wants to reduce the authority of IBA and its future benefits (through by-laws) from the BKZ even though they are the only ones in the region to have a management plan and regular patrols (PC06). Moreover, during the workshop, one representative of TFS accused ADAP to be responsible of the encroachment in FR and criticised its work with the Land Use Planning (AM03) even though ADAP was only a facilitator and not the leader of the process. Many stakeholders at the workshop think that without Land Use planning, the encroachment would have been worst (AM03). Since Miombo Project has arrived in the region in 2012, it has not tried to collaborate with local associations such as IBA on similar subjects. IBA and ADAP tried to conduct meetings but the project team never attended these. They are rather in competition. Furthermore, there are few results in the field from this 16-million \$ project in Inyonga, except some modern hives hung along the main roads and some training courses dispensed. During the field work, the Miombo Project people were almost never in Inyonga and avoided ADAP staff in the streets. A focus group of village natural resources stakeholders stated that Miombo Project did not help them (F_VS09) and it seems that they come to village’s meeting armed (PC10).

It is quite normal that **managers** have symbolic and physical conflicts with **users** as they are supposed to control them. However, some users are particularly hassled by managers for reasons that are not always justified. Beekeepers and fishermen are harassed by game wardens of WD and hunting companies, treated as poachers even when they have a permit and there is no evidence of poaching. An old beekeeper was chased away from Lukwati GR even with a permit (S_SR18) and beekeepers of Ilunde were beaten and verbally abused by a hunting company. A village chairman thinks that hunters have too much power and are misbehaving (S_KR11). Hunters use “honey poachers” when they talk about beekeepers. In fact, most of the government managers accuse beekeepers and fishermen of inviting timber and wildlife poachers at their camp and of collaborating with them (PC07). After the kill of 27 hippos along Rungwa River, the anti-poaching unit of Lukwati GR burnt all the fishermen’s camps even though they were not guilty. In fact it was them who informed the authorities of

⁵² In reality, according to the Forest Laws and Policies, FR is higher in status compared to a GCA as it is formally gazetted through a parliamentary process, while GCA is a status declared only by the Wildlife Director and is not a protected area. In this sense a FR is formally and legally a governmental protected area and is part of the Reserve Land, while a GCA can be declared on village land or General Land and only restricts wildlife use.

the poaching incident (PC03). It seems that fishermen were also kicked out of Lake Rukwa by WD game wardens (PC26) but they have come back to the annoyance of hunters (PC09). Loggers are mostly controlled in the bush by patrols from the WD or hunting companies and they are sometimes brought straight to the police even when possessing permits (S_CO12). Hunters do not like loggers because they disturb the wildlife and are active in the forest.

Lastly, there are conflicts between the different **users** of FRs. Hunting companies who mismanage their blocks irritate the ones who do it correctly, wildlife is killed and this impacts the population of other blocks (S_CO15; PC09; PC26). Some companies think that there was scheming in the block attribution (an operator which own several companies obtained 13 blocks whereas, in theory, a maximum of 5 blocks can be allocated per company). This operator is thus in conflict with many others and was black listed from international hunting salons and has no Western clients any more (PC16). There are also rumours about hunting companies which are engaged in illegal mining. Poachers harass beekeepers and fishermen to benefit from their camp and their food, threatening them with an AK-47 (PC15). Most of the beekeepers are afraid of poachers with automatic weapons, especially when they are in large groups (S_LU08). Beekeepers are angry when loggers come near their camp and cut a lot of trees but they can do nothing (F_VS10). There are also problems between beekeepers and tobacco farmers because they destroy the forest and their fields border the forest which impacts the quality of honey (use of pesticides⁵³). Lastly, beekeepers are in conflict with the Wasukuma who live near the forest because they destroy it and need a lot of water for their cows. One factor which could exacerbate the conflicts is the overlap of most of the activities the middle of the dry season.

This section about the “Effective management of Forest Reserves” has allowed us to have information about the components **Management activities**, the **local managers** and their **relationships** among themselves and with various users. In summary, there is a complex governmental organisation managing the FRs, even at local level. Local managers and indirect stakeholders are numerous, with different aims, overlapping authorities and very limited means. The new management system is not fully implemented and the tasks and duties are not clear between government managers. There is competition between the District and TFS with regards to the prerogatives they can keep, calling on different laws and regulations. The wildlife staff, and their historical long term presence as the only legal managers of these areas, still implement an important coercion strategy. Legally, the local managers in Inyonga have the position of claimant according to the bundles of rights of Schlager and Ostrom (1992). However in the reality, the WD and hunting companies have rather a position of claimant as they have de facto management rights (see Property-rights tables in APPENDIX 32).

The management of an area is not limited to regulation and control but should go further by planning inventories, managing fires, investing in infrastructures and staff competences, developing programs with communities, improving communication, etc. However it is obvious that even the basic activities such as regulation and control are not properly carried out. The government does not know what is left inside the FRs/GCAs, neither for wood nor for wildlife,

⁵³ Moreover, there is a rumour about the nicotine which can be found into honey (S_LU07). However, an employee of a tobacco company said that this is not proven scientifically (S_CO13).

but it still provides high quotas without other management actions. Instead of being a management tool of resources, licenses issuing is first of all a means to earn income for national and local authorities and allow them to assert their prerogatives on users. Consequently, anybody who pays has the right to harvest independently of the regeneration capacities of the natural resources. The aim of sustainability mentioned by TFS and the Mlele District is thus not reached. Considering the TFS and the District together, there are one car and less than 20 staff for more than 15,000 km². The governmental controls in the field are very poor and concentrated in some places only while users wide spread Even some hunting companies do not do their duty with anti-poaching patrols. Only IBA and Rukwa GR have regular patrols. When users are arrested, the sanctions do not always follow the law and users are not treated with equity but according to their social status (people with “low” social status have a harder time). Finally, there is a clear demotivation among the local staff and a lack of collaboration between managers and local authorities (such as the police), while they have limited means to work. There are conflicts at all levels, among the managers, between the managers and the users and among the users, with occasionally physical violence against users.

3.4. GOVERNANCE CHANGES VIEWED BY STAKEHOLDERS

In regards to the degradation of natural resources and its consequences for the local population, we have asked the interviewees what changes would be necessary to ensure a better management of FRs. This section gives thus an overview of interviewees’ perceptions.

Six interviewees (mostly government managers) hope that the situation will be better after the **elections** because managers will have more time and less pressure to act and they seem confident that the new president will introduce changes. However, five interviewees are doubtful about the possible changes after the elections because the problem is bad governance in general. Changing the President only would not be enough and reforms in the whole government system are necessary because, currently, the main political party has more influence than technicians, whose skills and knowledge are not recognised (F_GM01; S_KR11; S_LU08; S_NE14; PC23). Villagers are aware that some civil servants and parliament members are among those benefitting from elephant poaching but they do not see how they could do something against it (F_KR02). Like seven others they think that **general governance** should be improved to preserve the natural resources with law enforcement, transparency and far less corruption. Even if some interviewees think that everybody is guilty (S_LU20; S_LU05), villagers cannot act alone and the Wakonongo cannot return to their traditional rules to preserve natural resources. They need the presence and actions of the government but they do not know how to bring governmental leaders accountable to their constituency (F_KR02; S_FS17). That is why some villagers are favourable to put clear boundaries to FRs, evict the people who are settled inside and relocate them on village land (F_VS10). The TFS manager is even tougher on this subject because he thinks that newcomers should go back to their region of origin (S_GM02). TFS wants to retake control of the FRs of the Mlele District and manage them without political influence. The improvement of **education** is a solution proposed by ten interviewees as a complement to good governance. They think that if one wants to take care of natural resources, one should raise environmental awareness and create critical thinking through education and capacity building, at local and national level (S_FS17; S_CO12). S_FS09

adds that education is not enough in itself and local populations need more employment opportunities and alternatives if one wants them to stop cutting trees or poaching.

Considering all the challenges and threats, four interviewees think that a better **planning and collaboration** between managers is essential to successful law enforcement. They need to solve sectoral and human conflicts to avoid mistakes made in the past (S_GM02). Moreover, they need to collaborate, work together (in the offices and in the field) and make concessions to take some important decisions such as evictions, degazettements, status issues between FRs and GCAs (S_GM02; AM02). Before any eviction, they have to work on the land use planning (AM02) and to propose solutions to evicted people (F_GM01). The FRs managers should not be the only ones to work together. Local authorities, private companies and associations should also be included in the discussion as they are crucial stakeholders at the local level (AM03). This would help to plan activities inside FRs, needed to avoid conflicts between users (S_GM01). Stakeholders of the WD hope that the creation of Tanzania Wildlife Authority will improve the means to manage wildlife all over the country (Stampfli, 2016). Two village leaders think that instead of enforcing the current laws one should **degazette** some parts of FRs because there is not enough space in the village land caused by population growth (PC02; PC05). Some managers also consider this solution because evictions are not relevant for destroyed forest areas where people have settled for many years. (S_GM02).

Lastly, more than ten interviewees go further than the previous solutions and reconsider the whole governance structure of FRs and of natural resources harvesting. They ask for a **radical change** to tackle the causes of the natural resources and ecosystems degradation which are the asymmetry between central and local government, corruption, patronage and bureaucracy (S_GM01; S_KR11; AM02). A woman does not trust the current government to improve the future of the local population because it is not even able to solve “small things” of their daily life like water supply (S_LU07). This calls for the reconsideration of the state’s role. Villagers and users told us that they would invest themselves more in natural resources management if they benefited more from it (F_VS09). Villagers deplore to not have direct access to the resources in their ancestral forests (PC04). The example of the Mlele BKZ in the region is a good alternative to governmental management and it provides interesting results in terms of wildlife and forest preservation and community development through beekeeping and VGS jobs (AM03). A former District officer thinks that the BKZ is a good deal between government and traditional institutions (S_GM16). Local managers (AM02) find that the beekeeping value chain needs to be improved for the Inyonga Division in order to be more sustainable. For this, the global honey quality needs to be improved and new markets need to be developed. Several villagers (including village leaders and traditional chiefs) suggest that community management such as the Mlele BKZ should be repeated in other FRs of the District (S_KR10; F_VS10). Harvesting plans of the four FRs call for introducing participatory management (TFS; 2014) but TFS zonal office thinks that JFM cannot work in national FRs because the ownership is not given back to the communities and the areas are too large for community management (F_GM01). In their view, communities do not take care of natural resources when they know that the government could take back the rights anytime (F_GM01). Such assumptions about community management and the underlying causes of degradation mentioned by the interviewees will be considered and analysed in the discussion.

4. DISCUSSION

The discussion analyses the results according to the conceptual framework in order to answer the research questions and confirm or discount hypotheses. This chapter is divided into two parts, each of which answers two specific research questions. The first one analyses stakeholder strategies for generating incomes through FRs and the social and ecological outcomes they produce. The second part analyses the broader political-economic influences on the management and studies potential changes that, if implemented, would allow for fairer and more sustainable outcomes. CBNRM is examined to see how it could contribute to changing the situation. Lastly, we come back to the conditions of the study and make methodological reflections in order to highlight its limits and provide considerations for future studies.

4.1. STAKEHOLDER STRATEGIES AND THEIR OUTCOMES

Stakeholders are a substantial component of the social-ecological system, as their decisions design it and drive its dynamics. This section aims to outline the behaviour and actions of the different stakeholders in regards to FRs. Thus, we focus on physical persons instead of legal entities because the field work has shown that the employees do not always follow their organisation's interests. First, we present a classification of the different stakeholders and then their strategies. Next, ecological and social outcomes are analysed, presenting the threats and the winners and losers of the current situation.

4.1.1. Stakeholder classification and interests

First of all, we need a classification of direct stakeholders that goes further than the simple global categories (users, managers, local population). We have refined categories according to their proximity to the field (presented in Table 11. Interests (not theoretical ones but the ones observed during the study), collaboration and sources of legitimacy⁵⁴ to use natural resources inside FRs are described for each category. This list is not exhaustive and includes only the most relevant stakeholders in regards to their impacts at the local level for the Mlele District FRs.

There are different categories among users of FRs because they are not homogenous. They were not differentiated according to the resource they use but to their origins and the way they operate (company or independent) because they do not have the same interests concerning natural resources. The Wasukuma and other farmers encroaching on FRs are not considered pure users because they target the FRs only because the resources they need are not available in the village land anymore. The **local users** are strongly driven by their livelihoods but are preoccupied by the future of their region as well. It is not only a question of incomes as the cultural and heritage sides of activities like the beekeepers' camps can be very significant. Local users engage more in collective action, like beekeeper associations, to defend

⁵⁴ Legitimacy is the "acknowledgement of the existence of a governance arrangement, belief in its moral grounding and compliance with rules, which is associated with reduced costs enforcement and compliance" (Kooiman et al., 2005 in Ingram et al., 2015).

their legitimacy. The sources of legitimacy can be ancestral rights or legality (through permits). **Outsiders** are more focused on incomes and do not engage in collective action except within their small working groups. They use the legal permits or their wealth to legitimate their uses. **Companies** are driven by incomes and try to maintain their reputations as well⁵⁵. They can use legality (due to taxes and permits), their long time presence in the field, their social relationships and their wealth as sources of legitimacy Tobacco companies emphasize their contribution to the farmer livelihoods. However if there was no profit, they would not operate. It seems that there is little collaboration between hunting companies at the local level, in fact, they are even competing. There is more collaboration between logging companies as they share information about resources.

The local managers are considered stakeholders like the others because they have their own interests and do not always manage natural resources and FRs according to the laws. They are divided between field staff, community management and government managers. The **field staff** are considered differently because they execute orders from managers and are less involved in the decision making process. Their first interest is of course the salary and stable employment position, but some game wardens and VGS are really motivated by their work and do like the wildlife and being in the bush. Field staff legitimate their actions by their authority and position. The **community managers** represented by IBA have long term interests and their committee is made of volunteers who do not receive a salary, which perhaps limits personal interests in decisions. Their sources of legitimacy are their legal authority and the ancestral rights of the beekeepers they represent. **Government managers** paid by the state or semi-autonomous organisations are more concerned by their own interests, but they still have to find a balance between the minimum level of duties respected and the maximum number of side activities engaged in. As we have seen, they do not collaborate a lot because of sector based competition and human conflicts. Their sources of legitimacy come from their legal authority, their link with the central government and their long-time presence.

The villagers who are not direct users of natural resources in FRs (farmers, Wasukuma, women, children, employees, businessmen, etc.) were not considered as direct stakeholders because they are too heterogeneous (tribe, occupations, interests) to be classified and it would have required further investigation. Moreover, the local population is partially represented by the local users as many farmers have a secondary activity that deals with natural resources in FRs. Globally, we could say that the local population has a long-term interest in conserving their area for future generations⁵⁶, but they do not act collectively and they are not well represented by their leaders. The source of legitimacy that Wakonongo could claim is ancestral rights to resources and land inside FRs.

⁵⁵ For example, there are important pressures from western tobacco consumers who want sustainable tobacco. This implies new requirements for the field and in 2020, 100% of the tobacco should be sustainable for miombo woodlands (S_CO13).

⁵⁶ Some Wasukuma want to settle durably in Inyonga because they have built hard houses, bought motorbikes and sold some cows. Thus they are also concerned by the futures of forests and lands.

Table 11 Classification of stakeholders for their analysis.

Type	Class	Description	Interests regarding natural resources in FRs	Collective action/ collaboration	Legitimacy on natural resources
Users of FRs	Local	Local users operating legally or illegally in FRs	Subsistence Traditions Quality of life	Yes	Permits Ancestral rights
	Outsiders	Users coming from other regions operating legally or illegally in FRs	Subsistence or generating incomes	No	Permits Wealth
	Companies	Companies operating legally or illegally in the FRs such as trophy hunting or timber companies	Generating incomes, reputation	Few	Taxes and permits Long-time presence Social relationships Wealth
Local FR managers	Field staff	VGS, game wardens of WD, staff of TFS, etc.	Having a salary Being in the bush Protecting wildlife	Few	Authority Position
	Community managers	Community managers such as IBA	Defending the beekeeping activity and rights of beekeepers	Yes	Authority Ancestral rights
	Government managers	DLNRO, TFS Inyonga, DGO	Keeping their position Personal incomes Comfort Power	Few	Authority Link with central state Long-time presence

The diversity of local stakeholders is quite impressive and that their interests vary greatly according to their origin and status. Personal incomes, however, are targeted by all the stakeholders thus influence their behaviour the most. Many interviewees think that the degradation occurs mainly for income generation (S_GM02; S_LU08; S_NE14) and survival (S_GM02 only). For the state and communities, short-term personal interests seem to prevail over long term interests. Every stakeholder wants to benefit from FRs because they need an income for their household. The stakeholders with the least short-term interests are the smaller ones in terms of position and social status, the users and the field staff. Local users' main interests are subsistence and trying to benefit from natural assets, but they also seem concerned by long term interests as they are living in the region with their family. In regards to sources of legitimacy, they are not only linked to legal rules, but vary between the stakeholders among several sources. As we have seen, the unrecognised legitimacies invoked by stakeholders and diverging interests lead to conflicts. Most of the time it is the most powerful (or violent) who wins which shows the injustice and survival-of-the-fittest attitude that is related to resource access. Hunting companies can work legally but use violence to enforce their rights and poachers also use violence to dissuade game wardens from arresting them or people from denouncing them in villages. FRs could be seen as "arenas of conflicts"⁵⁷. Interests and sources of legitimacy push the stakeholders to act in regards to FRs, thus making them select strategies. These will be explained in the next subsection.

⁵⁷ This expression is suggested by Zimmerer and Bassett (2003a) in regards to protected areas.

4.1.2. Strategies for generating incomes from Forest Reserves

We saw in the results, that natural assets in FRs are still abundant enough in the region to fulfil the livelihood strategies of the local population and outsiders. However, these assets are not always legally accessible or can only be accessed by certain means. Consequently, people need to develop strategies. If the system functioned completely legally, the managers and people involved in governance would not have the possibility of earning additional personal incomes through FRs and would only receive their salary. However, some managers and state employees benefit (indirectly) from FRs through bribes or by supervising illegal activities. That is why this subsection details the strategies used to generate incomes from FRs more than the actual access to natural resources *per se*. We have identified three ways to generate incomes from FRs, each requiring different means from the stakeholders: the legal way, the legal loopholes way and the illegal way. The means needed for the different ways are presented in Table 12 and are described in the text with examples given for stakeholders.

Table 12 Means needed to generate incomes from FRs .

Assets	Means	Description	Legal	Loopholes	Illegal
Human	Information and knowledge	About laws and how to play with them	+	+	+
Social	Network and relationships	To receive information and ask for services	+	+	++
	Position	To use the prerogatives of the position (e.g. to provide access and use rights)	++	++	+++
Physical	Material	Vehicles, tools, arms, etc. which allow for a better harvest.	+	+	+
Financial	Money	To pay legal fees, workers or to corrupt people	++	++	+++

Legality concerns the rights given by Tanzanian laws, as, for example, authorised activities, sanctions, manager duties, etc. However, legal users need more means than simply the right to do something. Most of the time, users require knowledge or a social network to know how to use their rights. Moreover, the legal way does not exclude the need for money as all the legal uses require fees and means to practice the activity. Local users, who engage in legal activity, see their access to natural resources restricted to beekeeping, fishing, and gathering due to their limited financial means. If they have relationships with a timber company or business man they can be timber workers. Outsiders who have enough means can practice logging and can harvest more resources if they have physical assets such as motorbikes or good nets. Companies have more choice because if they have enough capital they can engage in activities such as trophy hunting or mining. Local managers should not generate personal incomes from FRs as they have a monthly salary.

Another way to generate incomes from FRs is to take advantage of legal **loopholes** which can be due to the superposition of status (BKZ, FR, GCA), to contradictions between legislations, to the lack of clarity in the law or to the lack of management. These “loopholes” are used by all the stakeholders. As the TFS does not show or mark the trees to be harvested, loggers have to select the areas of cutting themselves, which gives them advantages and choice. Even if bark hives are legally forbidden and the TFS blames beekeepers for that, there are still thousands of

such hives in the bush and managers do not fine their owners. Consequently, beekeepers save money as bark hives cost nothing. Tobacco companies make benefits with tobacco cultivated inside FRs but as they rely on cooperatives and the government to control the practice, they cannot be fined for this. In regards to game wardens, some sell the meat that they kill for their “subsistence” and they are not considered poachers because of their position. VGS get a percentage from seizures but this percentage is not fixed by the law. When it comes to local managers the incomes generated through activities on the edge of legality are not for them most of the time but for their organisations. This is the case for other Districts which issue permits for the Mlele District and receive the incomes or the WD which sells the wood seized from poachers (these cases are not illegal but they are not legal either because they are not fixed by the law). Opportunities to exploit law loopholes are thus crucial and do not require more means than for the legal way.

There are three scenarios in which people engage in illegal activity. First, because the targeted practice is not authorised by the law in FRs, as, for instance, farming or poaching. Second, because they do not have the means to follow the legal way (money, knowledge, etc.). Lastly, because there are good opportunities due to the lack of law enforcement and low risks. Local users and outsiders, such as poachers or illegal loggers, mostly take advantage of opportunities to access natural resources illegally without permits. Gaining information through a network (informers and other “colleagues”) is still very significant for poaching. For example, they know when government funds are late, which means that game wardens will not leave the headquarters (S_FS09). Some other users can use money and their position, as, for example, the Wasukuma who are not afraid to enter FRs to cultivate and feed their cattle because they are rich and have political protection at the regional and even the national level. Additionally, some rich national hunters were allowed to hunt in a forbidden area by the WD, using their social relations and money. Companies do not primarily engage in illegal activities. However, they do engage in some illegal activities behind the cover of legal activities. For instance, trophy hunting companies which do not respect the specific hunting regulations (overpassing quotas, shooting from a car) and, in some extreme cases, companies which deal with mining or ivory traffic by using their position and social networks. Field staff or local managers can receive illegal incomes through bribes from illegal users or companies so that they turn a blind eye to their illegal practices. Or, much worse, they can be implicated in poaching (PC09) or illegal logging themselves by using their privileged position in the bush. They can also legalise illegal timber in order to have more money for their organisation or for themselves. The regional and national natural resources managers and state employees can receive money to turn a blind eye to some illegal activities or to defend some reforms. They can also misappropriate funds coming from natural resources. Some government employees and party members are implicated in ivory poaching, as they organise the “harvest” and ensure that managers stay quiet in the field through bribing or intimidation.

All the assets are used to benefit from natural resources inside FRs. These assets give the stakeholders some **power** which allows them to exploit natural resources, be it legal or illegal. The power manifests itself mostly in the form of coercion power⁵⁸. Managers and hunting

⁵⁸ When “A has power over B to the extent that he can get B to do something that B would not otherwise do.” (Raik, Wilson & Decker, 2008).

companies impose this power over users (in legal and illegal ways) through physical means and their position which leads to physical or symbolic violence. Poachers only use their physical means to impose their power over other users and even do so with some managers. Financial means give users the power to constrain managers so that they turn a blind eye on their activities. Power can also be exercised through human assets or social assets, as, for instance, when managers try to impose their authority and legitimacy on other managers who are taking advantage of legal loopholes. There are clear abuses of power in the three ways to generate incomes from FRs. Furthermore, other stakeholders do not always think power is legitimate even when it is used to enforce legal rights (it is sometimes contested, as for instance, when users file a complaint about aggressions they endured in the bush by patrols) and this leads to conflicts.

In short, some stakeholders stay in the realm of legal activities, others play with loopholes, and still others engage in illegal activities. The stakeholder categories are not linked to one path and the same people can shift between the three ways depending on the situation. What influences whether or not they act legally seems to be the **cost/benefit balance** of each situation determined according to the assets and opportunities offered by the current management of FRs. The costs represented by sanctions (fines impacting financial assets, time in jail impacting human assets) are unlikely to occur due to the limited level of controls in the field. Thus, for many of the users, like fishermen, loggers or poachers, legality is more costly and complicated than illegality. However, local users are forced to act legally more often than outsiders because villagers could denounce them and the local managers know them. When controls increase, users can act on the border of legality and illegality. For example, in the case of fishermen, they may have permits, but harvest above the allowed limit or with the wrong nets. When controls are frequent, the opportunities for earning incomes illegally without detrimental effects decrease a lot and thus some users do not take the risk. For example, an old poacher who was hunting with traditional weapons stopped because he had too much to lose with sanctions and was afraid of the poachers with Ak-47s (S_LU04). This is not the case for ivory poachers because the promised incomes are huge and they are heavily armed which give them coercion power. In regards to cattle keepers, the fines seem to not be enough alone to repress the practice as the cattle keepers do not hesitate to enter the FRs. It is a bit different for beekeepers because the permits are very cheap, their camps are registered and there is no illegal way to harvest honey (except if they take it from a wild colony inside a tree or steal it from another beekeeper). Thus, doing this activity legally is worthwhile. For other stakeholders such as managers and state employees, the costs of being engaged in illegal activities are high when there is a political drive at the regional/national level to fight corruption and when sanctions are applied (e.g. firing employees or taking them to court). However, this is not currently the case.

The first two subsections of this chapter allow us to answer the first specific question: **Which strategies are used to generate incomes from the natural resources of FRs?** The strategies used to generate incomes from the natural resources of FRs are motivated by stakeholder interests and legitimacy and are selected (legal, legal loopholes or illegal) according to their assets, the opportunities offered by the system and a costs/benefit analysis of the risks taken. Poor management and law enforcement in FRs creates opportunities for many users and

managers to generate incomes illegally because the risks and associated costs are low compared to the huge financial returns. The illegal way can require fewer assets than the legal way, as it is cheaper and less complicated. When the management becomes more serious, users need most assets from position and money in order to operate illegally or to use legal loopholes. These assets can be acquired due to the superposition of status, contradiction between legislations and the diversity of local managers.

The different assets give some coercion power to the different stakeholders which they use to take advantage of natural resources inside FRs. Even if the social assets of people with the same standard of living are strong, the mutual assistance between groups of different social status are weak. Consequently, this does not allow the poorest to benefit from the power of others higher up the social ladder. The current management hinders the power given by the rights and requires people to have other assets. Access to resources (legally or illegal) is mostly linked to stakeholders' financial means, position and possession of weapons. This creates conflicts and injustice in regards to resource access. The legitimacies like legal or ancestral rights are taken into account only if the stakeholders have the power to enforce them. We could argue that the natural resources in FRs are not in pure open-access because even if there are opportunities due to the lack of management and law enforcement, there are still some controls and informal rules from powerful stakeholders which, through sanctions and violence, do not allow everybody to access resources. We could thus only partially confirm the hypothesis that claims that FRs are degraded because of an open-access situation.

Stakeholders and strategy elements can be added to our diagram of the FRs social-ecological system (see final version in APPENDIX 33). Now that we have described the strategies for generating incomes from FRs, it is important to analyse their ecological and social effects.

4.1.3. Human activities threatening the ecosystems

Miombo ecosystems of FRs are productive ecosystems that still harbour extensive mammal diversity and large surface areas of forests. There are no significant differences between the four FRs in terms of mammal species richness and capture rates. Wildlife is still diverse (43 species) but is not found in high densities except in habitats near water (because of the dry season) and with good pastures. Some patrimonial species, such as the elephant, the buffalo, the lion and the leopard, seem to be rare and this is not due to habitats or other ecological variables but to human pressures such as poaching, hunting, habitat degradation and disturbance. All the wildlife avoids the periphery of the villages and the main roads which indicates that these infrastructures have a negative impact on the wildlife. Interviewees attested to a decrease in wildlife over the last 20 years and they are conscious that large mammals could disappear totally from FRs within a few years. In the Central African Republic, wildlife disappeared from intact ecosystems because pressures on wildlife were too high (Bouché et al., 2010).

Even if cultivated areas represent only 7% of the study area today, their 250% increase since 2002 is worrying. Cultivated land has grown faster than the population, encroaching on the FRs and not respecting the Land Use Plans. Epstein et al. (2013) recommend taking ecological rules and natural variations into account when explaining SES outcomes. However, our results show

that there is a clear human influence on forest cover evolution and mammal species occurrence because the magnitude and speed of changes largely exceed the possible natural variations. The scale of the study area allows for a comparison between different places and rejects a local variation hypothesis. Even if the surfaces are huge and Blomley et al. (2008) think that miombo woodland tolerates disturbance, it could very quickly reach the ecosystem collapsing point once a certain threshold is passed as many ecosystems do not show precursory signs (Robbins,2012). According to Ostrom (2009, p. 419) “*the prediction of resource collapse is supported in very large, highly valuable, open-access systems when the resources harvesters are diverse, do not communicate, and fail to develop rules and norms for managing the resource*” which is partially observed in our case study. FR ecosystems are weakened every day because since the 2000s they have been under pressure from both the peripheries and the inside with an apparent acceleration in the past 5 years. The interviewees think that the situation is likely to become worse in the coming years if nothing is done to ensure a more sustainable use of natural resources. If natural ecosystems collapse, it would not only affect the natural resources targeted by humans but all the animals (mammals, fish, reptiles, insects, birds, etc.) and the large natural cycles like the rain, the carbon cycle or the soil-nutrients cycles. Using ecological data and the interviewees’ perception of the results, we propose a ranking of the activities that threaten FR natural ecosystems (presented in Table 13) according to their impacts on resources and habitats and the importance of their practice in the region (frequency).

Table 13 Ranking of threats according to their impact and frequency

Rank	Threats	Natural resources impacted	Degree of impact (as it is practised nowadays)	Frequency (in the study area)
1	Agriculture and settlements	Habitats, timber, wildlife <i>Indirectly: honey</i>	+++	+++
2	Logging	Timber, honey <i>Indirectly: wildlife, habitats</i>	++	++
3	Cattle keeping	Habitats, timber <i>Indirectly: wildlife</i>	++	++
4	Poaching	Wildlife	++	++
5	Fishing	Fish, wildlife	+	++
6	Charcoal production	Timber <i>Indirectly: habitats</i>	++	+
7	Beekeeping (using bark hives)	Timber	+	++
8	Mining	Habitats	+++	
9	Trophy hunting	Wildlife	+	+

We could argue that the main threat is habitat destruction through **agriculture and settlements** as we saw that there was no more wildlife or forest on cultivated land. Bhattarai (2011) found in her study in southern Tanzania that the significant variable that explained the degradation of miombo woodland was the distance to settlements. If miombo woodland is degraded too much by agriculture (destroying rootstocks and seeds), it has a hard time finding its initial state again since some species have a low dispersion capacity (Frost, 1996). As the population is still growing, we could make a conservative estimate that the need for land, if it is not better regulated and planned, will increase by the same proportion as it did in the last 13

years. It would be hazardous to give figures and estimations of future degradation as it depends on several parameters that cannot all be predicted (at least for this study). However, we could imagine that in 15 years the cultivated areas could easily exceed 1500 km² (the cultivated land now is 929 km²). All the stakeholders are aware that tobacco is one of the most destructive crops for the forest and that it also has negative effects on health and the environment due to chemicals. OSSREA (1999) confirms in its study in the Kahama District that tobacco cultivation plays a crucial role in the miombo deforestation because of the shifting cultivation system and the high level of fuelwood consumption needed for curing the leaves. Logging is considered the second threat, as we observed that **logging** occurs massively in FRs, especially in the Inyonga FR and the Rungwa River FR, and it opens tracks and disturbs wildlife. Overharvesting could be especially harmful for *Pterocarpus angolensis* because it has low germination rates (Borgerhoff Mulder et al., 2007). **Livestock** is not a harmful activity in itself if it remains at low densities. It is more the way people practice it which has negative consequences. Cattle keepers cut trees to have more pastures and avoid tsetse flies, they kill carnivores to protect the cattle⁵⁹ and have huge herds of cattle. The cattle compete with wildlife for pastures and water and bring diseases which can be very damaging to the wild population. That is why we could say that the high number of cattle in the periphery of villages is the third threat to FRs. **Poaching** is considered the fourth threat because even if it does not destroy habitats, killing wildlife can have substantial impacts on the food chain and ecosystem functions. For example, elephants and big herbivores, by grazing and browsing, are landscape designers, hippos produce food for the fishes and carnivores regulate the herbivore population.

Fishing has a great impact on fish stocks and aquatic fauna and flora when fishermen overfish or when they use nets with small meshes that capture everything (small crocodiles, insects, plants, etc.). That is why we considered it the fifth threat. **Charcoal production** was not observed in the field but was observed in all the village households. As it is a commonly used product, it is considered a threat but it is not so big of a threat on its own because most of the time it goes hand in hand with the encroachment front. There is also a huge selling area near Urawira, north of the Mlele FR. **Beekeeping** is not considered a threat to resources as it does not have a direct impact on bee populations. However, bark hives are harmful for the trees as they provoke their deaths. As there are about 28,000 bark hives (PC32)⁶⁰ in the District and hives last for a maximum of three years, we can estimate that roughly 9,000 trees are debarked every year. This kind of beekeeping was not a problem 10 years ago because the other threats did not exist. It is the combination of threats that makes bark hives harmful. **Mining** is very dangerous for the forest and the environment because it destroys soils and uses chemicals. However, it is the second to last threat in our list as there is only one illegal gold mine in our study area, in the Mlele FR. Nonetheless, this threat could increase as the District plans to have iron and gold mines in the future (URT, 2015). As it is the last threat, **trophy hunting** is not considered a big threat since its harvests are low compared to those of poaching, even if the quotas are still too high. However, one species for which trophy hunting seems to be a serious threat is the lion. According to Caro (2008), lion quotas could represent

⁵⁹ Some Wasukuma were seen in the Dar-Tabora bus with AK-47s.

⁶⁰ This figure is probably largely underestimated.

about 25% of the population of hunting blocks in the Katavi-Rukwa ecosystem and 10% is already too high. Moreover, trophy hunting impacts the population of Katavi NP as empty territories (empty because the males were killed) attract other males outside the park through what is known as a “sink effect” (Kiffner et al., 2009; Loveridge et al., 2007). We should bear in mind that all these threats interact and have combined effects and thus the ranking is not absolute. As a Msukuma explained to us (S_SR19), it is difficult to know who is destroying the forest because there are so many activities and stakeholders. **Gathering** activities (fuelwood, mushrooms, plants, clay, etc.) are not considered a threat because, even without statistics, they have a very limited impact on habitat degradation compared to other activities. Fire was not categorized as a threat because it is not an activity but rather a phenomenon resulting from activities. If managers do not start early burnings in June and July, fires started by users from August until October could be very harmful for the flora and the fauna as they will be hot and intense fires which can burn trees. However, the miombo ecosystem has been greatly affected by man induced fires for centuries and several of its vegetal components are immune to its effect.

4.1.4. The winners and the losers under the current management

Even if degradation and ecological data are a question of perception and are socially constructed (Robbins, 2012), most of the interviewees consider that the degradation of miombo ecosystems are worrying and they doubt their ability to maintain the ecosystems’ functions in the future. Thus, miombo ecosystems can be considered losers in the FRs system. On the social side, there are direct stakeholders who lose from environmental degradation, the poor management and flexible law enforcement and others who win from it. Stakeholders use different assets in order to implement the strategies used to generate incomes from FRs. Consequently, stakeholders are not equal with respect to the costs and benefits they face. Table 14 gives a summary of the winners and the losers (in terms of incomes vs. the consequences of the degradation on their life) for short and middle-term perspectives. It seems necessary to consider these two perspectives as we have seen that stakeholders have fairly short-term interests. The short-term is arbitrarily set from 1 to 10 years because it was the interval of time mentioned by interviewees before a serious collapse of natural resources in FRs would occur. Hence, the middle-term is set between 10 and 20 years (because difficult to predict further than this).

Table 14 Winners and losers of the current FRs system for short and middle term perspectives.

Short-term (<10 years)		Middle-term (10-20 years)	
Winners	Losers	Winners	Losers
Illegal users (outsiders, companies)	Legal users (local, outsiders or companies)	Local government	Local population
Managers engaged in illegal activities or lacking commitment	Local illegal users	New farmers and cattle keepers	Legal and illegal users
Field staff engaged in illegal activities or lacking commitment	Local government (as an institution)		Managers
Central government (as an institution)	Local population		Field staff
			Central government

The **short term winners** of the current management of FRs configuration are the illegal users (be they local, outsiders or companies) because they do not pay fees and are not limited in their harvest like poachers, loggers, fishermen, etc. However, the local illegal users win less than outsiders or companies because the added value is not created in the study area (like timber and ivory). Farmers and cattle keepers encroaching on FRs are winners as well and see the degradation of natural habitats as an increase in usefulness of the land (concept of environmental production from Robbins (2012)). Hunting companies engaged in illegal activities are winning as well because they have free rein to practice them. In the short term, managers and their staff are winners if they accept bribes and engage in the illegal trade of natural resources. Their organisations still receive money from natural resource fees but they have the latitude to manage illegal business. Moreover, as there are few controls from above, they have the possibility to take more time for themselves (without implying illegal practices) and do things like go into towns or not work a lot. With respect to the central government, we could say that it currently wins on both sides, receiving taxes from natural resource harvesting and from donors to fight against ecosystem degradation at the same time. However, a substantial part of potential taxation escapes the government as many lucrative activities are done illegally. For example, Milledge et al. (2007) estimate that 95% of the timber trade is informal in Tanzania and this deprives the state of about \$58 million per year. It is thus difficult to assess if the state really wins in the present situation and further investigations would be needed.

The decrease of large wildlife could be seen positively for user activities (except hunting) and the local population because there is less crop damage (by elephants), less cattle kills (by lions) and less risks involved in practicing activities in the bush such as logging, beekeeping and fishing. However, the disappearance of large wildlife such as hippos and crocodiles, which makes fishing easier and less dangerous, modifies the aquatic food chain. S_LU20 remarks that some fish species disappear and others decline when there are no more hippos and crocodiles (because there are fewer nutrients from the faeces and food).

The **short term losers** are users (local, outsiders or companies) who respect the law because they suffer from the lack of management. For example, fishermen who respect the rules are penalised because they have less fishes than their colleagues who fish with the wrong nets. Hunting companies who respect the law are penalised because they pay taxes, conduct anti-poaching patrols, open tracks and respect the quotas but do not receive the governmental support they should receive in order to maintain the resources. Thus they are alone to face illegal users and cover the management costs. Legal users can suffer punishment for activities for which they are not guilty, as, for instance, all the fishermen camps which were burnt along the Rungwa River by the WD because of one group of poachers. Illegal local users working for businessmen lose in all the cases because they do not earn more than if they took part in legal activities and face the costs of illegal activities while the businessmen make all the profit. Other illegal users can be seen as losers when they are caught by patrols because they are treated differently from the 90% of illegal users who are not caught and they can face violence. The local government (as an institution) is losing taxes that escape its control in the current situation. In contrast to the central state, it does not receive money from donors in “compensation”. Lastly, the current and intensive exploitation of resources does not greatly

benefit the means of living of the local population because huge income possibilities are limited due to their assets and are instead taken advantage of by external stakeholders. As Adams and Hutton (2007, p. 161) say “*There is no reason to expect illegal revenues to be any more equitably distributed than those that are legal*”.

Currently, trophy hunting and logging legitimate the presence of protected areas because they are significant sources of income for the local and central governments. In the middle term, if there is no more wildlife and less timber species are available, the government could review the status of FRS/GCAs as natural resource do not generate enough incomes anymore. Moreover, some protected areas already face high pressures from agriculture⁶¹ which seeks for more land. The FRs could be thus converted to land devoted to agriculture and cattle keeping, as it was the case for many protected areas in the Southern World (Mascia et al., 2014). Thus, the **middle term losers** would be users (legal or illegal) who would not be able to earn incomes and managers and their staff who would lose their jobs if there are no more resources to extract. The central government would lose donor funds if there is no more wildlife or forests. The village land could be extended but it does not guarantee that it would benefit the local population as the local authorities might not manage them well and favour newcomers.

If the FRs are degazetted, more village land would be available and the **middle term winners** would be new farmers and cattle keepers who settle in the region. Initially the local government would receive far less taxes from FR natural resources (especially wildlife taxes which are high) but later, taxes from agriculture, mining and other uses would increase and the local government would perhaps receive more incomes from agriculture than from the previous natural resource taxes⁶², especially if the mbuga are used for paddy cultivation. That is why the local government could be seen as a winner.

If we look briefly at the long term, it seems that there would be no winners at all because it is likely that the soils of the miombo would be exhausted and the rain patterns modified due to the lack of forest. Thus, even the farmers and the state would not win enough incomes because of low productivity. Whatever it is, short, middle or long term, the main losers of natural resource degradation through poor management would be the local population (including local users). Unlike companies, outsiders and managers, who could find new activities elsewhere, the local population would remain in the same place because first, they were born here and not all of them would be able to move, and second, it would not necessarily be better for them in other Tanzanian regions. Local people are aware of the consequences of a loss of the natural forest and an intense agriculture and are afraid for their livelihoods as they rely strongly on natural resources in the form of arable lands or forest resources. As Jacobs (2008, p. 336) says “*rural peoples can face environmental degradation in very immediate and concrete ways*”. The crop harvest could decrease due to the lack of rain and the secondary incomes coming from the forest could disappear, thus creating a big hole in

⁶¹ Today, Davenport & Caro (2015) already think that GCAs do not protect the mammal species well. From their perspective, the ones in good conditions should be upgraded in GR and the other ones given back to village land.

⁶² Most of the studies conducted throughout Africa show that conservation revenues are not competitive with those of agriculture when looking at income per surface unit generated by tobacco or cotton compared to trophy hunting or timber extraction, or tourism (Chardonnet, 2010).

financial assets which are already very limited. The degradation of ecosystems in FRs could consequently increase the vulnerability of the local population to shock, trends and seasonality. From a cultural perspective, the Wakonongo, whose society is already declining due to ancient and recent socio-economic changes, could lose its last links with their ancestral forests.

The last two subsections allow us to answer the second specific question: **What are the social and ecological effects of these strategies?** Even if the ecosystems of FRs still harbour huge forests and a diverse wildlife population, the lack of management and the personal interests of stakeholders lead to an overexploitation of natural resources and the degradation of habitats through many different activities. Some activities are problematic in themselves, like tobacco culture, which destroys habitats, while others are problematic only because of the way and the rate at which they are practised, like logging or fishing. The main threats that were identified are agriculture, logging, cattle keeping and poaching. All are illegal activities except logging. In combination, these activities seriously threaten the miombo ecosystems which could reach a threshold and provide far less resources and functions.

In the short-term, there are many winners in this situation, especially the external users and managers who are directly or not directly involved in illegal activities. The central government could be seen as a winner as well because it receives money from both legal extractions and from conservation donors. The local government (as an institution) loses many incomes because activities are done illegally. The local users and the local population are losers in the current situation because they do not benefit from the added value of extracted resources and are easily sanctioned. In the middle-term, the FRs could be degazetted and devolve to agriculture and other uses. In this case the winners would be newcomers looking for land and the local governments which could earn substantial taxes from new activities. However, in the long-term, there are no winners at all as the natural resources would be depleted (both forest products and land). Agriculture and cattle keeping could face severe productivity decreases after a few years due to the lack of rain and the degradation of miombo's nutrient-poor soils. For each time-scale, the stakeholders the most affected by ecosystem degradation are the local population (including local users) because they are still highly dependent on natural assets and would not necessarily be empowered by the new changes. Without natural resources, the local population is thus likely to become more vulnerable to trends and shocks.

4.2. FOREST RESERVES GOVERNANCE

Human activities directly impact natural resources but they are highly dependent on the management, the governance and macro socio-economic factors. As we have seen in the results, everybody seems to be conscious of the degradation of the FRs but there are few reactions from the users or managers' sides to avoid it. This section aims to trace the forces that influence user and management strategies. Then, in regards to the CPR theory, it proposes some changes in the variables of the sub-systems which could favour users' organisation. Next, it analyses to what extent CBNRM approaches could fulfil these needs of change and it finally comes back to a political ecology view of the current situation.

4.2.1. Politico-economic influences on the management

The FRs are poorly managed by government managers and legal operational rules are not enforced. Permit/license issuance is disconnected from a role to achieve sustainability, having only economic and power purposes, which maintain patronage⁶³ relationships. Controls in the field are very weak and users are not treated with equity. There are conflicts among the managers and between the managers and the users which sometimes result in violent interactions. Managers focus on less damaging practices such as bark hives or firewood collection instead of big threats like encroachment or logging. They prefer to focus on vulnerable users who imply fewer risks than powerful users. The Mlele District has the biggest FRs of the Western Zone and is seen as a paradise by the TFS managers (F_GM01) but they do not take care of this "paradise" and simply apply their slogan "Forest is Wealth" literally. The Mlele District does not seem to be an exception in the management of FRs. The TFS reports on its website (Kitabu, 2016) that they are unable to avoid grazing and encroachment inside a natural forest in the Rufiji District and villagers report that there is no governmental supervision. The few management activities (licenses, harvesting plans) are focused on timber production only and not on habitat and other resources preservation. According to the results, we could define the management's constraints with five elements: a lack of means, a lack of commitment, political pressures, a complex governmental structure and high human pressures. These elements are detailed below along with the dynamics influencing them.

A recurrent reason given by interviewees to explain the poor management is the lack of **means**, be it financial, human or material. One of the main problems seems to come from the allocation of funds and not the amount available. The TFS, the Mlele District and WD generate incomes from natural resources through fees but do not keep all of the revenue and a part has to be sent to the central government in Dar es Salaam. This proportion varies according to the resources⁶⁴ but the asymmetry is substantial for wildlife taxes as 75% goes to the central government. That is why Benjaminsen et al. (2013) mention a kind of resistance to decentralisation. Part of this money is supposed to come back through the allocated budget but it is not always the case. The few funds which stay locally are not reinvested in the staff or material. The main District activities are based on natural resources (farming, hunting, beekeeping and logging) but few means are allocated to these domains, especially for forest

⁶³ Appropriation of public resources for self-interests and abuses of authority (Benjaminsen et al., 2013).

⁶⁴ Beekeeping and fishing permit fees are the only ones for which 100% of the fees are kept by the District.

resources. The District earns 50 million TSH per year with wildlife (URT, 2015) but does not allot a car or material for patrols. This lack of means is worse for Ilunde as there is no office and no organisation managing natural resources except for the village authorities. The remoteness and the lack of network aggravate the situation and this could explain the higher rate of illegal activities noticed during field observations around the village and in the Rungwa River and Inyonga FRs. Private companies like tobacco companies or hunting companies have far more means to work with in comparison to the government (better offices, vehicles, employees, communication, funds, etc.). However, they do not use their means to ensure the preservation of FRs because of their short-term interests or demotivation due to the management of natural resources in the country.

Tanzania's insufficient means for natural resource management result from the allocation of funds to other national priorities concerning development⁶⁵, a lack of national capital as Tanzania's central government is not economically autonomous since 30% of its budget comes from the foreign aid (Policy Forum, 2011) and accusations of funds mismanagement. Currently, Tanzania is in the grip of a high level of national **corruption**⁶⁶ as it is ranked 168th out of 177 on the corruption perception index (Transparency International, 2016). According to Ingram et al. (2015, p. 50) "*Corruption [...] is the manifestation of a lack of respect of both the corrupter and corrupted for rules governing their interactions*". Corruption reduces national productivity, decreases the amount of taxes collected and encourages the violation of laws (Rose-Ackerman, 2008). Patronage practices occur at all the government levels and the country's governance is dominated by executive branch and the main political party (Benjaminsen et al., 2013; Nelson, Nshala and Rodgers, 2007). This latter is involved in state operations and that is why there are rumours about TFS revenues going straight to an account of this political party and nothing coming back for the management (PC10). The central government and main party are allegedly involved in national mismanagement of natural resources. Politicians and civil servants from all sectors are involved in the ivory trade (Majani, 2013) and several high ranking officers of the TFS were suspended by the MNRT (Siyame, 2016). The governance is not better for the hunting industry. It is not transparent at all and in the grip of extensive corruption, especially in regards to the leases of hunting blocks which are allocated to friends of politicians or former politicians (Benjaminsen et al., 2013; Nelson & Blomley, 2010).

In addition to impacting local level function, the corruption and behaviour of top leaders impact the motivation of civil servants. Local managers are **not committed** to their duties and focus only on their short-term interests because they know that their superiors are "eating money" much more than they are. PC23 thinks that the salaries of managers and staff are too low to prevent them from becoming corrupt and accepting bribes. Nelson and Blomley (2010) acknowledge the corruption and patronage practices of the village and district authorities in the timber business. In fact, government employees have access to the benefits of conservation and this gives them the opportunity to take these revenues (Adams & Hutton, 2007). Brockington (2008, p. 103) attests to the "*remarkable deficiencies in the workings of*

⁶⁵ The Human Development Index ranked Tanzania 151th out of 187 in 2015, and it was consequently categorized as low human development country (UNDP, 2015).

⁶⁶ Corruption is "*the exercise of power for private gain*" (Ingram et al., 2015, p. 50) and "*occurs where private wealth and public power overlap*" (Rose-Ackerman, 2008, p 493).

local government taxation and service delivery, despite the well-structured, downwardly accountable nature of local government". Moreover, the limited means to work and the remoteness of the Mlele area are sources of a low managers' motivation because they not enhance their position.

The people who could easily take the initiative to change the situation because of their influence do not do it because they are too focused on their own interests. Moreover, the ones who would act suffer from hierarchical and **political pressures**. A game warden told us that it is sometimes easier not to follow the law because if he enforced it, he would be putting his employment at risk (PC23). The TFS (2015a, p. 19) was restrained in its management of FRs due to a *"stop order to undertake eviction during Local Government election"*. We noticed that pre-election times hinder the work of all civil servants: no important decisions can be made and nobody is available because they are working for the campaign. Local managers depend on the politics as well. For instance, cattle keeping issue is controversial as some parliament members say that livestock is authorized in non-beneficial GRs and FRs (Stampfli, 2016). The status of GCA also complicates the situation as it does not prohibit livestock grazing, thus confusing users. As Turner (2003) explains, the fluctuation of livestock populations is not only driven by ecology but also by the economy. Consequently, livestock accommodation is a political issue which needs to be thoroughly addressed by the national government. As underlined by the National Land Use Planning Commission Director, if one wanted to accommodate all 28 million Tanzanian cows, one would need 60% of the country (AM03). Finally, there is a strong national propensity for short-term benefits such as a new law that would authorize mining inside GRs (PC09; PC23). It seems that Tanzania wants to have its cake and eat it too: with hunting and tourism and fossil resource exploitation. The same goes for the Mlele District which wants financial benefits from all sides: agriculture, livestock, industries, forestry, tourism, etc. even when some activities are threatening the others and there is no management in return.

In addition to a lack of means, wide spread corruption and political pressures, local managers face the complex structure of natural resources management. Tanzania's administration and government are composed of many levels, different sectors and different kinds of institutions (parastatal, central government, civil servant, elected leaders, political parties, etc.). Moreover, the procedures are complicated and take time due to a lack of efficacy of government institutions. Management of Mlele District FRs is even more complicated because of the double status of GCAs which involve different sectors with different rules on the same spaces. The managers interviewed did not give clear answers about the legal organisation and their prerogatives, which shows the ambiguity of the situation⁶⁷. In addition to a lack of collaboration and communication between central and local bodies, there are intersectoral conflicts between the local managers that Hausser et al. (2009) already observed in the region 7 years ago. The recent establishment of the Mlele District and the TFS complicate the situation further as it creates a transitional period when old stakeholders, such as the Mpanda District, are still there and try to take advantage of the situation.

⁶⁷ Even in laws many things are vague such as the role of the District for National FRs, the task partitioning between FBD and TFS, the power of the Forestry Director and the role of the MNRT.

The last factor which influences the management of FRs is the growing **human pressure** on Mlele District' natural resources, which would be difficult to contain even with a stronger management. The pressures are influenced by the population growth and economic conjuncture which pushes people to use natural resources for their livelihoods or to earn incomes. The international market also plays a significant role in resources extraction, especially for the timber, tobacco and ivory. Activities such as grazing or farming occur in FRs only because they cannot occur in the village land anymore due to a scarcity of land and its mismanagement. There is a general poor opinion of land use management in Tanzania. District Land Use Officers have to be financially supported by projects to do their assigned tasks, like in the Mlele District, and there is a lack of intersectoral coordination (AM03). We could also raise the hypothesis that not enough land was left for village land in the 50s and this is now causing problems in the Inyonga Division. The aforementioned elements allow us to complete the **diagram** of the social-ecological system of the FRs which is presented in Figure 16 (a larger version is available in APPENDIX 33). Influence, political parties and links between the different government actors were added.

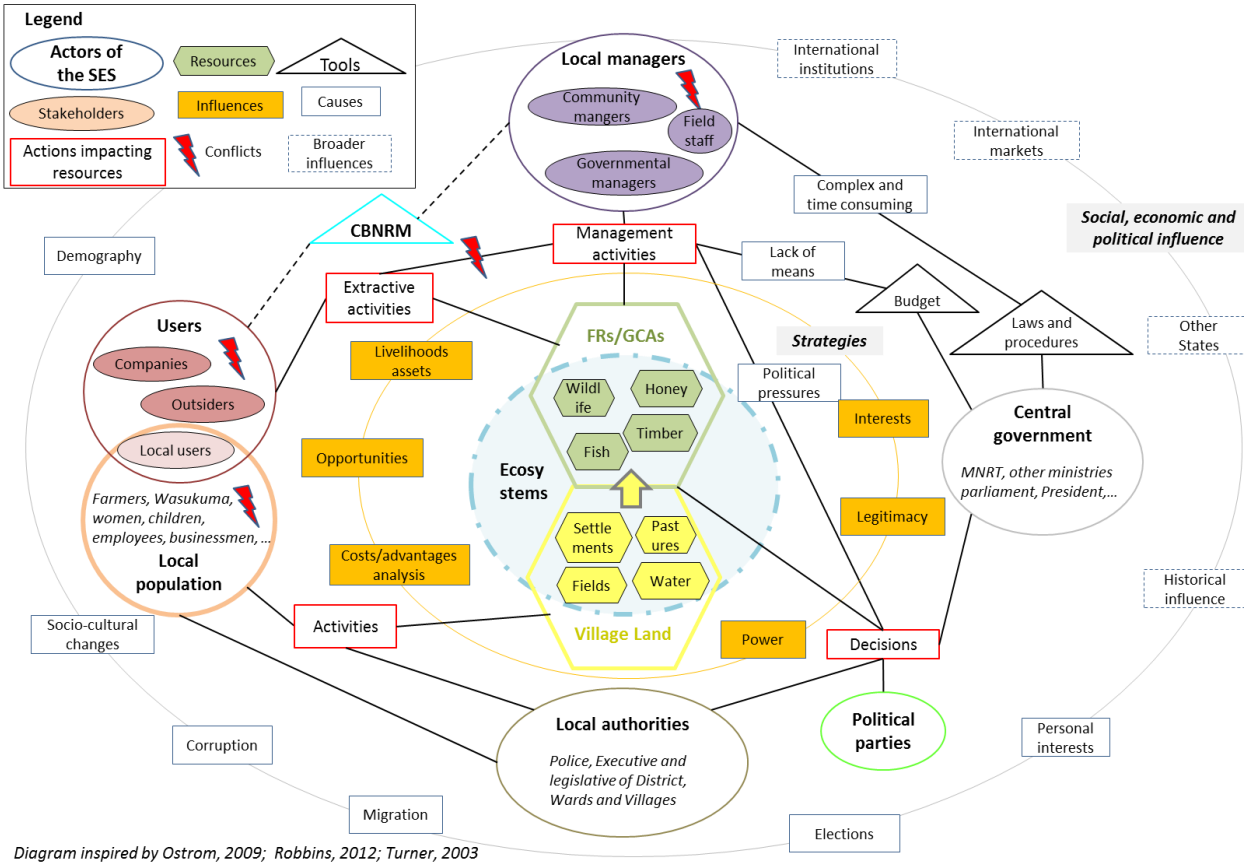


Figure 16 Diagram representing the SES of FRs with their components, interactions and broader influences.

At this point, we can try to answer the third specific research question: **What kind of internal and external dynamics influence the management of FRs?** Legal rules are not enforced, or only partially and randomly by government managers. There is no inventory of natural resources but high quotas are established for trophy hunting and timber harvesting and controls in the field are very low. Consequently, the current management hinders a sustainable use of natural resources and is unable to counter the high human pressures. All the actors have a strong interest in the exploitation of natural resources and if the lack of control offers them opportunities, they will take advantage of it. Even when the management is stronger, some users are still interested in taking risks because the potential benefits (linked to national and international networks like the one supporting the illegal ivory trade) outweigh the potential costs of illegal activity. All this provokes a gap in the governance of FRs as traditional rules are not enforced anymore and local users do not have the strength and the prerogatives to ensure themselves sustainable harvestings. This confirms the hypothesis that “the local users cannot self-organise to manage resources because they do not have recognised rights and sufficient means to counter the high human pressures. Local users have no power in the current governance arrangements”.

The current lack of government management is due to insufficient means, political pressures (strengthened during pre-elections) and a lack of commitment from managers (personal interests prevail over duties). All are influenced by high levels of national and local corruption. The government structure and function complicate the management even more and provoke intersectoral conflicts. It results in some legal inconsistencies between the different sectors and a misreading of the laws by the government managers. The causes of the degradation and social injustice inside FRs are multiple and inextricable, nested in different scales. However, to answer the research question, it seems that the elements which influence the degradation the most are from the central government level because human pressures and a poor management are led by national dynamics. Corruption has a crucial role on the social and ecological outcomes of Mlele District FRs, since it percolates from national to local authorities, engenders bad governance and decreases the already precarious means. We could thus argue that the state fails to manage its natural resources as provided by the law and this at each level.

Consequently, we cannot attribute natural resource degradation of the inside of FRs to the local population and “its” poverty. The greatest impacts are not made by the poorest people because they do not have enough assets to cause large scale degradation. The driver of degradation is rather the profit accumulation by wealthy actors such as politicians, businessmen or influent managers. We can thus confirm the hypothesis which states that “it is not the poorest who degrade the resources and benefit from it. There are underlying political processes which favour powerful actors at both the local and national levels”. Tanzanian politicians are indirect winners of the situation as they can “play” with the natural resources (land or forest products) to gain votes or incomes. The FRs are thus clearly “political forests” dependant on economic and political factors which strongly influence the situation in the field. This confirms Robbins’ statement (2012, p. 20) that “... *environmental change and ecological conditions are the product of political process*”.

4.2.2. Ecological and social needs for governance changes

Even if the government had more means and commitment to assume and implement the current laws, it could hardly face the current stakes in time. Moreover, the legal governance would still be unfair for the local population, which benefits little from these areas and does not have rights or power over them. Even in legality they need financial assets if they want to access FRs because of permits issuance and costs associated with access and extraction processes (transport, tools, etc.). Natural assets are not secured for local people and the current situation makes them more vulnerable. We could qualify this as environmental injustice (Robbins, 2012). Conservation and protected areas should not be a constraint on poverty alleviation and should take social justice and human-rights into account (Adams & Hutton, 2007).

However, one cannot give up the protection of ecosystems by pretending that it leads to unfair outcomes. Natural ecosystems within protected areas are of great importance for human well-being (Adams & Hutton, 2007, p. 160) and our results have attested to this for local livelihoods. Some changes in the current governance are thus necessary to avoid a collapse of ecosystems and natural resources. Moreover, one should thus try to reduce the discrepancies between the current regulations and local needs in regards to natural resources in FRs. As inhabitants of the Mlele District have very low incomes and still rely heavily on natural resources, FRs could contribute more to poverty alleviation and ecosystem preservation if they were managed in a sustainable way. Even if some authors (such as Christensen, 2004) think that there are no “win-win” solutions, for Adams et al. (2004), it is too early to abandon the attempt to combine conservation and livelihoods and these two objectives could be reached together if one addresses them properly. However, attempting to reach these conflicting goals would imply dealing with difficult trade-offs.

Even if the government decides to enlarge the village land, the FRs would still be present (at least for the middle term) and the need to find alternatives for their governance would still exist. Solutions cannot be found in traditional Konongo rules because they are obsolete and there are too many new actors and activities. Traditional authorities are vanishing and not strong enough to support the management of natural resources. Wakonongo tend to accuse other people about what happens to natural resources (20 years before it was the Wahutu and now it is the Wasukuma) instead of organising themselves to defend their rights and lands. Moreover, huge spaces without settlements such as FRs, which result from colonial politics, do not correspond to traditional land use management. Yami et al. (2009) suggest working on the conditions which hinder a sustainable CPR management, such as insecure rights, human and financial capacities of communities, lack of empowerment or conflicts about uses, to create more effective formal or unformal institutions. For political and practical reasons, it also seems difficult to completely remove the government from the governance. A new model should thus establish itself between government and community governance. This could re-establish a link between the two. For the moment, the private sector is limited to the companies who have a hunting lease. This could be seen as an opportunity for the communities to act and deal with the government for solutions.

If one want to design a new governance system to avoid an unsustainable⁶⁸ SES of the FRs in the way Ostrom (2009) understand it, **some changes in the system** are necessary in order to modify the outcomes and restore some equity and justice. Social, economic, and political setting variables cannot be influenced in the short and middle term, especially from a local level. Consequently, changes should occur at the user level and in governance variables to fit with the broader configuration. This will have an effect on interactions and outcomes. Two components, borrowed from Ostrom (1992), have to be addressed primarily in order to avoid over-exploitation of the resources (but are not sufficient alone): the organisation of users and the property-rights definition. We need to first define which users would be considered for a new framework. As the FRs are under Tanzanian laws, it would be a bit optimistic to work with users engaged in illegal activities. Moreover, some activities can simply not be integrated to the new model because they are not compatible with other uses. Farming, for instance, converts ecosystem into agrosystems which results in the loss of biodiversity. We will thus consider the users of the main authorized resources in FRs: wildlife, timber, fish and honey. Multiple-use is difficult to implement but it is the most sustainable and fair option and habitats of FRs allow it. Even if trophy hunting seems quite unfair and elitist, it provides important incomes for local and central authorities and is politically protected. Moreover, it indirectly benefits other users such as beekeepers or loggers as it justifies the habitat's protection.

In regards to the **likelihood of users' self-organisation**, we need to study if there are differences among resources by assessing the 10 variables mentioned by Ostrom (2009). Table 15 presents the estimation for the current situation of FRs and shows where changes could be implemented. The description of each variable in regards to the study areas follow hereafter. Currently, large territories such as FRs are not favourable for self-organisation. The exception is for the fish resource as it is found in few rivers. With regard to the productivity of the system, the need to manage resources is strong because although they are not exhausted, they are not very abundant. Another positive point is that abundance of the resources is fairly predictable, even if there are some seasonal trends. The high number of users is disadvantageous for loggers and fishermen because individuals do not know the others. It is a bit different for beekeepers who are linked to their camps and know their neighbouring colleagues. The low number of hunters is seen as an advantage when organizing wildlife uses. There is no social capital or leadership among the users except for the beekeepers who are organized in groups and can even create associations like IBA. The only users to have a poor knowledge of SES are the loggers since they do not come from the area and come only to harvest. Moreover, the loggers are not especially attached to the timber resources as they could engage in other activities. On the contrary, hunting companies, fishermen and beekeepers value their resource because a large part of their incomes depend on it. Lastly, the collective-choice rules have a negative impact on loggers, fishermen and beekeepers as they only have access and withdrawal rights. As we have seen in subsection 3.3.4., hunting companies could be seen as *de facto* claimants as they have some latitude with the management.

⁶⁸ Unsustainable could be defined by the "*rates of resource use which exceed rates of resources renewal*" (Nelson, 2010, p. 8).

Five variables are unfavourable for loggers and four for hunters. This indicates that the self-organization of users in order to achieve sustainability is currently not facilitated for them. Fishermen and beekeepers, for whom only three variables are unfavourable, are more likely to self-organise (the benefits of an organisation exceed the costs) (Ostrom, 1992).

Table 15 The likelihood of users’ self-organization.

Variable	Timber		Wildlife		Fish		Honey	
	Now	After changes	Now	After changes	Now	After changes	Now	After changes
Size of the resource system	-1	1	-1	1	1	1	-1	1
Productivity of the system	1	1	1	1	1	1	1	1
Predictability of the system dynamics	1	1	1	1	1	1	1	1
Resource unit mobility	1	1	-1	-1	0	0	1	1
Number of users	-1	-1	1	1	1	1	0	0
Leadership	-1	1	-1	1	-1	1	1	1
Norms/social capital	-1	-1	-1	-1	-1	-1	-1	-1
Knowledge of SES	0	0	1	1	1	1	1	1
Importance of the resource to users	0	0	1	1	1	1	1	1
Collective-choice rules	0	1	-1	1	-1	1	-1	1
Total	-1	4	0	6	3	7	3	7

Legend: -1 means negative effect, 0 neutral and 1 positive

Some of the variables could be changed to make the context more favourable and reduce the negative variables to two for hunters and loggers and one for fishermen and beekeepers (see the columns “After changes”). The creation of more management units could reduce the size of the resource system for users and facilitate the management and sanctioning processes. The leadership could be improved through local associations or other forms of self-organisation defined by the users (resource specific or multiple resource associations) and recognized both locally and by the government. This could improve, over time, the social capital between the users and the networking between different associations. The users with the less likelihood of self-organisation are the loggers because they are mostly outsiders who come for short time.

Collective-choice rules could be given to these associations of users through the redefinition of the **property-rights**. Currently, FR users have no legal rights on their resources’ operational and collective-choice rules and this does not create incentives to manage them sustainably (Schlager & Ostrom, 1992). Even hunting companies, who have more means and some de facto rights, simply extract the wildlife without investing and managing because of the 5-year allocation which is too short (they do not want to invest for their successors) (PC12). The local users and the local population are the ones with the least influence on decision-making whereas they are the most concerned by the FRs and have long term interests. They should be empowered to make more decisions on natural resources management and have more rights on them because as Quinn et al. (2007, p. 102) argue “any poverty alleviation strategies must consider access to and control over natural resources”. Moreover, we have seen that it is not the poorest who degrade natural resources. Even if the rights of alienation or exclusion do not protect the resources from over-exploitation or destruction (Schlager & Ostrom, 1992), the position of claimant (with management rights) or proprietor (with exclusion rights) for FR users could be very helpful as it would ensure more sustainable outcomes. The model of

conservancies in Namibia gives proprietor rights over wildlife to the members of the conservancies and this has great results in term of wildlife protection and community empowerment (Jones, 2006).

The aforementioned changes could allow for a users' organisation which would reduce conflicts among stakeholders, regulate harvesting levels and encourage investment and information sharing. In the end, this should lead to better governance. According to Dietz, Ostrom, & Stern (2003), an effective governance requires monitoring (of uses and resources), moderate rates of change (ecological, social, economic and technical), a social link and face to face communication within the community, easy exclusion of outsiders, an enforcement of rules and monitoring by users. The factors that are the hardest to establish seem to be the moderate rates of change and the easy exclusion of outsiders. Nevertheless, the other factors could be established through new governance arrangements. These arrangements should guarantee an adaptive governance and have rules that, in line with the success of commons governance, evolve according to the context (Dietz et al., 2003). Lastly, the whole population should be more involved in FR governance and not only the users. It is not enough to show pictures of wildlife to villagers and explain to them why protected areas are good, like WD did in 2014 at village meetings (Stampfli, 2016). The local population, and especially the children, need contact with natural resources in order to get to know them and understand their value. Moreover, the new FR governance system should foster what is available locally, as, for example, user traditional knowledge or strong social assets.

4.2.3. CBNRM contributions to the governance of Forest Reserves

If one wants to devise recognised governance arrangements to satisfy the necessary changes, one has to respect Tanzania's legal framework. Tanzanian CBNRM approaches could be used as a good alternative to the current governance to counter ecosystem degradation. Local users could see it as a means to take back control of governmental territories (Funder et al., 2013) and it could create incentives for them to protect the FRs. Mlele BKZ is a good example in the region as management rights of the Mlele FR were transferred to local beekeepers organised in association. Villagers through IBA and its VGS monitor and enforce the rules themselves. Such management allows for the preservation of natural ecosystems which is essential for honey production and contribute to a greater involvement of community members in the management. Many interviewees showed interest in having more areas such as the BKZ and the workshop in Dar es Salaam indicated that CBNRM is a model worth promoting for FRs (AM03). First of all, we need to study the CBNRM models which could fit with the national FRs of the Mlele District. As they are in reserved land, two models are possible: a JFM or a BKZ. As there is no model for the wildlife sector in reserved land, one could envisage a WMA but this would require transforming reserved land into village land. Hereafter we describe each model in regards to its implementation and evaluation by different studies.

A **Beekeeping Zone (BKZ)** is *"an area of land within a national or local authority forest reserve in which the keeping of bees and management of apiaries in accordance with an approved management scheme is permitted"* (Beekeeping Act, 2002). The power can be delegated to any neighbouring local authority (governmental or community) by the Director of Beekeeping. For the moment, the model is still uncommon in Tanzania and the largest BKZ is Mlele. A 10 year

Memorandum of Understanding was signed in 2010 between the MNRT and IBA. It has transferred the management of the BKZ to IBA and villages in collaboration with the District thus establishing a co-management system between IBA and local governments. Trophy hunting is still occurring inside the BKZ (but at a low rate) but IBA has no authority on this activity. Local stakeholders collectively decided to ban logging. The advantage of co-management between the government and the communities is that it allows for mutual control which can be useful in a high corruption climate. There is very little literature about the evaluation of the BKZ model except for ADAP and IBA experiments. According to Didier (2014), the current constraint of the model is the low sharing of benefits from governmental taxes for hunting and beekeeping because the permits are still delivered by the central government and the District respectively. IBA supports the management costs (with the support of ADAP) without receiving revenues from natural resources in exchange. The only revenues are made by selling seized material. Normally, benefit sharing schemes and by-laws should be adopted soon. However, the local population already benefits indirectly from the BKZ through improved revenues for beekeepers and job creation.

Under **Joint Forest Management (JFM)** the user and management rights (responsibility and returns) of National or Local Authority FRs are shared by the forest owner and neighbouring communities (village councils or any organisation) (Akida & Blomley, 2006). This can apply to a whole FR or part of it. In 2008, JFM covered 34% of National and Local Authority FRs (Blomley et al., 2008). This approach is formalized through a joint management agreement between the MNRT and village councils/organisation. As with the BKZ case, Akida and Blomley (2006) noticed for JFM a lack of legal framework for the sharing of benefits and reluctance from the central government to share revenues. It is mostly the fines and seizures from controls that contribute to local manager revenues. It is impossible to manage and benefit from wildlife with a JFM and this decreases the possibility of benefiting from all the natural resources present inside a FR (Akida & Blomley, 2006). That is why the authors suggest a harmonization of laws.

A **Wildlife Management Area (WMA)**, which is an area gazetted on village land, is managed by a community based organisation (CBO) which aims to make communities benefit from the wildlife industry. A WMA can be established in one or several villages' territories and has to be approved by the village assemblies and councils. The CBO is held accountable by village councils and represents its interests. In return, village councils have to monitor natural resource use and the activities of the CBO, ensure Land Use Plans, etc. The District level is implicated through the District Natural Resources Advisory Body. In addition to wildlife, WMAs allow for the control of other resources such as beekeeping, logging, fishing or tourism, as long as their respective laws are implemented (Wildlife Conservation Regulations, 2012). The WMA model is criticised because it does not meet communities' expectations about social outcomes, puts more restrictions on village land and creates few incentives for sustainable use (Songorwa, 1999). Two key points raised are the insufficient sharing of benefits (like with the other two models) which leads to few revenues for communities and the lack of control of hunting activities (Maliasili Initiatives, 2013). The revision of Wildlife Regulations in 2012 addressed these shortcomings by defining a benefit sharing scheme (75% of hunting block fees and 45% of other hunting fees) and allowing the CBO to make investment agreements for the use of wildlife in their hunting blocks. This leads to an increase in benefits for local

communities even if some authors are still critics of WMAs. For instance, Benjaminsen et al. (2013) evaluated the outcomes of the new wildlife management regulation in Tanzania and noticed a kind of recentralization and reconsolidation of the state control (even in a context of neoliberal policies).

In order to assess which model could be the most adapted for the FRs of the Mlele District, Table 16 presents main characteristics of each model in regard to the variables one needs to change and the logistical constraints.

Table 16 Main characteristics of each CBNRM model.

Variables/constraints	BKZ	JFM	WMA
Resources concerned	Honey ⁶⁹	Timber, honey, fish	Wildlife, timber, honey, fish
Structure responsible	Any organisation/Village Councils	Any organisation/Village Councils	CBO
Property-rights	Proprietor (shared with central government)	Proprietor (shared with central government)	Proprietor (accountable to Village Councils)
Sharing of benefits	No regulation (to be defined locally with a validation from MNRT)	No regulation (to be defined locally with a validation from MNRT)	Define by regulations
Leadership of users	++ (for beekeepers)	+ (few loggers are local)	+ (no local hunters but others users can be represented).
Size of resource system	Defined according to the user needs	Defined according to the user needs	Defined according to the user needs
Procedures	Complicated	Complicated	Very complicated because of the transformation to village land
Proneness of state and managers	-	-	---

In regards to the variables for better self-organisation, all models would change the property-rights regimes by giving the exclusion and management rights on resource(s) to local users (shared with the state for the BKZ and JFM models) through the village councils or the creation of a CBO. Even if some authors (Nelson & Blomley, 2010) deplore the additional governance layer added by a CBO (imposed in WMA), it can be seen as an opportunity to include users and diversify the legal stakeholders. CBO could allow for better leadership among users by federating them. However, some users may not be well represented if the CBO gather users of different resources together. The different models do not impose minimal surface areas and thus the size of the resource system could be adapted to the needs of its users (dividing FRs in smaller CBNRM units, self-zoning by users or formal zoning inside CBNRM units) as long as there is still ecological coherence. Monitoring and sanctioning processes would be enforced by local organisations which would give employment opportunities, value the local knowledge and allow for social control while reducing violence. The aforementioned changes could modify the current stakeholders' strategies. More adapted rules could be established (in compliance with the law) and an effective and adaptive management could reduce the opportunities and

⁶⁹ The Memorandum of Understanding also deals with other resources, like fish or timber, and clarifies the limits of the rights on wildlife resources (if there is a GCA overlapping).

the potential costs of illegal practices. Regular patrols and law enforcement could deprive the poorest to access natural resources as Lund and Treue (2008) observed it in Mfyome. However, these authors do not think that this situation is permanent and some mechanisms should be design to protect the minorities.

With regard to the different models, the only advantage of the BKZ, compared to the others, is its specialisation for beekeeping. It fits more with the needs and identity of one group of users, the beekeepers, who are still connected to traditions and committed to forest preservation (see Weber, 2013). This model could create more leadership among them but be less representative for other users. For the rest, it is quite similar to the JFM model, except that this latter allows for the control of (and possible benefits from) more resources, especially logging, which generates substantial incomes. The by-laws of BKZ and JFM, which are defined for each situation, allow for perhaps more flexibility than WMA, whose conditions are defined by official regulations. Meanwhile, this finer definition (like the sharing of benefits for hunting taxes which are the most valuable incomes) allows for less interpretation from the government. In regard to the multiple use possibilities, the WMA governs more resources within one feature. This simplifies the management organisation and gives more rights to the CBO than any other model because it is not a co-management. The legal loopholes due to several reserve statuses could be reduce if there is a WMA only with one CBO which manage it. Consequently, we could say that the WMA model presents the greatest advantages in terms of rights and benefits for the communities living in Inyonga and Ilunde. However, it might be complicated to implement due to the needed transformation of reserved land into village land and the cancelation of GCA and FR statuses (a process which imply a degazettement and regazettement of the area at the parliament level). These are long procedures which could face the reluctance of central and local authorities. Nevertheless, we know that this model is feasible as the Ipole WMA, Sikonge District, was previously a FR and a GCA. This WMA, which covers 2,540 km and, neighbours the Inyonga FR, was established in 2003 with the support of Africare (Strinning, 2006).

Even if these few elements highlight a path which could be followed, **further investigations** are needed and more examples should be found in order to design the future governance of Mlele District FRs. The difficulties encountered by Ipole WMA and other CBNRM models should be studied in details in order to present a realistic view to the stakeholders. In order to target sustainable outcomes, the following elements, among others, would need to be considered: the number of CBNRM units, their location inside the FRs, the number of CBOs and their organisation and the villages and stakeholders involved.

The division of FRs into smaller CBNRM units could facilitate the enforcement of rules by users. Zoning, with only some parts of FRs being under CBNRM, could be a means to mitigate the reluctance of governmental bodies to implement such an approach. It seems that FRs surrounding Ilunde (Inyonga and Rungwa River FR) are priorities because of the high amount of human pressure on them and because of their lack of management. Moreover, they harbour the two main rivers of the region. Several CBNRM units could mean one or several CBOs but one CBO seems better because CBOs require important management skills that are scarce in the region. Moreover, several CBOs and several units would complicate the management and be expensive. That is why zoning would be better and more flexible than having several units.

All the users should be involved in the CBO in order to take their needs into account. However, the organizations should not comprise too much outsiders such as loggers because they have less interest to self-organize. The poorest users should be represented in order to take their natural resources needs into account. In regards to the representation of different tribes, the Wakonongo would be essential as they still have traditional knowledge and legitimacy due to their ancestral rights. However, it seems necessary to also include other tribes to ensure equity and sustainability – especially Wasukuma as they are identified as a major threat. This does not mean that they would be allowed to cultivate or to feed their cattle inside the FRs but that they would be included in discussions. Moreover, some solutions for grazing could be found with the creation of buffer zones.

The local stakeholders who may be legitimate to ask for a CBNRM approach are the local users (beekeepers, fishermen, local loggers, gatherers) due to their likelihood of self-organization, the Wakonongo representatives (traditional chiefs, traditional healers) due to their ancestral rights and/or the villages leaders (villages chairmen, village councils) due to their legal authority. Ideally, they should all support CBNRM initiatives and collaborate in order to have more chance to success. However, the decision concerning the CBNRM approach and its models should be taken by the local population through village assemblies. It seems relevant to work on the long-term interests of stakeholders in order to develop a participatory process. A survey of the local population and natural resource stakeholders would be needed to determine which CBNRM model would fit best with which context. If the BKZ or JFM models are chosen, one should ensure that the benefits from all resources are shared with the communities from the start of the process. Even if CBNRM could be facilitated by ADAP or another NGO, it would be essential to take the needs of the local population and users into account and necessary trade-offs should be explicitly exposed and acknowledged. One should pay attention to not impose a top-down approach, regularly assessed in these kinds of projects, which compromises an effective decentralisation (Nelson & Blomley, 2010). Lastly, if a baseline study was defined to measure the outcomes of a CBNRM approach, it should take the historical and cultural context of the region into account and not only fix ecological and developmental indicators (De Vries, 2005).

The main **limitations** of a CBNRM approach for the FRs are twofold: the legal framework which does not allow substantial financial benefits and does not go far enough in the devolution of rights (even for WMA) to communities and the difficult implementation of CBNRM model and their management. Berkes (2004) thinks that one should go beyond the financial incentives only because they are not necessarily equally distributed. One should rather consider the resources access and empowerment. In regards to the implementation, all these CBNRM initiatives have in common that they are very difficult to establish for local populations because administrative procedures are expensive and complicated for people with a basic education (Songorwa, 1999). CBNRM areas require that communities prepare management and resources use plans and submit them for validation to the MNRT (while some governmental GRs do not even have one yet). Moreover, land use plans should be available and respected for the WMA model and this would be difficult as we have seen that local authorities did not manage to respect them for the Inyonga Division (however it should not be better elsewhere in Tanzania). Thus, all the models would require external support from NGOs

or bilateral programs which put communities in a situation of dependency towards external stakeholders. In such circumstances, there is a risk that the CBO set up by a project does not correspond with the local skills and that the project substitutes local stakeholders with external employees, which would imply the collapse of CBNRM when the project stops. The project would need to be supported in the long term since Berkes (2004) argues that the creation of such local institution and the achievement of its effectiveness may need 10 years, especially if there is a great need of local capacity building. However, few donors are open to such long term support. Even if traditional knowledge and local visions could be incorporated in the management through the CBO, the CBNRM models impose an “ecological modernisation”⁷⁰ of the way natural resources are managed (with management plans, monitoring, etc.). For example, IBA would not be able currently to manage the Mlele BKZ alone because of a lack of modern managerial skills and a lack of funds. ADAP still needs to support IBA with a substantial capacity building effort for some more years, and to ensure the validation of by-laws which would define the sharing of benefits.

CBO governance would not necessarily guarantee the absence of corruption and dysfunctions which characterized many local institutions. Brockington (2008) observed a lack of transparency, accountability and justice when he studied local government in the Rukwa Region. However, these problems do not automatically mean the failure of CBNRM. For instance, Lund and Treue (2008) observed a high degree of transparency of CBFM in Mfyome even if more accountability could be expected. A last limitation is the reluctance of current FR managers to some or every kind of power and resources devolution through CBNRM. Such approach would imply sharing, or giving back, the rights to and benefits of natural resources which are significant for government organisations. Employees could also see this as a threat to their own business if another institution is present to manage the resources. Thus they would probably resist to what they perceive as a loss of social status, power and economic opportunities through the current rent seeking behaviours. The TFS and the WD would be particularly reluctant to lose or share the power over the FRs in a time of reconsolidation of state power over natural resources (Benjaminsen et al., 2013). That is perhaps why TFS said that JFM is not a good idea for big national FRs like the ones in the Mlele District (F_GM01). In other words one might anticipate resistance to the power sharing process.

We can now try to answer the last specific question: **To what extent could CBNRM approaches allow for changes in the system and ensure social justice and sustainable use of natural resources?** Since solutions cannot be found in traditional Konongo rules or informal arrangements because they are vanishing or do not exist anymore, one needs to legally change the current governance arrangements in order to correspond to the social and ecological context of the Mlele District. Currently, the likelihood of users’ self-organisation seems limited, mainly due to the property-rights regimes (which do not give the collective-choice rules to users), the lack of leadership and the huge size of FRs. Theoretically Tanzanian CBNRM approaches have the potential to make the necessary changes to ensure more sustainable social and ecological outcomes.

⁷⁰ Western way to manage the environment which was imposed to Southern countries through globalisation and conservation and development programmes (Zimmerer and Bassett, 2003a).

Even if the legal framework does not necessarily provide expected power and benefits, it already gives more rights (exclusion and management rights) to users than the current governance. At this step, we could thus refute the hypothesis which says that “The existing Tanzanian CBNRM framework, as defined by policies and legislations, does not give enough rights and incentives to local communities to manage the resources in a sustainable way”. However further research and analysis of case studies would be needed to affirm this hypothesis. Nevertheless, the WMA model is the one which could offer the greatest advantages for the communities with full exclusion and managements rights (and not co-management with the state) for all resources and more financial returns to cover the management costs. Additionally, it could create more village land by transforming the FRs in WMA and not restricting the current village land (for which the model is often criticised). However, it would be the most difficult one to implement due to its complicated procedures and the power it gives to communities over wildlife resource. Consequently, implementation of CBNRM would not be easy and would require external support. A survey among the local population and users would be the first step necessary in order to determine the pertinence of CBNRM and the way it should be implemented so as to meet local expectations. Moreover, CBNRM does not guarantee the absence of local corruption at the governmental and association levels but pushes nevertheless towards more accountability and transparency (Lund & Treue, 2008). There is a high probability of reluctance from governmental bodies for all the models since the state does not want to lose revenues from natural resources. The current short-term winners would become losers whereas they are the most powerful actors. This theoretically supports the hypothesis that “The introduction of CBNRM for Mlele District FRs does not guarantee legal certainty and central and local government bodies will resist letting go of power and its associated rent caption opportunities”. However, more surveys about the government managers should be conducted.

To answer the second research question, we could say that even if Tanzanian CBNRM approaches are criticised (in regards to their implementation, the insufficient benefits and lack of real power), it would not be worse than now for the local population and ecosystems. Even if CBNRM does not provide direct financial assets for households, it could give users back more rights through community organisations. Moreover, the way CBNRM is implemented (through social acceptance and motivation) could influence the outcomes. Perhaps a pilot-project going beyond the sectoralization of CBNRM could be initiated. These pilot-projects are possible and often lead to legal and political reforms as was the case with a project run in the vicinity of the Ruaha NP by DfID and the Selous Conservation programme run by the German Development Agency (GTZ). They tested the WMA model before it was formally adopted by the government (see Baldus & Cauldwell, 2004). However, they were implemented by influential bilateral donors who pressured the Tanzanian government for the adoption of the new policies and legislations. Lastly, we should not forget that even if CBNRM is well implemented and corresponds to the social and ecological context, there are some drivers that are beyond the capacity for action of a local CBNRM project, such as population growth, national corruption, market influences, etc. For instance, if a uranium deposit is found in the FRs, all the other objectives or prerogatives could be taken away by the central government as was the case in the Mbarangandu and Nalika WMAs in the Selous Niassa Corridor (PC06).

4.3. REFLECTIONS ON THE SURVEY

For the last section of the discussion, we return to the survey done for this master's thesis. First, concerning the data collection, we could raise the question: how would it have been if I was not a French-speaking white woman who works for ADAP? Even if I tried to distance my research from the ADAP's project, the data collection was certainly influenced by my profile. However, it is difficult to know to what extent as Milner-Gulland & Rowcliffe (2008, p. 91) say "*Bias is an insidious problem because it is very hard to quantify, and hence it is difficult to correct for.*" Some villagers could have accentuated their words about the importance of natural resources for them or the managers could have tried to hide some failures or constraints on their management to avoid a too bad figure. I could have missed some points or tricks. The interests of some people on CBNRM were maybe biased because of the discourses of ADAP and its project in the Mlele BKZ. If I had spoken Kiswahili fluently, I would have been able to catch subtly the words of some interviewees. My translator's English proficiency was sometimes limited and I had to explain precisely what I expected (that I wanted nuances in the questions' formulation and all the details of the interviewees' answers instead of a summary). All my translators were men and this could have meant a bias, especially for groups of women. However, some interviews could have been different if we were two women (me and a translator) since most of the interlocutors of the study were men. Forests and their management are still a man's world, and not only in Tanzania as my previous work experience in Switzerland taught me. Finally, it was sometimes difficult for me to juggle between the data collection for the thesis, some support tasks for ADAP's project and the workshop preparation. However, I think this reflects the realities of professional world where we need to multi task.

In regards to the interviews conducted, it was the first time for me to collect social data. I think I was quite clumsy at the beginning and I tried to improve over the weeks. It was thus very instructive for me to learn social skills. That is why informal discussions were very useful to collect data about more sensitive subjects. I realised that it was very important to brief the interviewees, especially the villagers, about what I expected from them. For example, they were afraid to give wrong answers and I had to explain many times that there was no good or wrong answer and that I wanted their opinions. I sometimes gave examples to illustrate my questions but I had to be careful because some interviewees thought that the examples were the only possible answers. I noticed that it is essential to understand the way of thinking and the culture of the local population to be able to read between the lines of an interview. While not being an anthropologist of Wakonongo at all, I think that my previous knowledge of the field helped me to be more aware of the things which are not said. However, it was sometimes difficult to deal with the dichotomy between speech and practices observed and between traditions and modernity. Moreover, it was no easy to disentangle the past traditions from the remaining ones. Lastly, I noticed that the recorder was not always a good thing because people are not confident with it. Some are not used to such technology, others are more careful about what they say.

Concerning the field work in the bush, the presence of VGS with me have influenced the encounters with others users. Nevertheless, it would not have been possible to go alone with a translator only as some places were not so safe. Globally, I learnt a lot by travelling into FRs by observations and asking questions to VGS and users. Even if there had not been the camera

traps to install, it would have been useful to explore the FRs because interviews in the villages are not enough and sometimes they are not consistent with what happens in the forest (people can minimize or exaggerate the problems). Field observations are thus a good means to cross check and qualify the interviewees' words. Going into the bush made me aware of the presence of the fishermen, stakeholders that I had forgot when I prepared my interview guide.

Before doing the field work, I was thinking to use the CPR theory only as I imagined that traditional or users' rules were more present in the governance of FRs. However, after the field work, I opted for a political ecology approach due to the conflicts and injustice seen during the 3-months study. Since the field work has shown quite classic conflicts about resources access, theory and concepts were simplified because we were not in a post-structuralist issue. Moreover, as the field work was very important for this thesis, less time was available for an extensive theorization. I let the concept of sustainability aside because it depends on actors' perceptions and its evaluation is difficult. Nevertheless, it is quite impossible to avoid using this term when we speak about natural resource use.

A criticism of this thesis that may be made concerns its too broad scope. As it focused on social and ecological parameters on a large scale, the amount of data collected was substantial and it exceeded the concerns of FRs, like data on agriculture and village land governance. Although these data were useful to understand the whole situation, they were not fully exploited. I wanted to speak about all the aspects surrounding the uses of natural resources in FRs because I was very interested and there were many topics to study. However, I had to limit the subject to the FRs. The broader socio-political context, interactions between the different national sectors managing natural resources and their histories were studied only marginally because of a lack of time too.

Consequently, the case study of the natural resources and protected areas in the Mlele District would be prone to further researches. Long-term research could be undertaken to deepen some of the issues raised during this study to better understand the dynamics which influence the local governance on natural resources. Specific studies could be useful on subjects such as the migration and cultural practices of the Wasukuma, the effects of the refugees' camp, the evaluation of forest conditions (with finer satellite images analysis and field surveys), a detailed livelihoods evaluation, the functioning of government management at different scales (from Dar es Salaam to the field level) or the value chains of some products (honey, charcoal, tobacco, timber, bushmeat, etc.).

To conclude this section and the discussion of this thesis, I can say that despite some sad assessments during the field work (like the massive poaching, the deforestation and the helplessness of the local population to face the current situation), this master's thesis has been a terrific experience, on a professional and personal side. It enables me to go further and deeper into the local issues than I did with my bachelor's thesis. This thesis has made me aware of the importance of politics in the field and to reconsider the explanation of the poor peasants who killed wildlife and cut forest, often given by mass media and some conservation agencies. Moreover, I noticed that problems are always tangled and it is very difficult to sort them out and rank them.

5. CONCLUSION

This study combined a political ecology approach with the CPR theory to examine the relationships between the users, the resources, and the rules governing the FRs of the Mlele District in order to understand the factors which influence the governance arrangements. Once this assessment was established, a second point was to evaluate under which conditions the CBNRM approaches, as considered by ADAP, could lead to more sustainable outcomes.

Due to its limited financial, physical and human assets, the local population relies on its social and natural assets to cope with seasonality and shocks, be it through the farming activity or secondary activities using natural resources. However, natural assets from FRs are not secured because of the national regulations, the degradation and the competition with outsiders. The traditional rules of Wakonongo, the local tribe, are vanishing and are not effective anymore while the government management is not efficient to counter the current human pressures due to population growth, rent seeking behaviours of several stakeholders and rapid socio-economic changes. Relationships between the local managers and their authorities are complex and vague as a result of a superposition of legal status (FRs and GCAs), the establishment of new institutions (TFS and Mlele District) and sector based approaches hindering opportunities of coordinated management. There is therefore a lack of collaboration between the managers and conflicts, as they all try to keep or gain as many prerogatives as possible on the FRs and the resources they harbour. Government managers are all characterized by a severe lack of human, material and financial means, which does not allow them to properly implement basic management tasks such as inventories, regulations and controls. In addition to this, legal rules are only partially enforced by the managers because of political pressures and low commitment of employees, which are both influenced by high levels of national and local corruption.

Actually the government and its managers give little consideration to the management of natural resources. Instead, they are managing financial resources, parcels of power and personal benefits, which lead to an extractive natural resources exploitation. Even if the ecosystems of FRs are still harbouring huge forests, the lack of management and the personal interests of stakeholders lead to an over-exploitation of natural resources and the degradation of habitats. Cultivated land has grown faster than the population, encroaching on the FRs and not respecting the Land Use Plans. The encroachment front is accompanied by high rate of cattle grazing and progressive forest degradation. Inside the forests, some timber species are massively cut, large mammals are heavily poached along the main rivers and fish are overexploited in the Koga River. There are no significant differences between FRs in regards to the wildlife species and occurrence of human activities. However, the Inyonga FR is the most affected by encroachment and has to face, with the Rungwa River FR, a high rate of illegal activities. With a total of 43 species, the study area still harbours a diverse wildlife but human pressure through poaching, hunting, habitats degradation and disturbance seems to affect the occurrence of mammal species, especially for patrimonial ones such as the elephant, the buffalo and the lion. We could put things into perspective by highlighting that the region has already faced important fluctuations in forest cover and wildlife populations during the last two Centuries due to human activities. The forests were almost depleted of elephants in the

19th century and some areas were totally cleared (Water, 2009). However, the human population was far lower than now and the technical means to harvest were poor, which allowed fast regeneration. Nowadays, agriculture, logging, cattle keeping and poaching are identified as severe threats because their combined effects could seriously destroy the miombo ecosystems which could reach a threshold and not deliver resources and functions any more.

The greatest impacts are not made by the poorest people because they do not have enough assets to cause large scale degradation. Newcomers engaged in cattle keeping and outsiders have more means and incentives to extract or destroy natural resource of the FRs. The governance of the FRs creates opportunities for many users and managers to generate incomes in an illegal way because of taking advantage of the legal loopholes. The main assets to operate illegally are financial means, position and social relationships. Moreover, even in the legal way users require assets to benefit from natural resources. In this context of injustice with regard to natural resources rights, few means and human pressures, local users are unable to self-organise and ensure sustainable harvestings. However FRs are not in a pure open-access situation because even if there are opportunities due to the lack of management and law enforcement, there are still some controls and informal rules from powerful actors who, through sanctions and violence, do not allow everybody to access resources.

In the short-term, the winners of the situation are external users and managers involved in illegal activities. The local users and the local population do not really benefit from the exploitation of the natural resources because the added value is not created at their level and their harvests are limited. Moreover, even if the controls are low, they create inequity because the illegal users who are caught and punished are the poorest. In short, the costs of maintaining the FRs are mostly supported by the local population while the benefits are mostly accrued for outsiders and state employees. Local population is afraid for its future as it could become more vulnerable to trends and shocks without the safety net that natural resources currently represent. Moreover, they would not necessarily be empowered by the new changes because even agriculture and cattle keeping could be compromised due to rainfall patterns modification of degradation of miombo nutrient-poor soils.

It seems, according to our analysis, that the elements which influence the degradation the most are national dynamics. Consequently, we cannot attribute natural resource degradation in the FRs to the local population's poverty but to the profit accumulation by wealthy actors. Corruption and patronage have a significant role on the social and ecological outcomes of Mlele District FRs, since they percolate from national to local authorities, engender bad governance and decrease the already precarious means available to manage these areas. Natural resources are used in the national and local political game. We could thus argue that the state fails to manage its natural resources as provided by the law. There is a climate of impunity where some actors can control natural resources with violence and power. The legal rights are not guaranteed or become privileges granted to influent actors. Nevertheless, we need to be aware that the situation presented here is perhaps worsened by field work carried out during the pre-elections times and the recent installation of the District and the TFS. It could be interesting to study the same area in one or two years to assess if changes have been

induced by the new President, who is currently fighting the corruption within the highest levels of the state (Muvunyi, 2016).

The future of the FRs in the Mlele District could be their degazettement in village land where habitats are too degraded or their up-grading to stricter protected areas such as GR (Caro & Davenport, 2015) which would mean lesser rights for the communities than now. One alternative could be the CBNRM approach, which is a compromise between habitat conservation and local needs. The Mlele BKZ is a good example in the study area as it shows that users managed to reclaim some rights on their ancestral land and are motivated to manage it. The high rates of patrols have allowed limited encroachment and curbed the illegal activities in the BKZ. CBNRM approach has theoretically the potential to favour the users' self-organisation to manage natural resources, mainly through exclusion and management rights. Even if CBNRM in Tanzania is criticised for its lack of rights devolution, its unjust sharing schemes with the central government and its poor implementation, it offers rights to users that do not even exist under the current government management and could generate positive changes for the local population (Lund & Treue, 2008). The WMA model offers the greatest number of advantages for the communities with the exclusion and management rights and more financial returns. However, it would be the most difficult one to implement due to its complicated procedures and the high probability of reluctance from governmental bodies, especially the TFS and the WD, to let such territories escape their control.

ADAP's intention to extend the CBNRM approach to other FRs of the District seems thus relevant but should be undertaken under certain conditions. The local population should be properly informed about the benefits and costs associated with the establishment of CBNRM and the project should take their needs and wishes into account to avoid a top-down approach. The inclusion of all stakeholders in the process would be essential and the community organisation should be based on the local users Wakonongo representatives and the village authorities. There is a need of better local governance for the FRs and the institutions which managed the FRs should be redesign. However, even if CBNRM is well implemented and correspond to the social and ecological context, there are some drivers of degradation that are difficult to fight against, such as population growth, corruption or influences of markets. The insecure legal climate for local users and corrupt system governing the natural resources are important constraints which could imply the failures of CBNRM. Appropriate rights and rules are not sufficient in a context of disproportionate power balance. The central state's power and the legal uncertainty question the incentives created by CBNRM approaches at local level. Consequently, a new research question could be: What is the CBNRM initiative's ability to survive in an insecure political context where rights are not guaranteed?

To go further, in addition to its respect and implementation, the policy and legal framework of Tanzanian CBNRM would need to be reviewed and standardised to avoid the current sector based approaches (Akida & Blomley, 2006). The donors' role was, and is still, central in the Tanzanian CBNRM approaches but at the same time, they have few levers for actions to really push reforms because bilateral donors cannot change easily their programme or freeze funds and NGOs are dependent on their relationships with the state (Nelson et al., 2007). Reforms are thus limited to discourses in order to "suit" the requirements of donors and attract them,

but are not implemented because the state has no intention to give up the rights and incomes of natural resources (especially when the sector is not transparent (Benjaminsen et al., 2013)).

In regards to theory, the FRs are clearly “political forests”, according to the Vandergeest and Peluso’s (2015) concept, where socio-political factors prevail over the ecological conditions. The attributed land use in the 1950s has determined their regulations and provoked conflicts between the managers and the users. The label “FR” has justified the management of these areas by professional government managers whereas they do not ensure the sustainability they pretend. The current situation of the Mlele District FRs shows the limits of the sectoral approaches since it questions the actions which should be undertaken with the agricultural encroachments. Should one evict the encroachers in order to correspond to the status of FR or should one re-examine the areas of the FRs? In regards to the SES framework of Ostrom (2009), we can say that it was useful to design the research and keep an overview of all the elements which are involved in the use of natural resources. The ten variables which favour the user’s self-organisation were relevant to assess the contribution of CBNRM model to allow for more sustainable local outcomes. However, it was needed to go beyond the institutional arrangements to assess the natural resources use in the FRs since they depend on power relations and broader influences such as corruption, political game or international market and institutions. Consequently, the political ecology approach has allowed us to take a step back from the CPR theory and put it in perspective with political processes.

In conclusion, FRs are significant for local livelihoods, state incomes and ecosystems preservation in the Mlele District. FRs could thus be a relevant tool for a local sustainable development instead of a constraint to poverty alleviation and a reproduction of social injustice. This opens the discussion on the feasibility of targeting at the same time conservation and development, a heated debate among conservation and development partisans. However, we think that it more essential to rise above such theoretical debates and focus more on local configurations and opportunities to design solutions which respect the people and their environment without speaking about development goals, theories or international strategies.



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APPENDIX 1 Key information about ADAP, IBA and the Inyonga project

These documents were produced for the workshop "Tapping the uncaptured potential of Western Tanzanian Forest Reserves for sustained livelihoods and biodiversity conservation" held the 8 Sept. 2015 in Dar es Salaam



KEY FACTS AND FIGURES ON THE COMMUNITY-BASED NATURAL RESOURCES MANAGEMENT PROJECT OF ADAP AND IBA



KEY INFORMATION

Location : Inyonga Division, Mlele District, Katavi Region
 Project duration: Ongoing since 2002
 Direct Beneficiaries: 5'000 people
 Undirect Beneficiaries: About 25'000 people
 Budget: 2'500'000USD

LAND USE PLANNING AND MANAGEMENT



- Detailed management plans realised for 12 villages
- Village bylaws established and enacted
- Village tribunals for conflict resolution established
- Certificates of Customary Right of Occupancy issued
- 90 water wells repaired and managed

ESTABLISHMENT OF A COMMUNITY MANAGED PROTECTED AREA



- Management rights for a Beekeeping Zone of 850Km² transferred by the MNRT to IBA
- High mammal biodiversity with 53 species identified and persistence of endangered lion, wilddog and leopard
- High tree biodiversity with 124 species recorded and persistence of rare hardwoods species
- Over 50 poachers arrested in 2015 only

BEEKEEPING VALUE CHAIN DEVELOPMENT



- 3000 beekeepers trained to modern beekeeping
- Honey production increased from 7t to 120t with 40t for the Beekeeping Zone only
- Yearly Income increased from 1'200USD to 140'000USD
- IBA «MUV» honey certified by TDFA and TBS

CAPACITY BUILDING AND LOCAL EMPLOYMENT



- Local CBO largely recognized by all stakeholders
- 30 Village Scouts trained and employed on a daily basis
- Skills of 80 members of the Village Natural Resource Committees built over time
- Hundreds of women organised into economic groups and registered at District level



Presentation of ADAP and IBA

The Association for the Development of Protected Areas (ADAP) is a Swiss nongovernmental association founded in Geneva in 1997. ADAP promotes a community-based approach in the management and conservation of protected areas aiming to help local communities to turn natural resource management into a driver of development. ADAP was present in Central African Republic, Mozambique and in Tanzania in the Selous-Niassa Corridor. Currently, ADAP is working on community based natural resource management initiatives in Eastern Burkina Faso and Western Tanzania.

Inyonga Beekeepers Association (IBA) is a Tanzanian community-based organization established in 2002 and registered as a NGO since 2007. IBA is the result of a process launched by 17 subgroups of beekeepers that wanted to join their efforts under the umbrella of a local institution able to defend and represent their interests at local and national level. Long-term objective of the association is to turn beekeeping practices into a solid and sustainable income generating activities able to improve local livelihoods of its members.

Main objectives of the CBNRM project

Since 2002, ADAP has supported IBA through its Community-Based Natural Resource Management project. Based on a problem solving approach, the project has been focusing on the following objectives.

- Creation of a community based organisation (IBA) and capacity building of its members;
- Establishment and management of a community managed protected area on a portion of government Forest Reserve;
- Planning and running of the Planning of Land Use Management process (PLUM) in the 12 villages of Mlele District (with the collaboration of the Mlele District).
- Modernization of the beekeeping practices and development of a strong income generating value chain based on beekeeping;
- Development of various sustainable economic activities benefiting local communities.

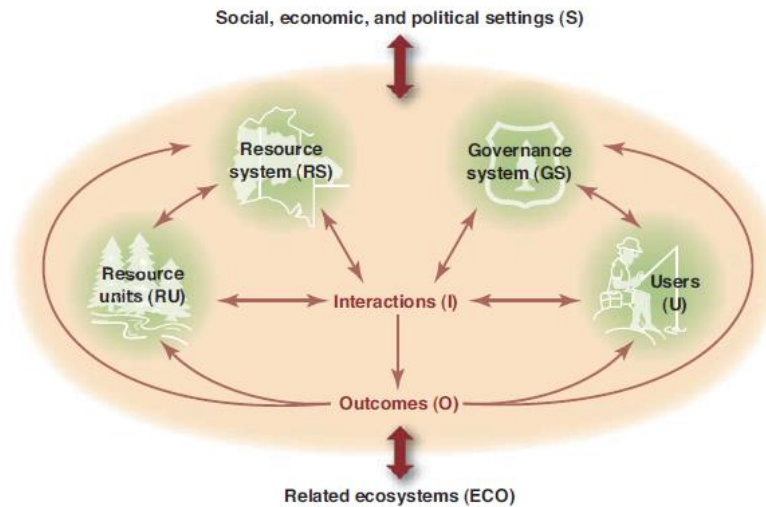
Main results of the CBNRM project

After 13 years of implementation, outcome of the project are very satisfying at several levels. Major achievements and results may be resumed as followed:

- Local beekeepers have succeeded in establishing their CBO. IBA is now well-established and recognized by all local stakeholders;
- A Beekeeping Zone (MBKZ) of 850km² has been established on a portion of Mlele Forest Reserve. Since 2010 and the signing of a Memorandum of Understanding with the Ministry of Natural Resources – FDB Division, the management rights of the MBKZ have been devoted to IBA. The MBKZ is thus managed by IBA in collaboration with the District of Mlele and is the largest area of high conservation value managed by communities for beekeeping production in Tanzania;
- Biodiversity monitoring conducted in MBKZ by ADAP and University of Applied Sciences of Western Switzerland (fauna monitoring) and TAWIRI (forest monitoring) since the start of the project demonstrated that the wildlife and forest cover are well managed and maintained by IBA;
- The PLUM process has led to the establishment of 12 Detailed Villages Management Plans and to the issuing of hundreds of Certificate of Customary Right of Occupancy. The process has contributed to solve numerous land conflicts and to accommodate the various activities conducted by the different groups of inhabitants;
- Over 3'000 beekeepers have been trained to modern beekeeping practices and honey production has increased from 7 tons in 2002 to an estimate of 120 tons in 2014, with 40 tons for the MBKZ only. The quality increase led to a price increase by a factor of ten. Total income generated by the beekeeping sector in Mlele District is estimated at 140'000USD per year;
- Hundreds of women have been organised into economic groups and registered at District level and a circuit for ecotourism has been created.

APPENDIX 2 Core sub-systems of SES framework and example of variables

Source: Ostrom (2009)



Social, economic, and political settings (S)

S1 Economic development. S2 Demographic trends. S3 Political stability.
S4 Government resource policies. S5 Market incentives. S6 Media organization.

Resource systems (RS)

RS1 Sector (e.g., water, forests, pasture, fish)
RS2 Clarity of system boundaries
RS3 Size of resource system*
RS4 Human-constructed facilities
RS5 Productivity of system*
RS6 Equilibrium properties
RS7 Predictability of system dynamics*
RS8 Storage characteristics
RS9 Location

Resource units (RU)

RU1 Resource unit mobility*
RU2 Growth or replacement rate
RU3 Interaction among resource units
RU4 Economic value
RU5 Number of units
RU6 Distinctive markings
RU7 Spatial and temporal distribution

Interactions (I) → outcomes (O)

I1 Harvesting levels of diverse users
I2 Information sharing among users
I3 Deliberation processes
I4 Conflicts among users
I5 Investment activities
I6 Lobbying activities
I7 Self-organizing activities
I8 Networking activities

Governance systems (GS)

GS1 Government organizations
GS2 Nongovernment organizations
GS3 Network structure
GS4 Property-rights systems
GS5 Operational rules
GS6 Collective-choice rules*
GS7 Constitutional rules
GS8 Monitoring and sanctioning processes

Users (U)

U1 Number of users*
U2 Socioeconomic attributes of users
U3 History of use
U4 Location
U5 Leadership/entrepreneurship*
U6 Norms/social capital*
U7 Knowledge of SES/mental models*
U8 Importance of resource*
U9 Technology used

O1 Social performance measures
(e.g., efficiency, equity,
accountability, sustainability)
O2 Ecological performance measures
(e.g., overharvested, resilience,
bio-diversity, sustainability)
O3 Externalities to other SESs

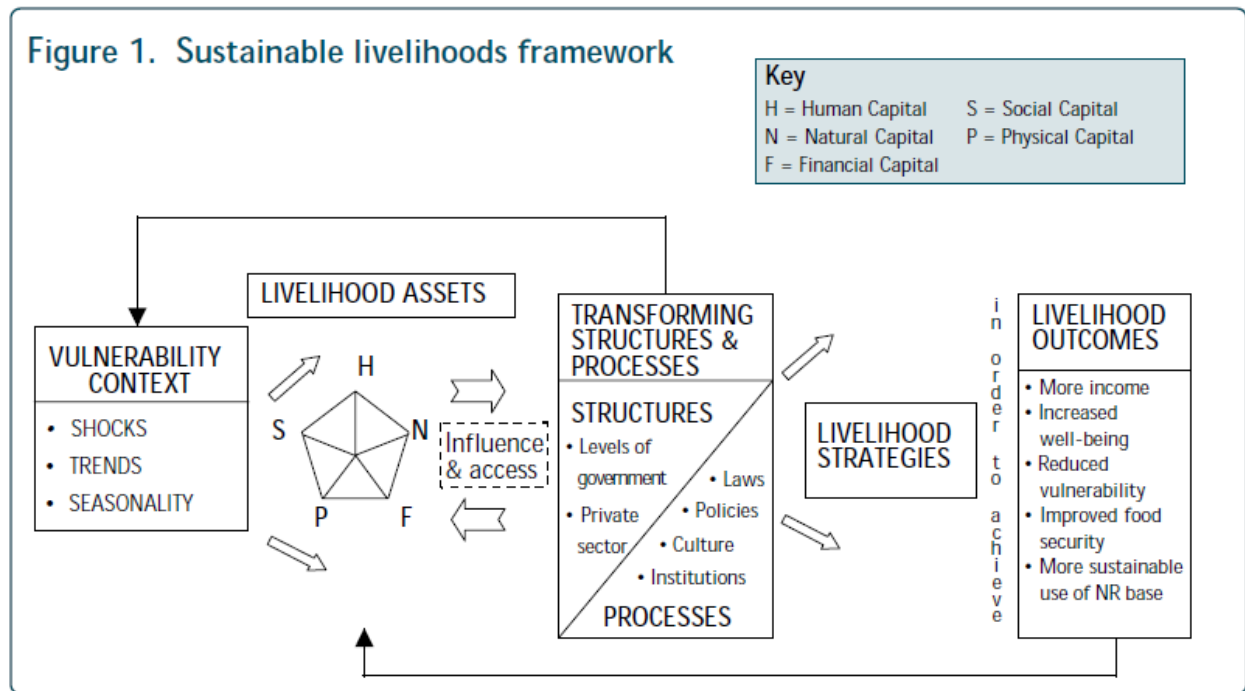
Related ecosystems (ECO)

ECO1 Climate patterns. ECO2 Pollution patterns. ECO3 Flows into and out of focal SES.

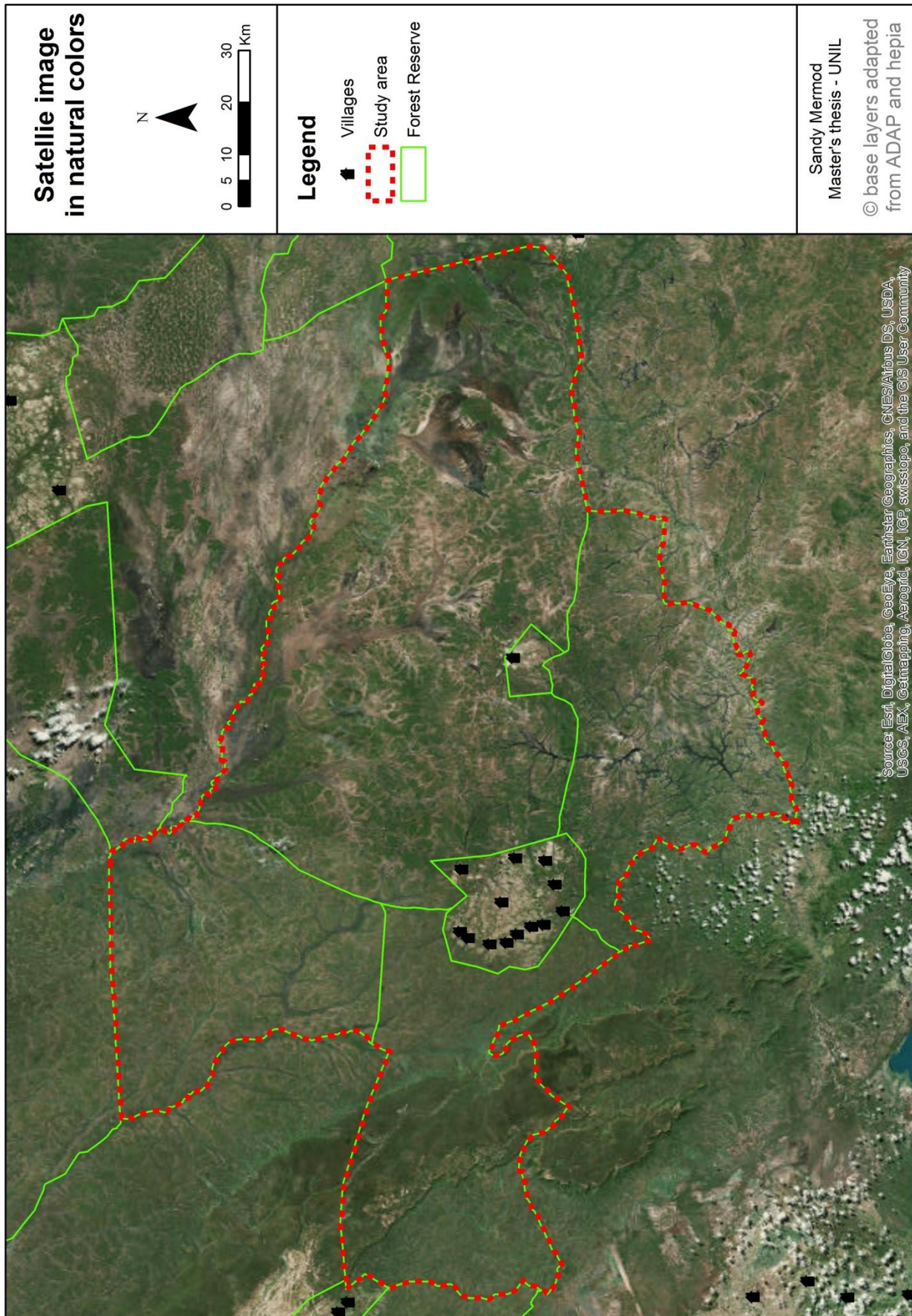
*Subset of variables found to be associated with self-organization.

APPENDIX 3 Sustainable livelihoods framework

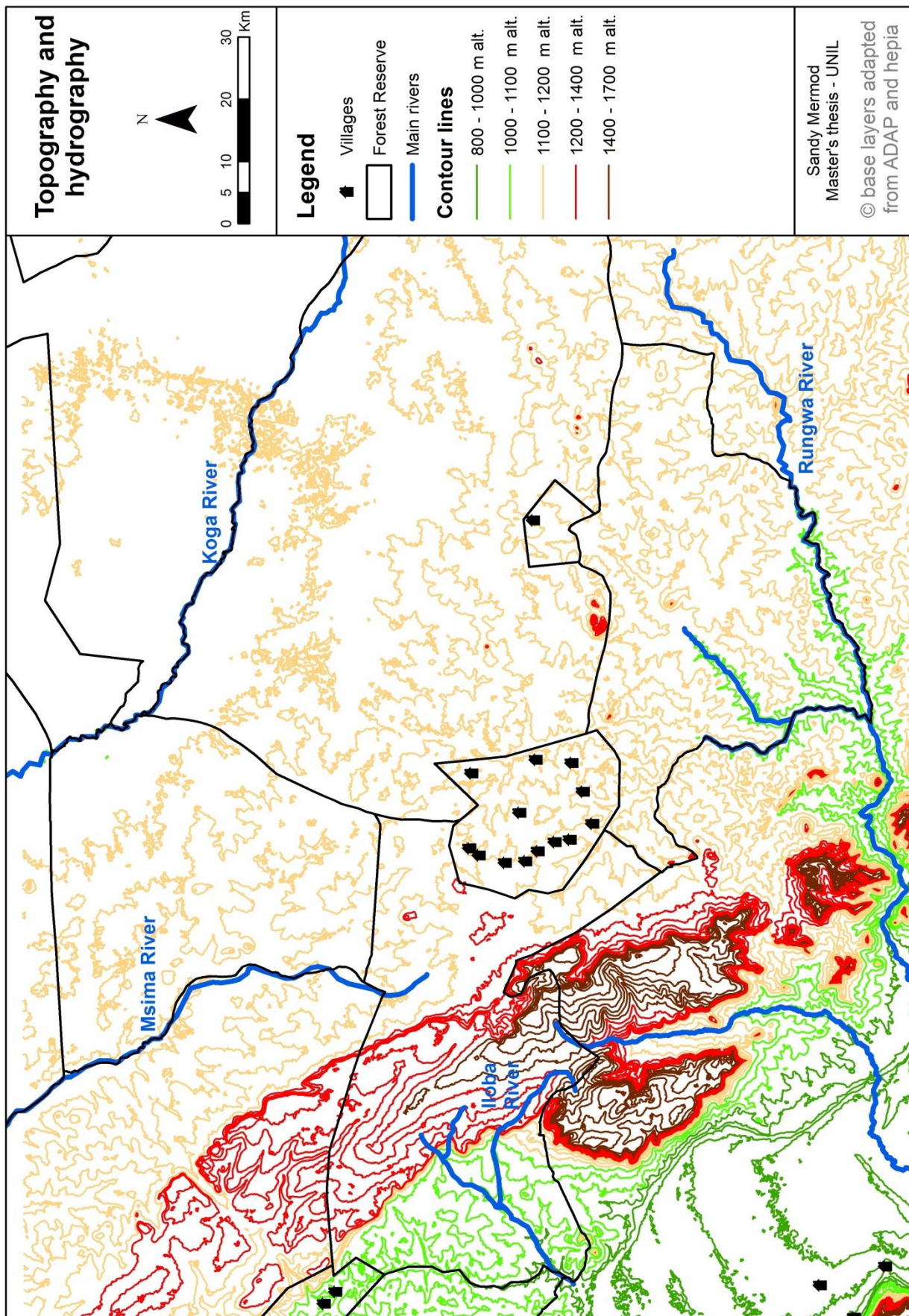
Source: DfID (1999)



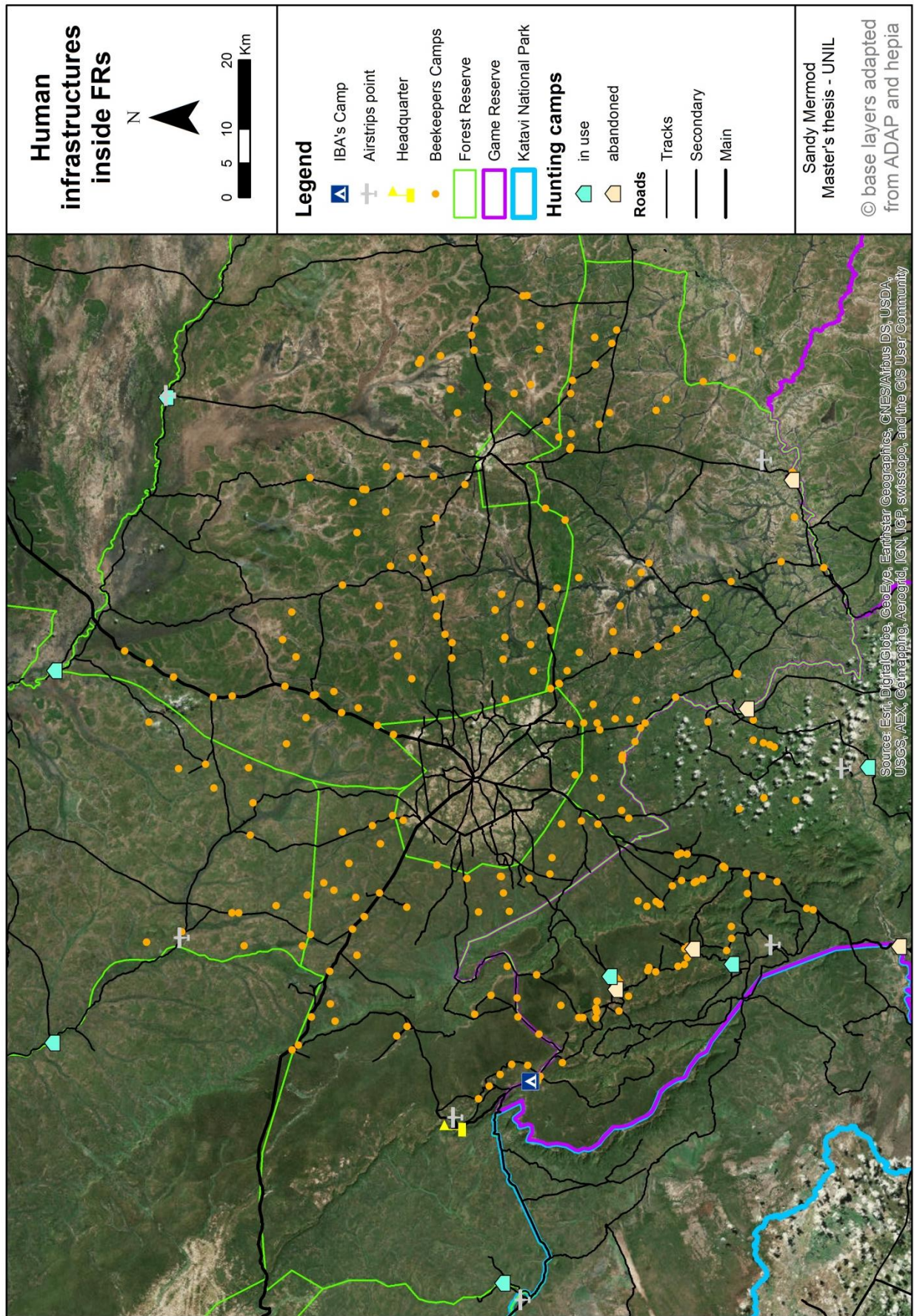
APPENDIX 4 Satellite image of the study area



APPENDIX 5 Topography and hydrography map of the study area



APPENDIX 6 Human infrastructures inside Forest Reserves



APPENDIX 7 Initial data collection strategy

Quest.	Dimensions	Indicators	Indirect indicators	Who/what
What are the resources degradations and their causes?	Ecological	Habitats degradations	Land conversion	km2 deforested in 15 years
		Human impacts	Human infrastructures	Villages, crops, roads, camps, houses, electrical infrastructure, gas, etc.
			Forest conditions	Cut trees, human uses of forest resources (densities of beehives, pit-sawing, traps, etc.)
		Mammals diversity	Mammal species richness among the different FRs	Medium and large mammals with a focus on carnivores
		Causes of impacts	Direct causes of impact	What category of people, from where et for what
			Indirect cause of impact	Politico-economical effect on direct causes (poverty of local population, macro-economic influence, etc.)
		Ecosystem services changes	Uses functions changes	Feeling of users about the products and services that they obtain in natural habitats and the changes they have noted during last years
Indicators for users of healthy ecosystems	Natural elements/phenomenon	Natural elements/phenomenon indicated by the users that confirm a healthy ecosystem		
What are the users' perceptions, uses and needs concerning natural resources?	Socio-economic	Uses of natural resources	Uses and harvests among all users	Uses of all natural resources and their harvest inside and outside FRs from all stakeholders. Perceptions of their sustainability among users and idea of good practices
		Effects of the commercialisation of natural products	Opportunities and threats of commercialisation	Accesses to markets and new services and/or exposure to threats (because illegal practices) for local populations
		Equity of benefits	Benefits repartition among stakeholders	Perception and estimation of amount perceived by each category of stakeholders and inside them
		Livelihoods and natural resources	Estimation natural resources importance in livelihoods	To what extend natural resources allow local populations to cope with shocks and stresses and recover from them (food supply, incomes, building material, medicine, etc.)
			Allocations of natural products and their incomes	Who benefits of natural products and their incomes in households
			Effects of habitats and resources degradation	Positive (incomes, food, charcoal, less crop damages, etc.) and negative (fines, arrests, time, diminution of products, etc.) effects on daily life of local populations
			Needs of local populations regarding natural resources	Needs in terms of access, ownership, rules, equity, etc.
What are the structures of governance for each of the natural resource?	Historical	Traditional rules for natural resources	Users and exploitation before and during colonial times	Rights, rules , sanctions, resources conditions inside Wakonongo communities
	Property	Property-rights regimes	Rights of each stakeholders	Access and withdrawal, Management, Exclusion and Alienation rights
	Institutional	Formal rules	Laws	Constitutional, collective-choice and operational rules
		Informal rules	Rules between users	Constitutional, collective-choice and operational rules
		Management	Rules enforced in the field	Which rules are enforced and by which stakeholders
			Monitoring and sanctions	Who controlled the respect of the rules and what are the sanctions if they are not respected
	Decision-making process	Decision-making process	How the formal or informal rules and there implementation are decided and by who ?	
	Socio-political	Legitimacy	Legitimated rules and actors	Rules and actors which are considered as legitimated, by who
		Power relations	Power through natural resources	How certain people can dominate others through natural resources
Conflicts		Conflicts and their resolutions	What are the conflicts about natural resources and how they are solved	

APPENDIX 8 Budget and calendar of field work

Approximate budget in Swiss francs (CHF)

Expenses	CHF	Incomes	CHF
International flight	1301	Ingénieurs du Monde	1252
Research permit	1550	ADAP	370
Visas	600	Personal funds	4818
Displacements outside study area	370		
Accommodation	650		
Food	400		
Bush field work (fuel, salaries, food)	1000		
Translation	100		
Internet and communication	230		
Miscellaneous expenses	239		
Total	6440	Total	6440

Field work calendar 2015

Week	Main activities	Location
15 - 21 June	International flight, research permit and visa procedures, bus trip to study area	Dar es Salaam, Tabora, Inyonga
22 - 28 June	Introduction, camera traps survey and visit of the FRs	Inyonga, FRs
29 June - 5 July	Fist interviews with managers and Wakonongo	Inyonga
6 – 12 July	Interviews with District representatives, tobacco companies and visits of encroached areas	Inyonga, Tabora
13 – 19 July	Camera traps removal and re-installation of the ones with virus on memory cards.	FRs
20- 26 July	Focus groups with village representatives, visit of Katavi NP	Ilunde, Inyonga, Katavi
27 July – 2 August	Patrol with VGS in Mlele BKZ, focus groups and interview with NR users	Mlele, Inyonga
3 – 9 August	Interviews and focus groups with regional managers and Wakonongo representatives	Inyonga, Tabora
10 – 16 August	Interviews in Ilunde and CT survey in Rungwa River with the other student	Ilunde, Rungwa FR
17 – 23 August	Interviews and focus groups with villagers, local NR users	Inyonga
24 – 30 August	Ecological data treatment, interviews with District officers, cattle keepers and women groups	Inyonga
31 August – 6 September	ADAP tasks, workshop preparation, trip to Dar es Salaam	Inyonga, Tabora, Dar es Salaam
7 – 13 September	Workshop in Dar es Salaam and international flight	Dar es Salaam

APPENDIX 9 Predictive list of mammal species

List of 64 mammal species which could be found in the FRs. Based on Foley et al. (2014) and completed with findings of the monitoring in Mlele BKZ.

N°	Order	Family	French name	English name	Swahili name	Latin name	Red List*
1	Proboscidea	Elephantidae	Eléphant d'Afrique	African elephant	Tembo	<i>Loxodonta africana</i>	VU
2	Proboscidea	Hyracoidae	Daman des steppes	Bush hyrax	Pimbi	<i>Heterohyrax brucei</i>	LC
3	Proboscidea	Hyracoidae	Daman des arbres	Tree hyrax	Pimbi mti, Perere	<i>Dendrohyrax arboreus</i>	LC
4	Proboscidea	Orycteropodidae	Oryctérope	Aardwark	Muhanga	<i>Orycteropus afer</i>	LC
5	Artiodactyla	Bovidae	Impala	Impala	Swala pala	<i>Aepyceros melampus</i>	LC
6	Artiodactyla	Bovidae	Bubale de Lichtenstein	Lichtenstein's hartebeest	Kongoni	<i>Alcelaphus lichtensteinii</i>	LC
7	Artiodactyla	Bovidae	Damalisque	Topi	Nyamera	<i>Damaliscus lunatus</i>	LC
8	Artiodactyla	Bovidae	Antilope rouanne	Roan antelope	Korongo	<i>Hippotragus equinus</i>	LC
9	Artiodactyla	Bovidae	Hippotrague noir	Sable antelope	Palahala	<i>Hippotragus niger</i>	LC
10	Artiodactyla	Bovidae	Cobe defassa	Defassa waterbuck	Kuro	<i>Kobus ellipsiprymnus</i>	LC
11	Artiodactyla	Bovidae	Puku	Puku	Sheshe	<i>Kobus vardoni</i>	NT
12	Artiodactyla	Bovidae	Dik-dik de Kirk	Kirk's dik dik	Digidigi	<i>Madoqua kirkii</i>	LC
13	Artiodactyla	Bovidae	Oréotrague	Klipspringer	Mbuzi mawe	<i>Oreotragus oreotragus</i>	LC
14	Artiodactyla	Bovidae	Ourébi	Oribi	Taya	<i>Ourebia ourebi</i>	LC
15	Artiodactyla	Bovidae	Raphicère de Sharpe	Sharpe's grysbok	Dondoro	<i>Raphicerus sharpei</i>	LC
16	Artiodactyla	Bovidae	Cobe des roseaux	Southern reedbuck	Tohe ndope	<i>Redunca arundinum</i>	LC
17	Artiodactyla	Bovidae	Redunca	Bohor reedbuck	Tohe	<i>Redunca redunca</i>	LC
18	Artiodactyla	Bovidae	Buffle d'Afrique	African buffalo	Nyati	<i>Syncerus caffer</i>	LC
19	Artiodactyla	Bovidae	Céphalophe bleu	Blue duiker	Ndimba / Paa chesi	<i>Philantomba monticola</i>	LC
20	Artiodactyla	Bovidae	Céphalophe couronné	Common duiker	Nsha / Nsya	<i>Sylvicapra grimmia</i>	LC
21	Artiodactyla	Bovidae	Eland du Cap	Common eland	Pofu	<i>Tragelaphus oryx</i>	LC
22	Artiodactyla	Bovidae	Guib harnaché	Bushbuck	Pongo / Mbawala	<i>Tragelaphus scriptus</i>	LC
23	Artiodactyla	Bovidae	Grand koudou	Greater kudu	Tandala mkubwa	<i>Tragelaphus strepsiceros</i>	LC
24	Artiodactyla	Giraffidae	Girafe	Giraffe	Twiga	<i>Giraffa camelopardalis</i>	LC

N°	Order	Family	French name	English name	Swahili name	Latin name	Red List*
25	Artiodactyla	Hippopotamidae	Hippopotame	Hippopotamus	Kiboko	<i>Hippopotamus amphibius</i>	VU
26	Artiodactyla	Suidae	Phacochère commun	Warthog	Ngiri	<i>Phacochoerus africanus</i>	LC
27	Artiodactyla	Suidae	Potamochère	Bushpig	Nguruwe pori / mwitu	<i>Potamochoerus larvatus</i>	LC
28	Carnivora	Canidae	Chacal à flancs rayés	Side-striped jackal	Bweha miraba	<i>Canis adustus</i>	LC
29	Carnivora	Canidae	Chacal à chabraque	Black backed jackal	Bweha mgongo mweusi	<i>Canis mesolemas</i>	LC
30	Carnivora	Canidae	Lycaon	Wild dog	Mbwa mwitu	<i>Lycaon pictus</i>	EN
31	Carnivora	Felidae	Caracal	Caracal	Simbamangu	<i>Felis caracal</i>	LC
32	Carnivora	Felidae	Serval	Serval	Mondo	<i>Leptailurus serval</i>	LC
33	Carnivora	Felidae	Chat sauvage	Wild cat	Kimburu / Pakapori	<i>Felis sylvestrus</i>	LC
34	Carnivora	Felidae	Léopard	Leopard	Chui	<i>Panthera pardus</i>	NT
35	Carnivora	Felidae	Lion	Lion	Simba	<i>Panthera leo</i>	VU
36	Carnivora	Herpestidae	Mangouste des marais	Marsh mongoose	Nguchiro maji	<i>Atilax paludinosus</i>	LC
37	Carnivora	Herpestidae	Mangouste à queue touffue	Bushy tailed mongoose	Nguchiro kijivu	<i>Bdeogale crassicaudata</i>	LC
38	Carnivora	Herpestidae	Mangue rayée	Banded mongoose	Nguchiro miraba	<i>Mungos mungo</i>	LC
39	Carnivora	Herpestidae	Mangouste naine du Sud	Dwarf mongoose	Nguchiro mfupi / Kitafe	<i>Helogale parvula</i>	LC
40	Carnivora	Herpestidae	Mangouste ichneumon	Egyptian (large grey) mongoose	Nguchiro mkubwa	<i>Herpestes ichneumon</i>	LC
41	Carnivora	Herpestidae	Mangouste rouge	Slender mongoose	Nguchiro (mwembamba) / Kicheche	<i>Herpestes sanguinea</i>	LC
42	Carnivora	Herpestidae	Mangouste à queue blanche	White tailed mongoose	Nguchiro (mkia mweupe)	<i>Ichneumia albicauda</i>	LC
43	Carnivora	Herpestidae	Mangouste de Meller	Meller's mongoose	Nguchiro	<i>Rynchogale melleri</i>	LC
44	Carnivora	Hyaenidae	Hyène tachetée	Spotted hyena	Fisi	<i>Crocuta crocuta</i>	LC
45	Carnivora	Hyaenidae	Protèle	Aardwolf	Fisi Mdogo	<i>Proteles cristata</i>	LC
46	Carnivora	Mustelidae	Ratel	Honey badger	Nyegere	<i>Mellivora capensis</i>	LC
47	Carnivora	Mustelidae	Zorille commune	Zorilla (striped polecat)	Kicheche	<i>Ictonyx striatus</i>	LC
48	Carnivora	Nandinidae	Nandinie	African palm civet	Fungo	<i>Nandinia binotata</i>	LC

N°	Order	Family	French name	English name	Swahili name	Latin name	Red List*
49	Carnivora	Viverridae	Civette d'Afrique	African civet	Ngawa / Paka wa zabidi	<i>Civettictis civetta</i>	LC
50	Carnivora	Viverridae	Genette d'Angola	Miombo genet	Kanu / Kamsimba (mkia meusi na madoa meupe)	<i>Genetta angolensis</i>	LC
51	Carnivora	Viverridae	Genette d'Europe	Common genet	Kamsimba (mkia duara zake nyeusi sana)	<i>Genetta genetta</i>	LC
52	Carnivora	Viverridae	Genette pardine	Large spotted genet	Kanu/ Kamsimba / mavalevale	<i>Genetta maculata</i>	LC
53	Carnivora	Viverridae	Genette servaline	Servaline Genet	Kanu	<i>Genetta servalina</i>	LC
54	Lagomorpha	Leporidae	Lièvre des rochers	Scrub hare	Sungura	<i>Lepus victoriae</i>	LC
55	Insectivora	Erinaceidae	Hérisson africain	White-bellied hedgehog	Kalunguyeye	<i>Aterix albiventris</i>	LC
56	Perissodactyla	Equidae	Zèbre des plaines	Plain zebra	Punda milia	<i>Equus q. boehmi</i>	LC
57	Primates	Cercopithecinae	Cercopithèque diadème	Mitis monkey	Karasinga, Kima	<i>Cercopithecus mitis</i>	LC
58	Primates	Cercopithecinae	Vervet bleu	Vervet monkey	Tumbili	<i>Chlorocebus pygerythrus</i>	LC
59	Primates	Cercopithecinae	Cynocéphale	Yellow baboon	Nyani njano	<i>Papio cynocephalus</i>	LC
60	Primates	Galagonidae	Galago moholi	Southern lesser Galago	Komba mdogo	<i>Galago moholi</i>	LC
61	Primates	Galagonidae	Galago à queue touffue	Large-eared Greater Galago	Komba makubwa	<i>Otolemur crassicaudatus</i>	LC
62	Rodentia	Hystricidae	Porc-épic à crête	African Porcupine	Nungunungu	<i>Hystrix africae australis</i>	LC
63	Rodentia	Pedetidae	Lièvre sauteur	Spring hare	Kamendegere	<i>Pedetes surdaster</i>	LC
64	Pholidota	Manidae	Pangolin terrestre du Cap	Ground pangolin	Kakakuona (wa aridhini)	<i>Smutia temminckii</i>	LC

*LC = least concern, NT = nearly threatened, VU = vulnerable, EN = endangered (IUCN, 2015).

APPENDIX 10 Treatment of satellite images

Extract of an individual report done for the course “Géovisualisation” UNIL (Mermod, 2015) which used the same procedure as the one done for this master’s thesis. Based on: Mermod, 2014.

Choix des images satellitaires

J’ai choisi des images Landsat car elles sont gratuites et avec une résolution convenable. C’est également le plus grand programme d’acquisition d’images satellites et de nombreuses données sont à disposition (amplitude spatiale et temporelle). Ces images permettent un large spectre d’analyses avec leurs nombreux canaux, ce qui n’est pas le cas des photographies aériennes. J’ai choisi des images entre mai et juin (début de la saison sèche) car il y a peu de nuages et les arbres ont encore leurs feuilles. J’ai choisi l’année 2015 (Landsat8), puisque c’est l’année où j’ai récolté mes données sur le terrain et 2002 (Landsat7) car c’était l’année la plus ancienne que l’on pouvait obtenir et où les images étaient de bonne qualité (sans une couverture nuageuse trop importante). Je les ai téléchargées en GeoTIFF sur la plateforme Earth Explorer, USGS¹. J’ai utilisé quatre tuiles pour couvrir ma zone d’étude: 170/64, 170/65, 171/64 et 171/65.

Rehaussement radiométrique

Le rehaussement radiométrique consiste à fixer bornes de nuances de gris (minimum-maximum dans la Symbologie) en se basant visuellement sur l’histogramme. Ce traitement est fait pour chaque canal et a pour but de redistribuer les valeurs d’une image (anamorphose de l’histogramme) afin de profiter de toutes les nuances d’intensité pour des raisons visuelles et d’analyse.

Compositions colorées

Pour faire ressortir les zones sans forêt j’ai ensuite réalisé une composition colorée dénommée Vegetation Analysis. Vegetation analysis permet de faire une bonne différence entre les zones avec et sans couvert forestier. Pour la créer, il faut superposer trois bandes dans un ordre précis (ordre des bandes trouvé sur le blog d’ESRI²) avec l’outil Composite Bands. La Figure 12 montre l’outil et le résultat visuel. C’est à partir de cette image que les shapefiles de la limite des cultures ont pu être dessinés. Un shape pour la composition colorée de 2002 et un autre pour 2015.

¹Earth Explorer, USGS. Repéré à <http://earthexplorer.usgs.gov/> (consulté le 11 novembre 2015).

² Band Combinations for Landsat 8, by kevin_butler on July 24, 2013:

<http://blogs.esri.com/esri/arcgis/2013/07/24/band-combinations-for-landsat-8/>, (consulté le 20 janvier 2014)

APPENDIX 11 Interview guide for semi-directed interviews and focus groups

Inspired from: Jones, 2006; Ostrom, 2009; Quinn et al., 2007; Songorwa, 1999.

NATURAL RESOURCES USES INSIDE FRS

Practices and visits frequency in forests
Respect of spirits and sacred places
Perceptions of the sustainability of activities
Legitimacy of users
Values of each resource (market, indirect and moral)
Organisation of some value chains
Kind of users (motivations, origins, social status, ...)
Organisation between users (for the same and different activities)
Conflicts between users and their resolution
Clarity of legal boundaries and others boundaries
Changes due to Mlele BKZ

FRS AND VILLAGE LAND GOVERNANCE

Government organisation
Nongovernment organisation
Property-rights system for resources and users
Collective-choice rules (formal and informal)
Past rules and organisation
Legitimacy of the rules
Resources without rules
Government practices
Importance and reason of rules followed (Tradition, fear, violence, pragmatism, ...)
Political issue
What should be undertaken to change the situation?

ECOLOGICAL CONDITIONS AND THREATS

Perceptions of evolution of forest and wildlife conditions
Causes of ecosystems degradations (ranked)
Indirect causes driving degradations
Indicators of a healthy of ecosystem for people
Changes concerning ecosystem services
View about the future

FRS MANAGEMENT

Rules enforced in the field (legal, illegal, informal, ...)
Monitoring and sanctioning processes
Tasks of NR managers
Activities practiced and frequency
Patrols organisation
Conflicts between stakeholders
Problems faced to manage and enforce laws
Collaboration between NR managers
Private-community-government interactions and links
View of community based management
Changes needed and possible solutions

LIVELIHOODS OF THE LOCAL POPULATION

Origins and life story
Activities practiced to earn incomes
Life inside the community
Problems faced in everyday life
In what they would invest
Role and life of women in society
Relationships with other tribes, gender, generation
Traditions and traditional organisation
Konongo knowledge
Importance of traditional medicine
Evolution of lifestyle and improvements
Basic needs which cannot be satisfied without natural resources (contribution of NTFPs in diet)
Importance of wild ecosystems for their other part of their lives (spiritual, incomes, stresses)
Consequences of living near wildlife
Bushmeat consumption and access
Opportunities and risks of NR commercialisation (arrests for illegal activities)
Sharing of benefits among users
Impacts of RN rules in household organisation and revenues
Effects of environmental degradation for livelihoods
Problems of actual system of NR harvests

APPENDIX 12 List of interviewees

Semi structured interviews

Code	Kind of stakeholder	Occupation	Place	Date	Recorded?	Translation
S_GM01	Government manager	District officer	Inyonga	18.08.15	Yes, 70 min	No translation
S_GM02	Government manager	TFS manager	Inyonga	05.07.15	Yes, 80 min	No translation
S_KR03	Konongo Representative	IEA manager	Inyonga	02.07.15	No	No translation but limited English
S_LU04	Local user	retired poacher, farmer, beekeeper	Inyonga	22.08.15	Yes, 60 min	English-Swahili, Dickson
S_LU05	Local user	Witchdoctor, traditional healer, farmer	Inyonga	23.08.15	Yes, 30 min	English-Swahili, Dickson
S_DE06	District employee	District officer	Inyonga	24.08.15	No	No translation but limited English
S_LU07	Local user	Farmer, and beekeeper, woman	Ilunde	11.08.15	Yes, 60 min	English-Swahili, Dickson
S_LU08	Local user	beekeeper, IBA member and farmer	Kanoge	24.08.15	Yes, 50 min	English-Swahili, Dickson
S_FS09	Field staff	VGS, farmer, small old poacher	Inyonga	20.08.15	Yes, 60 min	English-Swahili, Dickson
S_KR10	Konongo Representative	Traditional chief	Masigo	09.08.15	Yes, 60 min	English-Swahili, Dickson
S_KR11	Konongo representative	Traditional chief, local government	Ilunde	11.08.15	Yes, 80 min	English-Swahili, Dickson
S_CO12	Company	Timber company	Inyonga	30.07.15	Yes, 90 min	No translation
S_CO13	Company	Tobacco company	Tabora	08.07.15	Yes, 50min	No translation
S_NE14	NGO employee	Land use expert, working of a NGO	Inyonga	04.07.15	No	No translation
S_CO15	Company	Hunting company	Msimba	25.06.15	No	No translation
S_GM16	Government manager	District Officer	Inyonga	12.07.15	Yes, 40min	Kiswahili – English, Shaaban
S_FS17	Field staff	VGS	Inyonga	01.08.15	Yes, 50 min	No translation
S_SR18	Sukuma representative	Cattle keeper, farmer and beekeeper	Inyonga	28.08.15	Yes, 80 min	Kiswahili – English, Dickson
S_SR19	Sukuma representative	Cattle keeper and farmer	Inyonga	28.08.15	Yes, 40 min	Kiswahili – English, Dickson
S_LU20	Local user	Fisherman	Inyonga,	26.08.15	Yes , 30 min	Kiswahili – English, Dickson

Focus groups

Code	Kind of stakeholder	Occupation	Place	Date	Recorded?	Translation	Remarks
F_GM01	Government manager	TFS regional managers	Tabora	06.08.15	Yes, 70 min	No translation	At their office. Interacted both.
F_KR02	Konongo representative	Elders Wakonongo, farmers and beekeepers, IEA members	Inyonga	02.07.15	Yes, 90 min	Kiswahili – English, Raphael	Between 65 and 70 years old, below a mango tree. Difficult to obtain precise information
F_FS03	Field staff	VGS, farmers	Bush	28.06.15	No	Kiswahili – English, Dickson	Around a fire in the bush, three of them are Wakonongo, including one traditional healer.
F_CM04	Community manager	Beekeepers, IBA members	Inyonga	31.07.15	Yes, 50 min	Kiswahili-English, Napoleon	8 people including 1 woman, after IBA meeting
F_SR05	Sukuma representative	Cattle keepers and farmers	Ilunde	11.08.15	No	Kiswahili – English, Dickson	There were not informed so they had few time because busy with their cows. Chairman of Ilunde was here.
F_WG06	Women group	Farmers, beekeepers, shops, restaurants	Ipwaga	21.08.15	Yes, 40 min	Kiswahili-English, Napoleon	17 women of all ages, some with babies, joint with IBA communication
F_WG07	Women group	Farmers, restaurants	Inyonga	26.08.15	Yes, 50 min	Kiswahili – English, Dickson	In their house, quite relaxed
F_VS08	Village NR stakeholders	Chairmen, secretary, beekeepers, farmers, ...)	Ilunde	20.07.15	No,	Kiswahili – English, Dickson	~30 pers. Focus group was the second part of an ADAP meeting.
F_VS09	Village NR stakeholders	Chairman, secretary, beekeepers, farmers, ...	Kanoge	13.07.15	No	Kiswahili – English, Baraka	23 people, with 5 women. Second part of an ADAP meeting. They were shy at the beginning but spoke a lot after. Few people slept.
F_VS10	Village NR stakeholders	Chairman, secretary, beekeepers, farmers, 1 chief...	Mapili	18.08.15	Yes, 50 min	Kiswahili – English, Napoleon	15 people, with 3 women. Second part of an ADAP meeting. Few people slept. Everybody spoke but women less.

Personal communications

Code	Kind of stakeholder	Date(s)
PC01	Tobacco	07.07.
PC02	Local government	11.08
PC03	Fishermen	14.08
PC04	Villager, young	11.08
PC05	ADAP employee	20.06/10.07/21.07/29.07/
PC06	ADAP committee member	02.06/15.07/23.07/01.08/18.04.2016
PC07	ADAP employee	21.06/25.08
PC08	VGS	24.06/02.07/19.07/11.08/13.08/25.08
PC09	Hunting company	07.07
PC10	ADAP employee	10.07/13.07/21.07/02.08/11.04.16
PC11	TFS Manager	11.07/19.08/31.08
PC12	Hunting company	15.07
PC13	Fishermen	17.07
PC14	Cattle keepers and farmers	17.07
PC15	Fishermen	19.07
PC16	Field staff hunting company	19.07/30.08
PC17	District officer	22.07/29.10 (from Stampfli)
PC18	Konongo representative, old	08.08
PC19	VGS	25.07
PC20	Young who has emigrated	11.08
PC21	Young who has emigrated	11.08
PC22	VGS, old poacher	14.08
PC23	Game warden WD	15.08
PC24	VGS	16.08
PC25	WD manager	24.07
PC26	WD manager	17.08
PC27	Hunting company	24.08
PC28	Farmer women	26.08
PC29	Tobacco company	02.09
PC30	TFS manager	03.09
PC31	Previous WD game warden	08.09
PC32	District officer	October 2015, from Stampfli

ADAP's meetings where there was information

AM01 Meeting with NR stakeholders of Mlele (DLNRO, Acting District Executive Director, TFS manager, ADAP), 03.08.15

AM02 Short meeting with District Executive Director, 12.07.15

AM03 Discussion times during the one-day workshop in Dar es Salaam (where most of important stakeholders were present), 09.08.15

APPENDIX 13 Extracts of social data collected

The social data were organised into a chart divided by the nature of information (semi-structured interviews, focus groups, etc.) and by topics (views of environmental degradation/threats, FRs management, land and government, activities, conflicts, livelihoods) like the example below. Because of their numerous pages (31 pages) the raw data were not integrated in the appendices. Nevertheless, they are available for anyone who would see them.

Here is an extract of the data organisation:

Order No.	Interview topic	Interviewee	Summary	Key findings
1	Views of environmental degradation/threats	Participant 1	Views of environmental degradation/threats	Views of environmental degradation/threats
2	Views of environmental degradation/threats	Participant 2	Views of environmental degradation/threats	Views of environmental degradation/threats
3	Views of environmental degradation/threats	Participant 3	Views of environmental degradation/threats	Views of environmental degradation/threats
4	Views of environmental degradation/threats	Participant 4	Views of environmental degradation/threats	Views of environmental degradation/threats
5	Views of environmental degradation/threats	Participant 5	Views of environmental degradation/threats	Views of environmental degradation/threats
6	Views of environmental degradation/threats	Participant 6	Views of environmental degradation/threats	Views of environmental degradation/threats
7	Views of environmental degradation/threats	Participant 7	Views of environmental degradation/threats	Views of environmental degradation/threats
8	Views of environmental degradation/threats	Participant 8	Views of environmental degradation/threats	Views of environmental degradation/threats
9	Views of environmental degradation/threats	Participant 9	Views of environmental degradation/threats	Views of environmental degradation/threats
10	Views of environmental degradation/threats	Participant 10	Views of environmental degradation/threats	Views of environmental degradation/threats
11	Views of environmental degradation/threats	Participant 11	Views of environmental degradation/threats	Views of environmental degradation/threats
12	Views of environmental degradation/threats	Participant 12	Views of environmental degradation/threats	Views of environmental degradation/threats
13	Views of environmental degradation/threats	Participant 13	Views of environmental degradation/threats	Views of environmental degradation/threats
14	Views of environmental degradation/threats	Participant 14	Views of environmental degradation/threats	Views of environmental degradation/threats
15	Views of environmental degradation/threats	Participant 15	Views of environmental degradation/threats	Views of environmental degradation/threats
16	Views of environmental degradation/threats	Participant 16	Views of environmental degradation/threats	Views of environmental degradation/threats
17	Views of environmental degradation/threats	Participant 17	Views of environmental degradation/threats	Views of environmental degradation/threats
18	Views of environmental degradation/threats	Participant 18	Views of environmental degradation/threats	Views of environmental degradation/threats
19	Views of environmental degradation/threats	Participant 19	Views of environmental degradation/threats	Views of environmental degradation/threats
20	Views of environmental degradation/threats	Participant 20	Views of environmental degradation/threats	Views of environmental degradation/threats
21	Views of environmental degradation/threats	Participant 21	Views of environmental degradation/threats	Views of environmental degradation/threats
22	Views of environmental degradation/threats	Participant 22	Views of environmental degradation/threats	Views of environmental degradation/threats
23	Views of environmental degradation/threats	Participant 23	Views of environmental degradation/threats	Views of environmental degradation/threats
24	Views of environmental degradation/threats	Participant 24	Views of environmental degradation/threats	Views of environmental degradation/threats
25	Views of environmental degradation/threats	Participant 25	Views of environmental degradation/threats	Views of environmental degradation/threats
26	Views of environmental degradation/threats	Participant 26	Views of environmental degradation/threats	Views of environmental degradation/threats
27	Views of environmental degradation/threats	Participant 27	Views of environmental degradation/threats	Views of environmental degradation/threats
28	Views of environmental degradation/threats	Participant 28	Views of environmental degradation/threats	Views of environmental degradation/threats
29	Views of environmental degradation/threats	Participant 29	Views of environmental degradation/threats	Views of environmental degradation/threats
30	Views of environmental degradation/threats	Participant 30	Views of environmental degradation/threats	Views of environmental degradation/threats
31	Views of environmental degradation/threats	Participant 31	Views of environmental degradation/threats	Views of environmental degradation/threats

On the next page, examples of semi-structured interview and personal observations are given.

Semi-structured interviews

Code	Views of environmental degradation/threats	What should we do
5_LU08	<p>Now there are more poachers for wildlife and timber than 20 years ago but except in the BKZ where there are less poachers and forest is in better conditions, which is good for beekeepers. Some of his friends from other village have explained him that forest is not so good in other FRs and the quantity of honey is decreasing. People who destroy natural resources are doing this only for money.</p> <p>If forest disappear he will miss the rain and traditional things (snakes, rituals, ...). Culture and traditions have better chance to survive if there is forest.</p> <p>For the BKZ he's confident because there are VGS patrols.</p>	<p>Problems come from TFS, WD and District who are no supervising.</p> <p>He does not know he the situation will change with the new president.</p>
5_FS09		<p>We should explain more environmental stakes here through education.</p> <p>And we have to offer good jobs to young people. Education is not enough if after they have nothing to do, except to cultivate, cut trees or poach.</p>
5_KR10	<p>Wasukuma are a problem because their cows eat crops and they beat Wakonongo with big sticks. They cut a lot of wood as well.</p> <p>They are destroying source of water.</p> <p>If there are no more trees, it will be a desert. If we do nothing, in 10 years there will be only dust and no more forest.</p> <p>Before wildlife was inside the villages but now there are too much people and poachers.</p> <p>Even in Ilunde, there are changes.</p>	<p>Now chiefs don't have the power to stop the degradations.</p> <p>But old Wakonongo should cooperate and try to preserve some traditions and resource but it is impossible to come back to traditional rules.</p>
5_KR11	<p>Ilunde was preserved more than Inyonga because of its remoteness and its unique tribe but now it is finished. Wasukuma arrived massively 5 years ago.</p> <p>In 20 years, few natural resources will remain. They have already noticed changes with rain patterns these last years. Wakonongo culture won't survive as well, particularly if NR disappear.</p> <p>If there is no more forest, they will miss rain, medicine, honey, food (leaves, mushrooms and meat).</p>	<p>If we want to improve the situation, we should invest in more education and change to system of the central government because people in Dar es Salaam take all the resource of the country and there is a lot of clientelism and corruption. To change the president only is not enough.</p>
5_CO12	<p>Now timbering is unsustainable. They will finish all the precious wood.</p> <p>Here people are not aware of resources finitude. No survey, no harvesting quotas or no management plan are guilty for this situation => lack of means and corruption.</p> <p>There is a lot of waste because timbermen cut only the standards size and let the rest in the forest.</p> <p>Most of the companies want money and don't care about environment and people</p>	<p>They should have a policy like "Cut a tree, plant a tree" like in Dar Region.</p> <p>Company should pay more attention to sustainability but the government should be committed to its duties.</p> <p>We should invest in education to raise awareness of the population concerning environmental and social issues.</p> <p>With education, people would add value to the waste, protect them during their work and make better profits without losing money with small things.</p> <p>Timbering can be sustainable and legitimate if it respects environment and people.</p> <p>Good practices of timbering are monitoring, management, contributes to local livelihoods and use wastes.</p>

Personal observations

	Agriculture	Management	Users
<p>website and facilities and the work in Inyonga (where) and try to go difficult to work management members are arty... (ren) in the forest with hunting and here are using the and on the other side ent of the situation : meeting with NR oge to arrest ar and WD prefer to ne high level of ans to work compare es, employees, sukuma and try to ng village meetings.</p>	<p>Wasukuma with A5-47 in the bus DAR-TAB Wasukuma who stopped after Koga in the middle of the bush with provisions. Wasukuma are not only cattle keeper, they are good farmers and have big fields. That's why they need a lot of land. It the company "Premium" which is working in Inyonga. They are driving like crazy and are arrogant.</p>	<p>No maps inside TFS office in Inyonga (but quite new building) and no maps available (soft or hard copies). Usually there are old calendars in office, 1-2 years old. VGS like to harass poachers (beating them) when they catch them. Frustration or revenge for what they suffered in the past from WD? VGS/rangers have a lot of power on users. Even if these latter are legal, they have to give them honey or fishes. Maybe they are scared of their guns. Boundaries of FRs are not delimited and are not the same with GCA. In Ilunde there no government or village institution to manage forest while they are surrounded by forest... Manager of NR are often absent from their office. They have few vehicles but use them to go to town instead of letting them for field work... Slogan of TFS begins by "Forest is Wealth..." Rangers of WD and from hunting companies like to be in the villages instead of patrolling in the bush and they know that it is not good because they tried to hide from their boss and were ashamed when we saw them. Villagers are not aware about which institution is responsible of what and doing what (TFS, District, WD, IBA, ADAP, ...). I had to ask TFS document in Tabora 2x by mail and 1x by phone. When I arrived nothing was prepared and they gave me only a quarter of what I wanted (on what they agreed 1 month before). They didn't find the management plans. Outside their office they are many dead vehicles, some with Donor Funded Project on the plates.</p>	<p>Difficult to be sure that people who have permits are not doing other things in the forest. There were many people inside the FRs in June and July (timbering, honey, fish, trophy hunting, ...). People without permits or with bad nets run when they see rangers/VGS because they know that they are not allowed. When they are caught, they first try to lie (doing beekeeping, transporting food, ...). There are many people from Sikonge inside Inyonga FR and some received directly their permits from there. Illegal users caught and punished are often poor and at the end of the chain (like the fishermen we arrest or timbermen). The big poachers or big men responsible of few problems because people are afraid to attack such powerful people => unfair system. Social status of users determines the way they are controlled by rangers/VGS. Indian businessmen who are hunting without permits are not beaten, lying on the ground like the farmers are. These latter can be beaten even if there is no evidence of their illegality.</p>
<p>Relationships between stakeholders</p>	<p>Wakonongo</p>	<p>When Wakonongo want to build a museum to explain the culture to new generations, it means the traditions are almost</p>	<p>Livelihoods and traditions Fast changes inside Inyonga, even since 2012. New buildings, more traffic, electricity.</p>

APPENDIX 14 Activities practiced inside Forest Reserves

The activities which use timber, wildlife, fish and honey from FRs are described below in regards to the way they are practised, the stakeholders implied, their organisation, the location and their importance for local livelihoods. The aim is not to give technical details of each activity but rather to give the key points and stakes for each activity. This information was collected through semi-structured interviews, focus groups and observations in the field. We separated trophy hunting from poaching, even if they target the same resource because the stakeholders and their organisation are very different.

Beekeeping, a common in miombo woodlands, has been practiced by the Wakonongo since long time and there is thus an important traditional knowledge of it. Beekeepers use camps in the bush which consist of a hut and a fire place. There are a minimum of 265 camps registered in FRs or in the Rukwa GR. Beekeeping camps are inherited from ancestors and are considered like the territory of the Konongo clans (S_KR03). Beekeepers harvest two types of honey, the standard one from African bee and the one from stingless bee which is available in fewer quantities. The beekeepers go by bicycle to their camp. They carry with them food (ugali flour, small dried fish, onions and beans), buckets, knives and axes. The material used has not changed a lot for many years except the honey buckets which are in plastic now. Many beekeepers were poacher before but now it is more controlled by anti-poaching patrols and they have few advantages to mix these activities (S_FS17).

It is important to put the hives near water and bee-forage trees in order to guarantee enough quantity of honey (S_LU20). Protected areas are thus suitable places to put hives and are far from farming pollutions which are important in village land (especially because of the pesticides used for tobacco). Harvesting season is in June and July and in November and December. Moreover, beekeepers need to go regularly in the bush to control their hives. The majority of beekeepers make their hives with barks or logs. Few use protection gears or smokers. They just use smoke of a fire to harvest the honey. However, these practices are changing slowly. Beekeepers are trained to use modern hives (which last longer and avoid cutting trees), to collect honey without killing all the colony, to use protection gears, to process (filtering, decantation) and store their honey in better conditions. The aim is to produce a better quality honey (paid at a better price) and have less impact on forest and bees. Moreover, according to Tanzanian law, the bark hives are prohibited (Beekeeping Act, 2002). Most of these trainings were proposed by ADAP and the community funds of hunting companies. However, the beekeepers still require trainings and materials in order to improve their activities and they cannot afford them alone (F_VS08, F_VS09). The transport is still a big issue for beekeepers as they have only bicycle. And it is worst for Ilunde people as they are very far from Inyonga and markets (F_VS08).

Most of the time, beekeeping is an activity practised by farmers who learn it with their father when they are teens (S_LU08). They do it as far as they can as, for instance, a 65 years old man who is still engaged in beekeeping (S_LU04). Even if it is commonly said that Wasukuma are not engaged in beekeeping or just poaching wild honey, we met one Msukuma who has 250 hives (S_SR18). Few women practice beekeeping because they were not traditionally engaged in it. The ones who practice beekeeping put their hives in the periphery of the villages and do not go

in the bush because they are afraid and women's hives can be stolen easily (S_LU07). Beekeepers operate with their relatives, in group of 3-5 people. Beekeepers or businessmen who have a lot of hives pay employees (2000 TSH per day) to take care of them. Businessmen have more means to work such as modern beehives, cars to transport the honey and packaging stuff. For other beekeepers, the sales and packaging are done in groups or association like IBA. The groups can easily break if they have difficulties like a group of 30 women in Ilunde which split because they did not receive 50 promised hives by a project (S_LU07).

Between 14 and 20% of the local population is engaged in beekeeping which represents about 5,500 and 7,500 people. However, the intensity is not the same as some beekeepers have 30 hives (S_LU07) and other 250 hives (S_SR18). S_LU08 thinks that beekeeping is the best activity to earn money and if he needed to keep only one activity, it would be this one. S_SR18 sees beekeeping as fast money and S_FS09 thinks that beekeeping is a good alternative to poaching even if it earns less money, because it is legal, sustainable and allow them to be in the bush. A litre of standard honey is sold 7,000 TSH in the streets of Inyonga and a litre of stingless honey 17,500 TSH. In 2014, 118,400 kg of honey were produced in the Mlele District (PC32).

Fishing is a traditional activity but is not widespread among the Inyonga Division population, because there a few areas for fishing near the villages. Fishermen do not have permanent camps like beekeepers; they go where the fish are. However, some fishermen come back every year to the same area (PC03). The material needed is nets, baskets, food, knife and axes. They go in the bush by bicycle or motorbike and they do frequent journeys way and back to sell the fish in villages. Most of the time, fish are smoked in the camp in order to be conserved until villages. The high fishing season is the dry season when fish are concentrated in less water. Some fishermen also fish during rainy season in temporary rivers. The only rivers with water in dry season, Koga, Rungwa and some parts of Msima River, are far from the villages. Some fishermen fish in Lake Rukwa, outside from our study area.

Fishermen are local farmers who practice a secondary activity. We saw fishermen of many tribes (Wakonongo, Wafipa, Wanyamwezi, etc.), especially along the Koga River where there are people from Tabora region. However, according to S_LU20 Wasukuma do not fish. Fishermen work in small groups in the field (2-4 persons) and some of them are relatives. It seems that there are no groups or associations for the selling. Some fishermen work for big businessmen who provide the nets and all the material and come later to collect the fish. Some fishermen along the Koga River fished with permits but with an illegal and expensive net provided by a big man from Tabora (PC13). Some fishermen combine their activity with beekeeping but according to S_LU20, few are engaged in poaching. Fishing is not necessarily practised life-long like beekeeping. It can be practised for few years if there are gaps in incomes. A fisherman of Inyonga (S_LU20) sees fishing as fast and quick money because he has nothing to do before (unlike the beekeepers who need to prepare and put their hives). In Inyonga a big fish is sold 3000 TSH, a middle one 1200-1500 TSH and 3 small fish 100 TSH (S_LU20, PC03). In Ilunde a middle fish is 500 TSH only.

Logging activity was not a consequent activity in the region 20 years ago. Local people were used to cut poles to build house framework, hives or for firewood but very few logged for commercial purpose (S_FS17). Today, logging activity is a wide spread activity occurring in all the FRs (a license is required) and even inside GRs (where it is totally illegal). During the field work, many trucks which carried logs or planks crossed Inyonga. Professional loggers come to harvest timber in the region because they have heard that there are good opportunities. There are still a lot of forests compared to the North and East of the country and the District advertises the place for logging (S_CO12). The high season is from May to November. The targeted species for timber are few. The main one is the Mninga (*Pterocarpus angolensis*), the second one is the Mkora (*Afzelia quanzensis*) and the third one is the Mkurungu (*Pterocarpus tinctorius*). African Blackwood (*Dalbergia melanoxylon*) is also targeted for the cabinet work and music instruments. This rare timber was seized in Ilunde by TFS (PC11).

Loggers go mostly by motorbike in the bush with axes, saws, rulers, pens and food. They select a place in the forest, build a pit-sawing, cut the trees and saw the trees in standard planks. They do a temporary camp in the bush. According to S_CO12, there is a lot of waste of wood because loggers cut only the standard size and let the rest of the tree in the forest. They carry the planks until a collection centre, near an existing road, or they open new tracks in the forest (illegal). Transport of timber is not authorised during the night and trucks have to be uncovered during the day (PC11). Loggers are not allowed to have guns. Timber can be sawed in Inyonga or in bigger towns. The timber is sold in towns and some is even exported to China (S_CO12). A standard plank (2 inch. x 6 inch. x 9 feet) of Mninga is sold 32,000 TSH while workers receive 400 TSH for producing it. The local population has never built his houses in wood (likely because of termites and rain) and will not do it now as it appears more lucrative to sell the wood (S_FS17).

The loggers who lead operations are rarely local people because they need capital and connexions to the markets. Thus, the majority of licences are delivered to businessmen or companies from northern towns such as Tabora, Singida, Shinyanga, Mwanza, Kilimanjaro, etc. (S_GM02). Most of their employees come from these places as well. The Wakonongo are employed to show the good harvesting places and to do the hard work for a small salary (F_VS10). The importance for local livelihoods is thus limited. Wahutu from Katumba camp are engaged in logging and it seems they are quite skilled (S_LU08; S_NE14). Wasukuma are also loggers. A big amount of timber was seen behind a Sukuma house in Ilunde (F_SR05). Moreover, they have the capital to pay permits and salaries. Since loggers are not from the region, they do not take care of sacred places (S_LU08). The loggers are not known to be engaged in poaching wildlife. They seem to be afraid by the shoot-to-kill policy, which does not occur in reality (S_CO12).

Local hunting, labelled nowadays “poaching”, is a traditional activity of the local population. The practice has been forbidden since colonial times but controls were not enforced until the early 90s. In the past, children learnt the practice with their father. However, not all the Wakonongo men were hunters. The current “poaching” can be divided into 3 categories: subsistence hunting, commercial bushmeat hunting and commercial hunting for by-products with high added value (ivory, rhino’s horn, etc.). The kind of guns used evolves with the purpose of the activity, from the subsistence hunters which use muzzleloader to the commercial hunters which use semi-automatic guns or even modern hunting guns. According to S_FS09, about 50% of the

poachers use semi-automatic guns (SMG, AK-47). Local people say that most of these guns are from Burundi. However, it seems that guns from Tanzanian police were found during the big anti-poaching operation, Tokomezza in 2013. Traditional hunting, using spears, arrows and traps, still occurs but is decreasing.

The material used is similar to beekeeping except the buckets which are replaced by guns. Poachers never use hunting tracks in the bush. They do temporary camp or use fishermen's or beekeepers' camp. Poachers work with the people they need who are not necessarily family members. Usually, there are 1-2 guns per group. Some poachers also use dogs (S_CO15). People without gun dry and carry the meat to the villages. Over there, the meat is sold on the black market where 1 kg of dried buffalo meat is 5,000 TSH (the same price as fresh cow meat). Some of the meat leaves villages by bus to be sold in towns. Ivory poachers do not take care of the meat and cut only the ivory in pieces to put them inside bags. They are linked to businessmen who provide them guns and arrange the export. Tabora was well known in the past for its Arabic ivory sellers and is still nowadays a hub for this product (S_FS17).

Nowadays, poachers have to go far from the villages to find wildlife. Thus they spend at least one week in the bush each time (S_LU04; S_FS09). They target mostly mbuga and rivers where there are more animals. The elephant poachers have to go very far now as the FRs have been almost cleared from this species. Poaching occurs all the yearlong but with different constraints. During the rainy season, animals are more widespread but there are less patrols and during the dry season, animals are concentrated near the water but there are more users and more patrols. Poachers cultivate crops as well, either to cover themselves or to have different incomes if they do not only live from meat selling (S_FS09). They come from villages of the study areas and from other Districts like Sikonge, Ipole or Kitunda. Some of them come also from Katumba refugees' camps (Stampfli, 2016). The Wahutu are well known in the region for their implication in elephant poaching because they had semi-automatic guns very early (since 1993, the civil war in Burundi) but it seems that implication of the Wahutu is exaggerated by local people. It is difficult to estimate the number of poachers among the study area population but according to S_FS09, not more than 20 big poachers. A member of ADAP (PC06) thinks that this figure is underestimated and the poachers should be about 100. Whatever it be, an old poacher thinks that there are more poachers now than in the past (S_LU04).

In regards to local livelihoods, commercial poaching activity is not widespread among the population and thus only the households of poachers benefit from meat and incomes. The incomes can be important for "efficient" poachers who sell huge quantities of meat but most of the time they do not manage properly the money and drink a lot. Moreover, it is costly to be caught as a poacher (police, fine, time in jail not earning money) and has repercussion on the household. That is why most of the time, the families do not like to have poachers in their members and one guy did not hesitate to denounce his own father (S_FS09).

Trophy hunting dates back to the beginning of the 20th century during the German colony. The practice was then maintained under the British rules and after Independence within GCAs, GRs and Open areas. It is an crucial activity for Tanzania which is well known abroad for it. This activity requires significant material and funds because of expansive taxes and high standard services. Vehicles in good conditions, luxurious camps (with electricity, bathrooms and kitchen), field material and skilled staff (licenced professional hunters, trackers, skimmers, cooks, managers, etc.) are necessary to satisfy the hunters who can pay until 100,000 USD a 21-days safari. The clients come by plane in the bush (on small airstrip near the camps) with their own guns. One hunting block welcomes very few clients per season, generally not more than 5.

The hunting season is open from July to December. In the region, trophy hunting occurs in GCAs (which overlap the FRs) and in GRs (Rukwa, Lukwati, and Ugalla). These areas are divided in blocks which are allocated to registered companies. One company can have several blocks and has the exclusivity rights of hunting in these blocks for a 5-year lease. The owners of the companies are not all Tanzanian and some are from Western countries. The clients are mostly western people but there is an increase of clients coming from India, Arabic Peninsula or China. Trophy hunting seems to be hit by the financial crisis and some companies convert to visual tourism (S_CO15). Moreover, the reputation of trophy hunting is not so good in western countries with mediatisation of some scandals.

Trophy hunting is not directly significant for local livelihoods as most of the employees are from others regions or states. Only the trackers are former local poachers (S_CO15). However, this activity contributes indirectly to livelihoods as the Mlele District receives part of the hunting taxes (URT, 2015) and this money could contribute to physical and human assets of local population. Few companies have community development programmes in the region. Sometimes companies give extra meat to village but it does not happen often because the clients have to approve and the distance to village are quite far (S_CO15). Some companies have stopped to give meat to villages because it was impossible to differentiate illegal and legal bushmeat during controls in the villages (AM03).

APPENDIX 15 Interviewees' opinions about factors which have weakened Konongo rules

The explanations about the loss of traditional power and traditions differ between the interviewees. Some think that the culture began to decrease when monotheist religions (Islam and Christianity) arrived in the region in colonial time. As an old chief explains, when they were going to church, the priest preached them that it was bad to pray the spirits and drink traditional medicine (S_KR10). Contrarily, another chief, younger, argues that religion is not responsible of the decrease of traditions as Christianity gives only good belief (S_KR11). People of a focus group in village think that the Tanzanian government is guilty because it removed all the power of the Tanzanian chiefs (especially since 1974 according to S_NE14) while German and British respected them and worked with them (F_VS10). Singleton (2010) noticed that old people were nostalgic of colonial time with doctors and missionaries and were disapproving the socialist policy of Nyerere, by telling him during a meeting in Tabora. Nonetheless, most of the interviewees think that the main factors which contributed to weaken Wakonongo culture are globalisation and modernity, represented by modern infrastructures, TV, radio, mobile phones, music videos, clothes and a global change of lifestyle (type of houses, young who study in other regions, newcomers who settle here). A group of women think that this influence is sad because young people think that what they see on a screen is the reality but it does not show the reality of Tanzanian people at all (F_WG07). A young from Ilunde (PC04) notes a big influence of western countries even in small villages and based on what we could observe, this is quite true. In remote villages located 1600 km from Dar es Salaam, one can see some music videos clips of famous Tanzanian singers portraying them in luxurious western style houses, drinking champagne and driving expensive cars. Almost every adult has a mobile phone and like to watch TV in small street shops. Some have even posters of "western" garden and Britney Spears in their house. Advertisement for consumers good such as drinks and mobile phones have great impacts on the "needs" of local population and the representation they have about the world. The new comer girls put jeans, adopts fashion style haircuts and make-up and local boys find this very cool and most of the young villagers find Dar es Salaam trendy even if they have never been there.

People do not have the same opinion about the role of new comers in the decrease of traditions. Some think that as they do not follow the traditional rules of the place, they contributed to weaken the culture (F_VS09) and some others think that every Wakonongo is guilty of the decrease and it is not the fault of newcomers (S_LU07). Finally, a different view is that it is not only modernity with technologies which destroys kikonongo culture but the kinds of activities people are practising. Wakonongo are traditional hunters and beekeepers but for 50 years they are farming and since early 2000 they are engaged in many new activities and they have difficulties to adapt to them and to be competitive (S_NE14).

On the next page are graves' pictures that Singleton (2009) took in the 70s

Source: Singleton (2009)



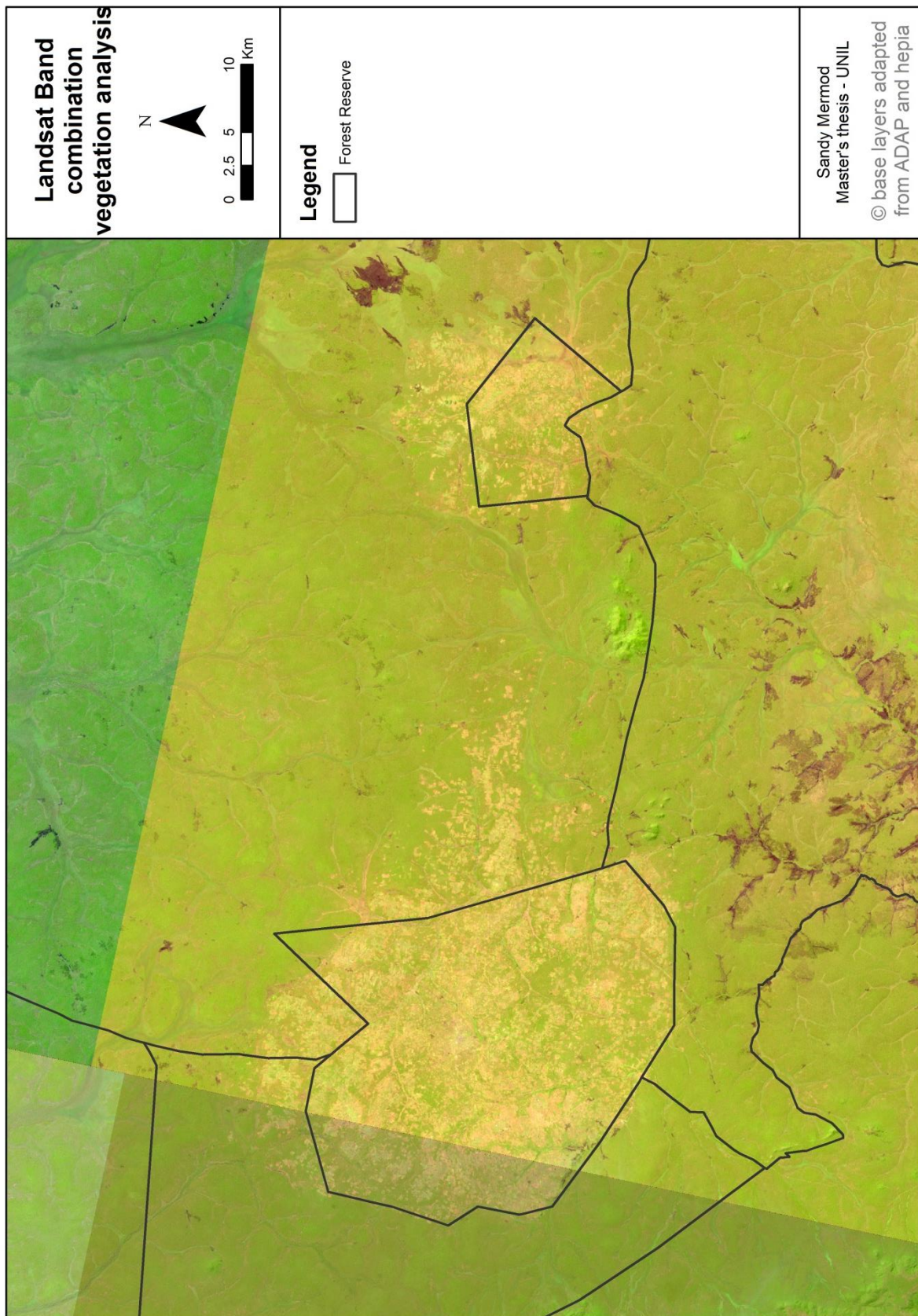
Fig. 2: Cemetery.



Fig. 3: Chiefly grave.

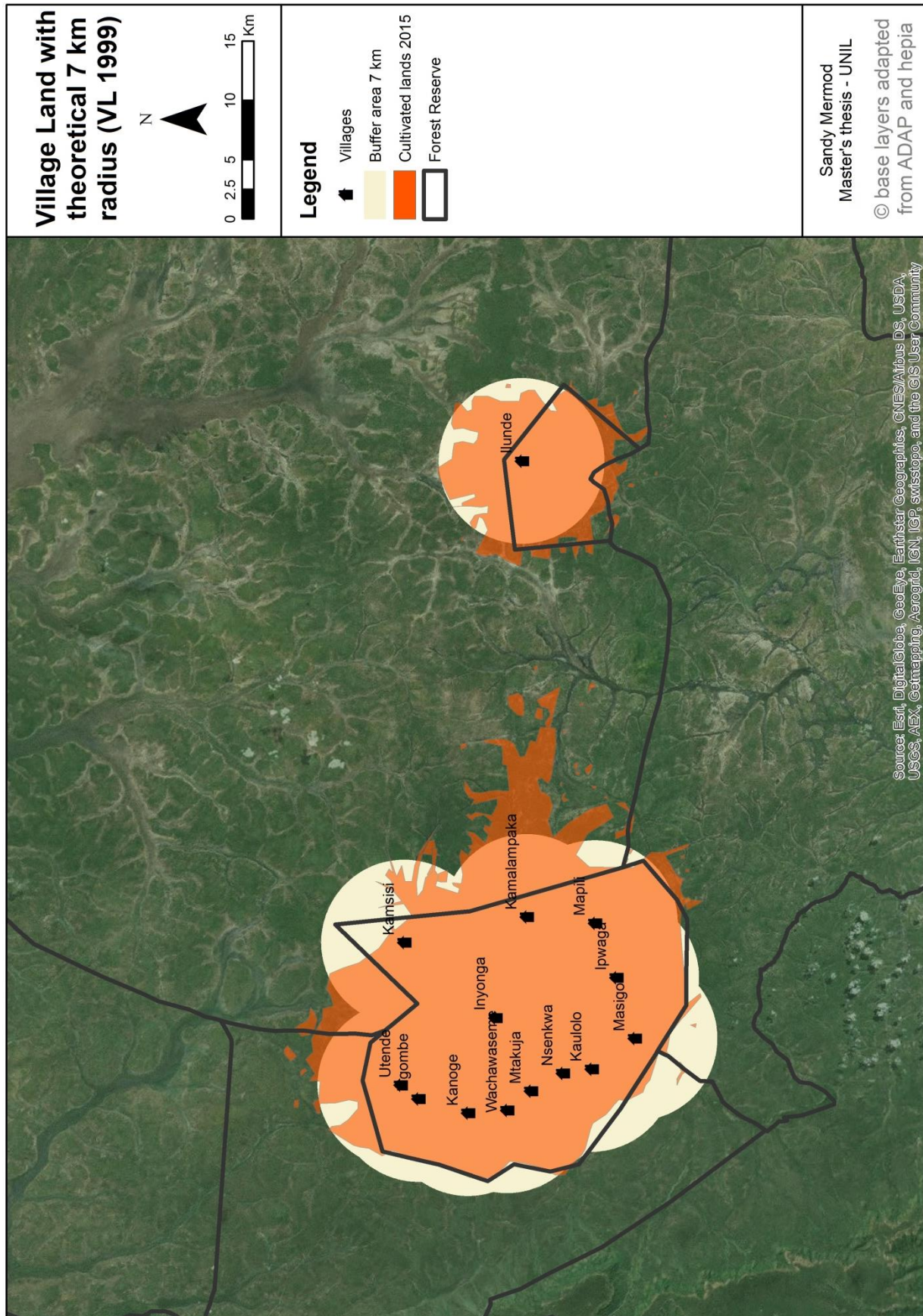
APPENDIX 16 Satellite images band combination

Band combination *Vegetation analysis* with landsat image L08 – 2015. Source: U.S. Geological Survey (n.d.) Earth Explorer. Retrieved from: <http://earthexplorer.usgs.gov/>



APPENDIX 17 Supposed Village Land with a 7 km radius

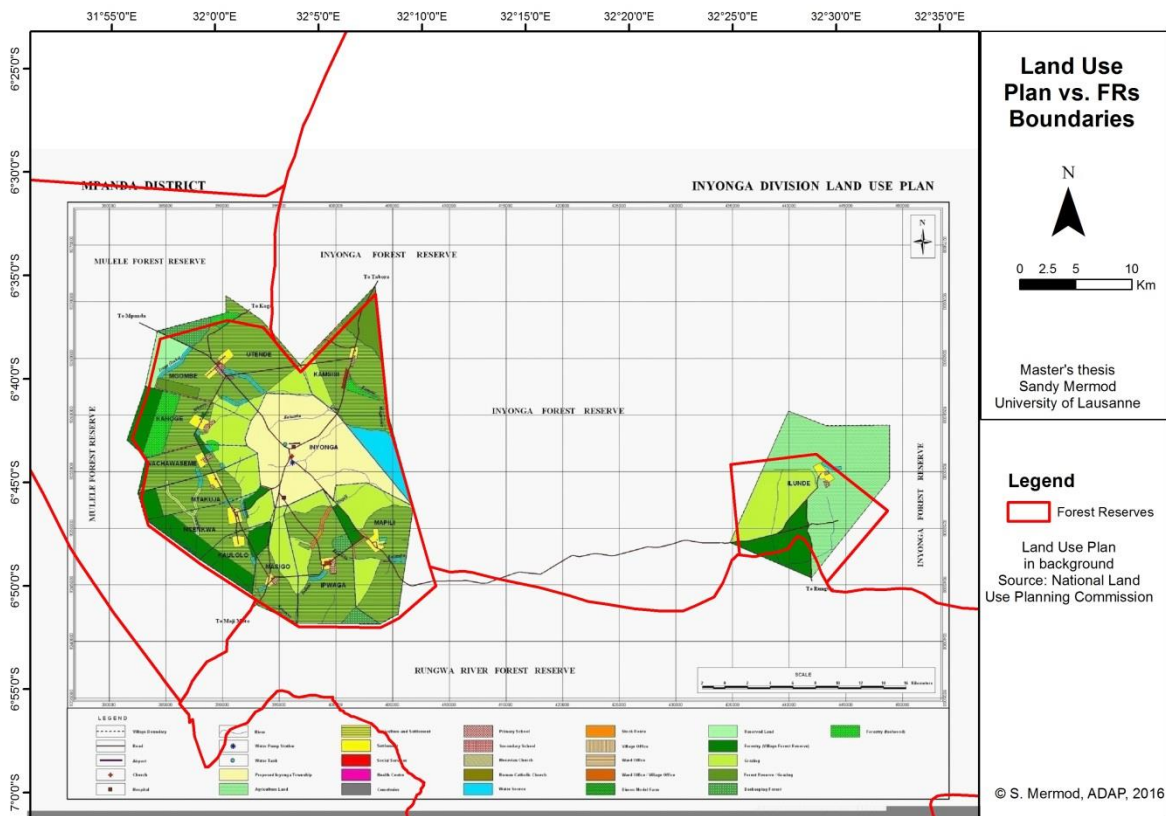
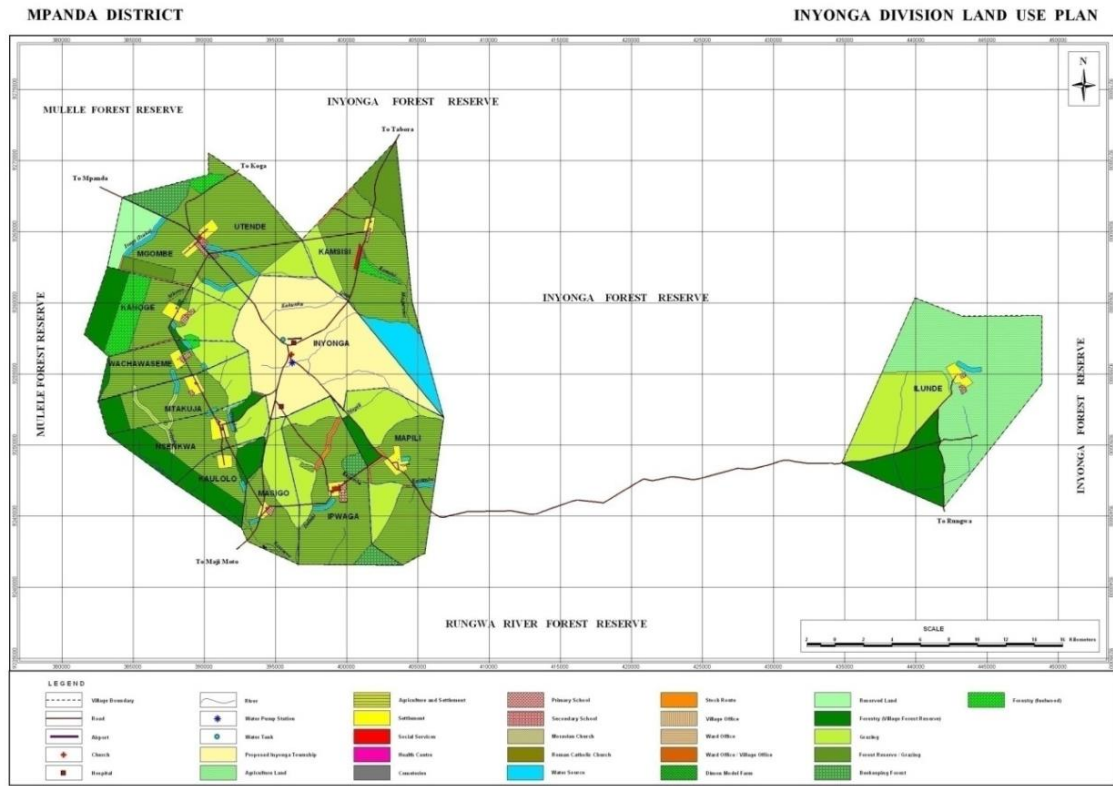
According to F_FM01 based on Village Land Act n°5 1999



APPENDIX 18 Land Use Plan and Forest Reserves

Land use planning and management in Tanzania case of Inyonga division (Mlele district)

Source: Jayson M. Kami, Ag. Director General, National Land Use Planning Commission, Presentation at the ADAP workshop, 08.09.2015



APPENDIX 19 Camera traps sites data

Mlele FR, Inyonga FR

FRs	Site	S	E	Habitats	Funct hours	CT days	Nb pict total	Indep mamm pict	Nb. mamm sp.	Species/CT days	Indep./CT days	Species	
Mlele	M30	4	-6.55942	31.79679	Riverine forest	504	21.00	88	24	7	0.3333	1.1427	<i>Bdeogale crassicauda</i> , <i>Chlorocebus pygerythrus</i> , <i>Civettictis civeta</i> , <i>Crocota crocuta</i> , <i>Mungos mungo</i> , <i>Phacochoerus africanus</i> , <i>Potamochoerus larvatus</i>
Mlele	M31	1	-6.57863	31.81041	Miombo	330	13.76	2893	4	3	0.2180	0.2907	<i>Civettictis civeta</i> , <i>Crocota crocuta</i> , <i>Phacochoerus africanus</i>
Mlele	M31	6	-6.59166	31.78826	Open woodland	501	20.86	1010	10	7	0.3355	0.4793	<i>Alcelaphus lichtensteinii</i> , <i>Equus q. boehmi</i> , <i>Genetta angolensis</i> , <i>Pedetes surdaster</i> , <i>Potamochoerus larvatus</i> , <i>Sylvicapra grimmia</i> , <i>Tragelaphus scriptus</i>
Mlele	M42	1	-6.66754	31.88305	Miombo	503	20.96	48	9	4	0.1908	0.4293	<i>Genetta angolensis</i> , <i>Hippotragus niger</i> , <i>Pedetes surdaster</i> , <i>Sylvicapra grimmia</i>
Total Mlele					1838	77	4039	47	14	0.1828	0.6137	<i>Alcelaphus lichtensteinii</i> , <i>Bdeogale crassicauda</i> , <i>Chlorocebus pygerythrus</i> , <i>Civettictis civeta</i> , <i>Crocota crocuta</i> , <i>Equus q. boehmi</i> , <i>Genetta angolensis</i> , <i>Hippotragus niger</i> , <i>Mungos mungo</i> , <i>Pedetes surdaster</i> , <i>Phacochoerus africanus</i> , <i>Potamochoerus larvatus</i> , <i>Sylvicapra grimmia</i> , <i>Tragelaphus scriptus</i>	
Moyenne Mlele					460	19	1010	12	4	0.0457	0.1534	-	
Inyonga	I01		-6.50795	32.5337	Miombo	481	20.05	626	14	8	0.3991	0.6984	<i>Genetta angolensis</i> , <i>Giraffa camelopardalis</i> , <i>Ichneumia albicauda</i> , <i>Lepus sp.</i> , <i>Panthera pardus</i> , <i>Pedetes surdaster</i> , <i>Sylvicapra grimmia</i> , <i>Tragelaphus oryx</i>
Inyonga	I02		-6.53876	32.5361	Wooded grassland	438	18.25	2855	13	5	0.2740	0.7125	<i>Alcelaphus lichtensteinii</i> , <i>Damaliscus lunatus</i> , <i>Lepus sp.</i> , <i>Panthera pardus</i> , <i>Redunca arundinum</i>
Inyonga	I03		-6.61531	32.4992	Open woodland	203	8.46	57	10	6	0.7091	1.1819	<i>Alcelaphus lichtensteinii</i> , <i>Chlorocebus pygerythrus</i> , <i>Civettictis civeta</i> , <i>Hippotragus niger</i> , <i>Phacochoerus africanus</i> , <i>Sylvicapra grimmia</i>
Inyonga	I04		-6.7445	32.5641	Wooded grassland	144	5.98	2927	9	4	0.6686	1.5044	<i>Genetta angolensis</i> , <i>Giraffa camelopardalis</i> , <i>Lepus sp.</i> , <i>Sylvicapra grimmia</i>
Inyonga	I06		-6.72799	32.6717	Mbuga	452	18.83	2438	18	5	0.2656	0.9560	<i>Alcelaphus lichtensteinii</i> , <i>Crocota crocuta</i> , <i>Ichneumia albicauda</i> , <i>Lepus sp.</i> , <i>Orycteropus afer</i>
Inyonga	I07		-6.6617	32.3735	Miombo	447	18.62	2797	8	7	0.3760	0.4297	<i>Bdeogale crassicauda</i> , <i>Genetta angolensis</i> , <i>Hystrix africae australis</i> , <i>Ichneumia albicauda</i> , <i>Orycteropus afer</i> , <i>Pedetes surdaster</i> , <i>Raphicerus sharpei</i>
Inyonga	I08		-6.67689	32.2971	Miombo	507	21.13	116	17	8	0.3787	0.8047	<i>Bdeogale crassicauda</i> , <i>Genetta angolensis</i> , <i>Genetta genetta</i> , <i>Giraffa camelopardalis</i> , <i>Hystrix africae australis</i> , <i>Raphicerus sharpei</i> , <i>Rhynchogale melleri</i> , <i>Sylvicapra grimmia</i>
Inyonga	I10		-6.32099	32.5588	Wooded grassland	197	8.20	2908	17	6	0.7318	2.0735	<i>Chlorocebus pygerythrus</i> , <i>Hippotragus equinus</i> , <i>Hippotragus niger</i> , <i>Lepus sp.</i> , <i>Madoqua kirkii</i> , <i>Papio cynocephalus</i>
Inyonga	I11		-6.30871	32.4485	Open	45	1.87	162	5	3	1.6083	2.6806	<i>Civettictis civeta</i> , <i>Lepus sp.</i> , <i>Phacochoerus africanus</i>
Inyonga	I12		-6.32074	32.4302	Open woodland	455	18.95	554	26	8	0.4221	1.3719	<i>Chlorocebus pygerythrus</i> , <i>Genetta angolensis</i> , <i>Giraffa camelopardalis</i> , <i>Hippotragus niger</i> , <i>Ichneumia albicauda</i> , <i>Lepus sp.</i> , <i>Phacochoerus africanus</i> , <i>Sylvicapra grimmia</i>
Total Inyonga					3368	140	15440	137	25	0.1782	0.9763	<i>Alcelaphus lichtensteinii</i> , <i>Bdeogale crassicauda</i> , <i>Chlorocebus pygerythrus</i> , <i>Civettictis civeta</i> , <i>Crocota crocuta</i> , <i>Damaliscus lunatus</i> , <i>Genetta angolensis</i> , <i>Genetta genetta</i> , <i>Giraffa camelopardalis</i> , <i>Hippotragus equinus</i> , <i>Hippotragus niger</i> , <i>Hystrix africae australis</i> , <i>Ichneumia albicauda</i> , <i>Lepus sp.</i> , <i>Madoqua kirkii</i> , <i>Orycteropus afer</i> , <i>Papio cynocephalus</i> , <i>Panthera pardus</i> , <i>Pedetes surdaster</i> , <i>Phacochoerus africanus</i> , <i>Raphicerus sharpei</i> , <i>Redunca arundinum</i> , <i>Rhynchogale melleri</i> , <i>Sylvicapra grimmia</i> , <i>Tragelaphus oryx</i>	
Moyenne Inyonga					337	14	1544	14	3	0.0178	0.0976	-	

Ugalla River FR

FRs	Site	S	E	Habitats	Funct hours	CT days	Nb pict total	Indep mamm pict	Nb. mamm sp.	Species/CT days	Indep./CT days	Species
Ugalla River	U01	-6.48849	31.8645	Miombo	476	19.85	182	20	4	0.2015	1.0075	<i>Bdeogale crassicauda</i> , <i>Genetta angolensis</i> , <i>Pedetes surdaster</i> , <i>Sylvicapra grimmia</i>
Ugalla River	U02	-6.45168	31.883	Mbuga	476	19.84	1066	30	11	0.5544	1.5120	<i>Alcelaphus lichtensteinii</i> , <i>Civettictis civetta</i> , <i>Genetta angolensis</i> , <i>Giraffa camelopardalis</i> , <i>Hippotragus equinus</i> , <i>Ichneumia albicauda</i> , <i>Lepus sp.</i> , <i>Otolemur crassicaudatus</i> , <i>Pedetes surdaster</i> , <i>Phacochoerus africanus</i> , <i>Sylvicapra grimmia</i>
Ugalla River	U04	-6.32942	31.8437	Edge between Mbuga/Miombo	363	15.12	2957	21	9	0.5953	1.3890	<i>Alcelaphus lichtensteinii</i> , <i>Bdeogale crassicauda</i> , <i>Chlorocebus pygerythrus</i> , <i>Damaliscus lunatus</i> , <i>Giraffa camelopardalis</i> , <i>Phacochoerus africanus</i> , <i>Potamochoerus larvatus</i> , <i>Sylvicapra grimmia</i> , <i>Syncerus caffer</i>
Ugalla River	U05	-6.29119	31.8218	Miombo	458	19.07	2716	17	6	0.3147	0.8916	<i>Civettictis civetta</i> , <i>Genetta angolensis</i> , <i>Papio cynocephalus</i> , <i>Pedetes surdaster</i> , <i>Phacochoerus africanus</i> , <i>Sylvicapra grimmia</i>
Ugalla River	U06	-6.23684	31.7925	Mbuga	498	20.77	278	44	15	0.7222	2.1184	<i>Civettictis civetta</i> , <i>Crocota crocuta</i> , <i>Genetta angolensis</i> , <i>Hippotragus equinus</i> , <i>Hippotragus niger</i> , <i>Hystrix africae australis</i> , <i>Ichneumia albicauda</i> , <i>Mellivora capensis</i> , <i>Mungos mungo</i> , <i>Panthera pardus</i> , <i>Phacochoerus africanus</i> , <i>Potamochoerus larvatus</i> , <i>Sylvicapra grimmia</i> , <i>Syncerus caffer</i> , <i>Tragelaphus scriptus</i>
Ugalla River	U07	-6.2044	31.7322	Open woodland	292	12.16	2852	27	8	0.6580	2.2208	<i>Alcelaphus lichtensteinii</i> , <i>Chlorocebus pygerythrus</i> , <i>Hippotragus equinus</i> , <i>Hippotragus niger</i> , <i>Kobus ellipsiprymnus</i> , <i>Phacochoerus africanus</i> , <i>Redunca arundinum</i> , <i>Sylvicapra grimmia</i>
Ugalla River	U08	-6.16975	31.7163	Edge between Mbuga/Miombo	462	19.25	302	66	9	0.4676	3.4288	<i>Chlorocebus pygerythrus</i> , <i>Crocota crocuta</i> , <i>Hippotragus equinus</i> , <i>Hippotragus niger</i> , <i>Kobus ellipsiprymnus</i> , <i>Phacochoerus africanus</i> , <i>Sylvicapra grimmia</i> , <i>Tragelaphus scriptus</i> , <i>Tragelaphus strepsiceros</i>
Ugalla River	U09	-6.37975	31.955	Mbuga	475	19.80	290	31	5	0.2526	1.5659	<i>Alcelaphus lichtensteinii</i> , <i>Giraffa camelopardalis</i> , <i>Lepus sp.</i> , <i>Phacochoerus africanus</i> , <i>Sylvicapra grimmia</i>
Ugalla River	U10	-6.453	31.9781	Miombo	481	20.03	96	8	3	0.1498	0.3994	<i>Alcelaphus lichtensteinii</i> , <i>Raphicercus sharpei</i> , <i>Sylvicapra grimmia</i>
Ugalla River	U11	-6.4628	31.9588	Miombo	480	20.01	24	9	4	0.1999	0.4497	<i>Alcelaphus lichtensteinii</i> , <i>Galago senegalensis</i> , <i>Giraffa camelopardalis</i> , <i>Sylvicapra grimmia</i>
Ugalla River	U12	-6.28914	31.9201	Miombo	476	19.82	308	7	4	0.2018	0.3532	<i>Genetta angolensis</i> , <i>Orycteropus afer</i> , <i>Sylvicapra grimmia</i> , <i>Tragelaphus oryx</i>
Total Ugalla River					4937	206	11071	280	31	0.1507	1.3611	<i>Alcelaphus lichtensteinii</i> , <i>Bdeogale crassicauda</i> , <i>Chlorocebus pygerythrus</i> , <i>Civettictis civetta</i> , <i>Crocota crocuta</i> , <i>Damaliscus lunatus</i> , <i>Galago senegalensis</i> , <i>Genetta angolensis</i> , <i>Giraffa camelopardalis</i> , <i>Hippotragus equinus</i> , <i>Hippotragus niger</i> , <i>Hystrix africae australis</i> , <i>Ichneumia albicauda</i> , <i>Kobus ellipsiprymnus</i> , <i>Lepus sp.</i> , <i>Mellivora capensis</i> , <i>Mungos mungo</i> , <i>Orycteropus afer</i> , <i>Otolemur crassicaudatus</i> , <i>Panthera pardus</i> , <i>Papio cynocephalus</i> , <i>Pedetes surdaster</i> , <i>Phacochoerus africanus</i> , <i>Potamochoerus larvatus</i> , <i>Raphicercus sharpei</i> , <i>Redunca arundinum</i> , <i>Sylvicapra grimmia</i> , <i>Syncerus caffer</i> , <i>Tragelaphus oryx</i> , <i>Tragelaphus</i>
Moyenne Ugalla					449	19	1006	25	3	0.0137	0.1237	-

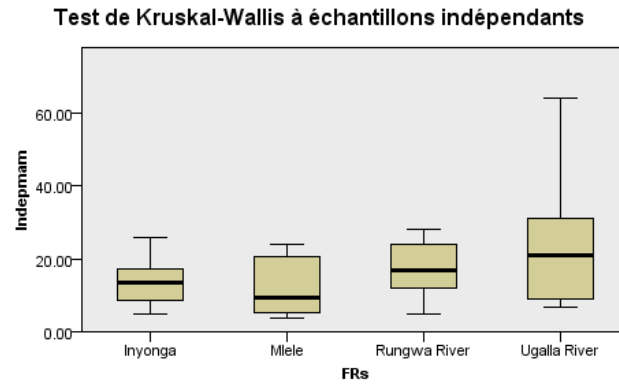
Rungwa FR and total

FRs	Site	S	E	Habitats	Funct hours	CT days	Nb pict total	Indep mamm pict	Nb. mamm sp.	Species/ CT days	Indep./ CT days	Species
Rungwa River	I05	-6.91365	32.641	Edge between Mbuga/Miombo	436	18.19	622	22	10	0.5499	1.2098	<i>Alcelaphus lichtensteini</i> , <i>Genetta angolensis</i> , <i>Giraffa camelopardalis</i> , <i>Hippotragus niger</i> , <i>Ourebia ourebi</i> , <i>Phacochoerus africanus</i> , <i>Redunca arundinum</i> , <i>Sylvicapra grimmia</i> , <i>Tragelaphus oryx</i> , <i>Tragelaphus strepsiceros</i>
Rungwa River	RW1_15	-6.9092	32.206	Miombo	507	21.14	1641	24	9	0.4257	1.1352	<i>Alcelaphus lichtensteini</i> , <i>Genetta angolensis</i> , <i>Orycteropus afer</i> , <i>Otolemur crassicaudatus</i> , <i>Papio cynocephalus</i> , <i>Potamochoerus larvatus</i> , <i>Raphicerus sharpei</i> , <i>Sylvicapra grimmia</i> , <i>Tragelaphus</i>
Rungwa River	RW1	-6.96424	32.2236	Miombo	479	19.97	1768	14	4	0.2003	0.7010	<i>Genetta angolensis</i> , <i>Hippotragus equinus</i> , <i>Phacochoerus africanus</i> , <i>Sylvicapra grimmia</i>
Rungwa River	RW2_12	-6.89654	32.4139	Miombo	505	21.02	1176	15	6	0.2854	0.7135	<i>Giraffa camelopardalis</i> , <i>Hippotragus niger</i> , <i>Pedetes surdaster</i> , <i>Raphicerus sharpei</i> , <i>Sylvicapra grimmia</i> , <i>Tragelaphus oryx</i>
Rungwa River	RW2_27	-6.95086	32.3598	Miombo	466	19.42	443	17	8	0.4120	0.8755	<i>Bdeogale crassicauda</i> , <i>Genetta maculata</i> , <i>Mungos mungo</i> , <i>Panthera pardus</i> , <i>Phacochoerus africanus</i> , <i>Potamochoerus larvatus</i> , <i>Raphicerus sharpei</i> , <i>Sylvicapra grimmia</i>
Rungwa River	RW3_04	-7.00034	32.4819	Miombo	502	20.93	623	24	7	0.3344	1.1465	<i>camelopardalis</i> , <i>Pedetes surdaster</i> , <i>Potamochoerus larvatus</i> , <i>Sylvicapra grimmia</i> , <i>Tragelaphus strepsiceros</i>
Rungwa River	RW3_16	-7.03555	32.4822	Miombo	167	6.96	2858	5	4	0.5749	0.7186	<i>Mungos mungo</i> , <i>Orycteropus afer</i> , <i>Pedetes surdaster</i> , <i>Raphicerus sharpei</i>
Rungwa River	RW3_33	-7.09018	32.4632	Open woodland	501	20.88	3499	28	10	0.4790	1.3413	<i>Alcelaphus lichtensteini</i> , <i>Genetta angolensis</i> , <i>Giraffa camelopardalis</i> , <i>Hippotragus equinus</i> , <i>Hippotragus niger</i> , <i>Lepus sp.</i> , <i>Phacochoerus africanus</i> , <i>Sylvicapra grimmia</i> , <i>Syncerus caffer</i> ,
Rungwa River	RW4_13	-7.11694	32.2605	Miombo	437	18.20	907	12	5	0.2748	0.6595	<i>Genetta angolensis</i> , <i>Pedetes surdaster</i> , <i>Raphicerus sharpei</i> , <i>Sylvicapra grimmia</i> , <i>Tragelaphus</i>
Rungwa River	RW4_32	-7.17164	32.2781	Miombo	529	22.06	368	18	11	0.4987	0.8161	<i>Crocuta crocuta</i> , <i>Equus q. boehmi</i> , <i>Genetta angolensis</i> , <i>Genetta maculata</i> , <i>Giraffa camelopardalis</i> , <i>Hippotragus niger</i> , <i>Hystrix africae australis</i> , <i>Mellivora capensis</i> , <i>Papio cynocephalus</i> , <i>Pedetes surdaster</i> , <i>Sylvicapra</i>
Rungwa River	RW4_36	-7.17214	32.3506	Open woodland	149	6.21	2975	6	4	0.6444	0.9666	<i>Hystrix africae australis</i> , <i>Kobus ellipsiprymnus</i> , <i>Lepus sp.</i> , <i>Panthera pardus</i>
Total Rungwa River					4679	195	16880	185	29	0.1487	0.9489	<i>Alcelaphus lichtensteini</i> , <i>Bdeogale crassicauda</i> , <i>Civettictis civetta</i> , <i>Crocuta crocuta</i> , <i>Equus q. boehmi</i> , <i>Genetta angolensis</i> , <i>Genetta maculata</i> , <i>Giraffa camelopardalis</i> , <i>Hippotragus equinus</i> , <i>Hippotragus niger</i> , <i>Hystrix africae australis</i> , <i>Kobus ellipsiprymnus</i> , <i>Lepus sp.</i> , <i>Mellivora capensis</i> , <i>Mungos mungo</i> , <i>Orycteropus afer</i> , <i>Otolemur crassicaudatus</i> , <i>Ourebia ourebi</i> , <i>Panthera pardus</i> , <i>Papio cynocephalus</i> , <i>Pedetes surdaster</i> , <i>Phacochoerus africanus</i> , <i>Potamochoerus larvatus</i> , <i>Raphicerus sharpei</i> , <i>Redunca arundinum</i> , <i>Sylvicapra grimmia</i> , <i>Syncerus caffer</i> , <i>Tragelaphus oryx</i> ,
Moyenne Rungwa					425	18	1535	17	3	0.0135	0.0863	-
Total Master Mermod 2015					14822	618	47430	649	37	0.0599	1.0509	<i>Chlorocebus pygerythrus</i> , <i>Civettictis civetta</i> , <i>Crocuta crocuta</i> , <i>Damaliscus lunatus</i> , <i>Equus q. boehmi</i> , <i>Galago senegalensis</i> , <i>Genetta angolensis</i> , <i>Genetta genetta</i> , <i>Genetta maculata</i> , <i>Giraffa camelopardalis</i> , <i>Hippotragus equinus</i> , <i>Hippotragus niger</i> , <i>Hystrix africae australis</i> , <i>Ichneumia albicauda</i> , <i>Kobus ellipsiprymnus</i> , <i>Lepus sp.</i> , <i>Madoqua kirkii</i> , <i>Mellivora capensis</i> , <i>Mungos mungo</i> , <i>Orycteropus afer</i> , <i>Otolemur crassicaudatus</i> , <i>Ourebia ourebi</i> , <i>Panthera pardus</i> , <i>Papio cynocephalus</i> , <i>Pedetes surdaster</i> , <i>Phacochoerus africanus</i> , <i>Potamochoerus larvatus</i> , <i>Raphicerus sharpei</i> , <i>Redunca arundinum</i> , <i>Rynchogale melleri</i> , <i>Sylvicapra grimmia</i> , <i>Syncerus caffer</i> , <i>Tragelaphus oryx</i> , <i>Tragelaphus scriptus</i> , <i>Tragelaphus strepsiceros</i>

APPENDIX 20 Kruskal-Wallis test for the variable Forest Reserve

Effect of Forest Reserves on the distribution of independent mammal pictures, number of mammals' species, species/CT days and independent pictures/CT days.

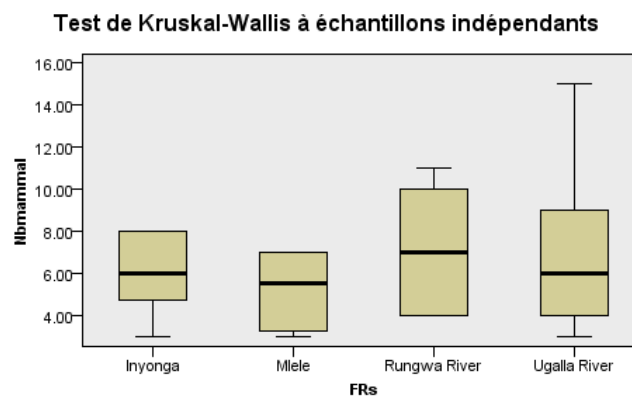
Number of independent pictures



N Total	36
Statistique de test	4.888
Degrés de liberté	3
Sig. asymptotique (test bilatéral)	.180

1. La statistique de test est réglée pour les ex aequo.
2. Aucun comparaison multiple n'est effectuée car le test général ne contient pas de différence significative entre les échantillons.

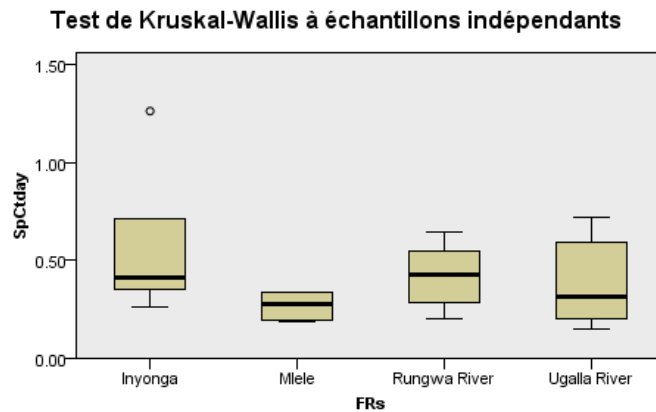
Number of mammal species



N Total	36
Statistique de test	1.909
Degrés de liberté	3
Sig. asymptotique (test bilatéral)	.591

1. La statistique de test est réglée pour les ex aequo.
2. Aucun comparaison multiple n'est effectuée car le test général ne contient pas de différence significative entre les échantillons.

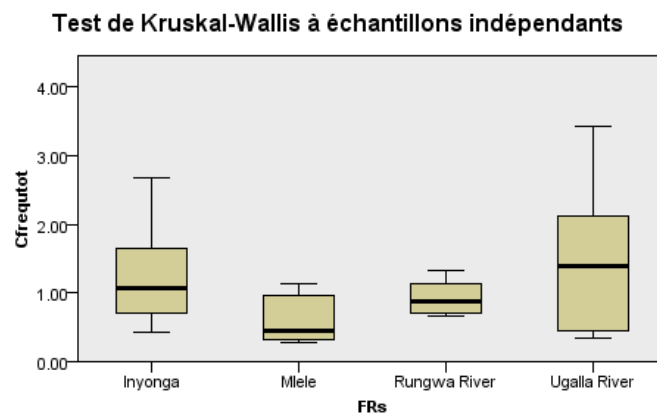
Species/CT days



N Total	36
Statistique de test	5.185
Degrés de liberté	3
Sig. asymptotique (test bilatéral)	.159

1. La statistique de test est réglée pour les ex aequo.
2. Aucun comparaison multiple n'est effectuée car le test général ne contient pas de différence significative entre les échantillons.

Independent pictures/CT days



N Total	36
Statistique de test	5.217
Degrés de liberté	3
Sig. asymptotique (test bilatéral)	.157

1. La statistique de test est réglée pour les ex aequo.
2. Aucun comparaison multiple n'est effectuée car le test général ne contient pas de différence significative entre les échantillons.

APPENDIX 21 Capture rates for each species

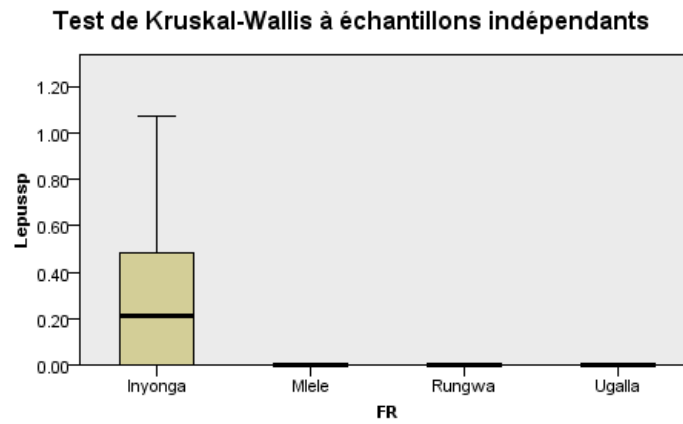
N° Site	TOTAL	Total Mlele	Total Inyonga	Total Ugalla	Total Rungwa	Mean Mlele	Mean Inyonga	Mean Ugalla	Mean Rungwa
<i>Alcelaphus lichtensteinii</i>	0.086	0.013	0.114	0.078	0.103	0.012	0.093	0.086	0.090
<i>Bdeogale crassicauda</i>	0.019	0.052	0.021	0.019	0.005	0.048	0.015	0.023	0.005
<i>Chlorocebus pygerythrus</i>	0.028	0.052	0.050	0.029		0.048	0.071	0.039	
<i>Civettictis civetta</i>	0.034	0.026	0.021	0.073	0.005	0.030	0.119	0.066	0.004
<i>Crocuta crocuta</i>	0.024	0.131	0.007	0.015	0.005	0.125	0.005	0.013	0.004
<i>Damaliscus lunatus</i>	0.003		0.007	0.005			0.005	0.006	
<i>Equus q. boehmi</i>	0.006	0.039			0.005	0.036			0.004
<i>Galago senegalensis</i>	0.002			0.005				0.005	
<i>Genetta angolensis</i>	0.052	0.065	0.057	0.034	0.062	0.060	0.052	0.032	0.055
<i>Genetta genetta</i>	0.002		0.007				0.005		
<i>Genetta maculata</i>	0.005				0.015				0.013
<i>Giraffa camelopardalis</i>	0.039		0.064	0.039	0.036		0.068	0.040	0.031
<i>Hippotragus equinus</i>	0.015		0.007	0.019	0.021		0.012	0.021	0.018
<i>Hippotragus niger</i>	0.039	0.013	0.057	0.034	0.041	0.012	0.090	0.046	0.038
<i>Hystrix africae australis</i>	0.011		0.029	0.005	0.010		0.020	0.004	0.019
<i>Ichneumia albicauda</i>	0.013		0.043	0.010			0.031	0.009	

N° Site	TOTAL	Total Mlele	Total Inyonga	Total Ugalla	Total Rungwa	Mean Mlele	Mean Inyonga	Mean Ugalla	Mean Rungwa
<i>Kobus ellipsiprymnus</i>	0.042			0.122	0.005			0.124	0.015
<i>Lepus sp.</i>	0.070		0.171	0.053	0.041		0.302	0.050	0.066
<i>Madoqua kirkii</i>	0.002		0.007				0.012		
<i>Mellivora capensis</i>	0.005			0.010	0.005			0.009	0.004
<i>Mungos mungo</i>	0.013	0.039		0.015	0.010	0.036		0.013	0.018
<i>Orycteropus afer</i>	0.008		0.014	0.005	0.010		0.011	0.005	0.017
<i>Otolemur crassicaudatus</i>	0.005			0.005	0.010			0.005	0.009
<i>Ourebia ourebi</i>	0.002				0.005				0.005
<i>Panthera pardus</i>	0.013		0.021	0.015	0.010		0.015	0.013	0.019
<i>Papio cynocephalus</i>	0.011		0.021	0.005	0.015		0.037	0.005	0.013
<i>Pedetes surdaster</i>	0.050	0.026	0.014	0.063	0.072	0.024	0.010	0.060	0.070
<i>Phacochoerus africanus</i>	0.083	0.039	0.043	0.160	0.046	0.048	0.093	0.159	0.042
<i>Potamochoerus larvatus</i>	0.016	0.039		0.019	0.015	0.036		0.019	0.013
<i>Raphicerus sharpei</i>	0.029		0.036	0.005	0.062		0.024	0.005	0.073
<i>Redunca arundinum</i>	0.011		0.007	0.019	0.010		0.005	0.030	0.010
<i>Rhynchogale melleri</i>	0.002		0.007				0.005		
<i>Sylvicapra grimmia</i>	0.244	0.065	0.143	0.360	0.267	0.060	0.135	0.370	0.232
<i>Syncerus caffer</i>	0.005			0.010	0.005			0.010	0.004
<i>Tragelaphus oryx</i>	0.011		0.007	0.005	0.026		0.005	0.005	0.022
<i>Tragelaphus scriptus</i>	0.042	0.013		0.122		0.012		0.118	
<i>Tragelaphus strepsiceros</i>	0.010			0.005	0.026			0.005	0.023

APPENDIX 22 Kruskal-Wallis test on capture frequencies with the variable Forest Reserves

Here are presented only the species for which the Forest Reserve is significant.

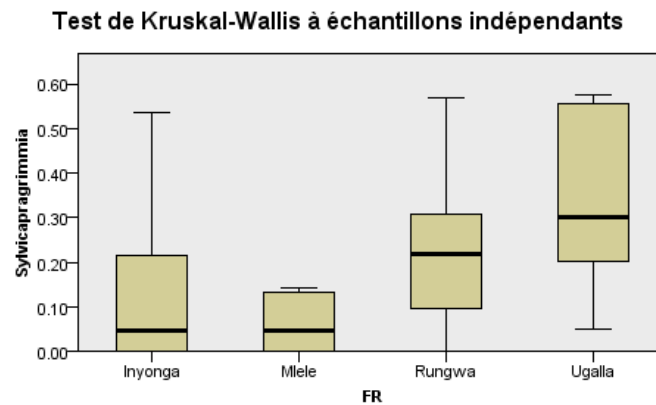
Scrub Hare



N Total	36
Statistique de test	9.691
Degrés de liberté	3
Sig. asymptotique (test bilatéral)	.021

1. La statistique de test est réglée pour les ex aequo.

Common duiker

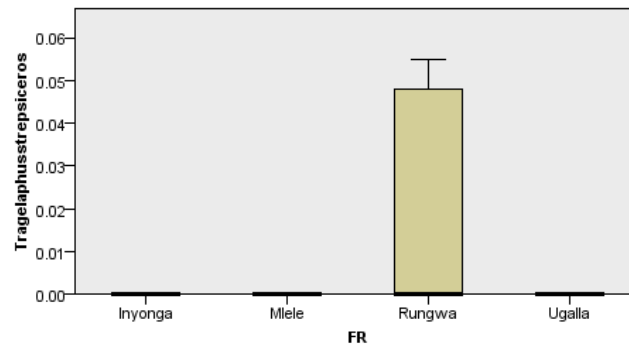


N Total	36
Statistique de test	11.287
Degrés de liberté	3
Sig. asymptotique (test bilatéral)	.010

1. La statistique de test est réglée pour les ex aequo.

Greater Kudu

Test de Kruskal-Wallis à échantillons indépendants

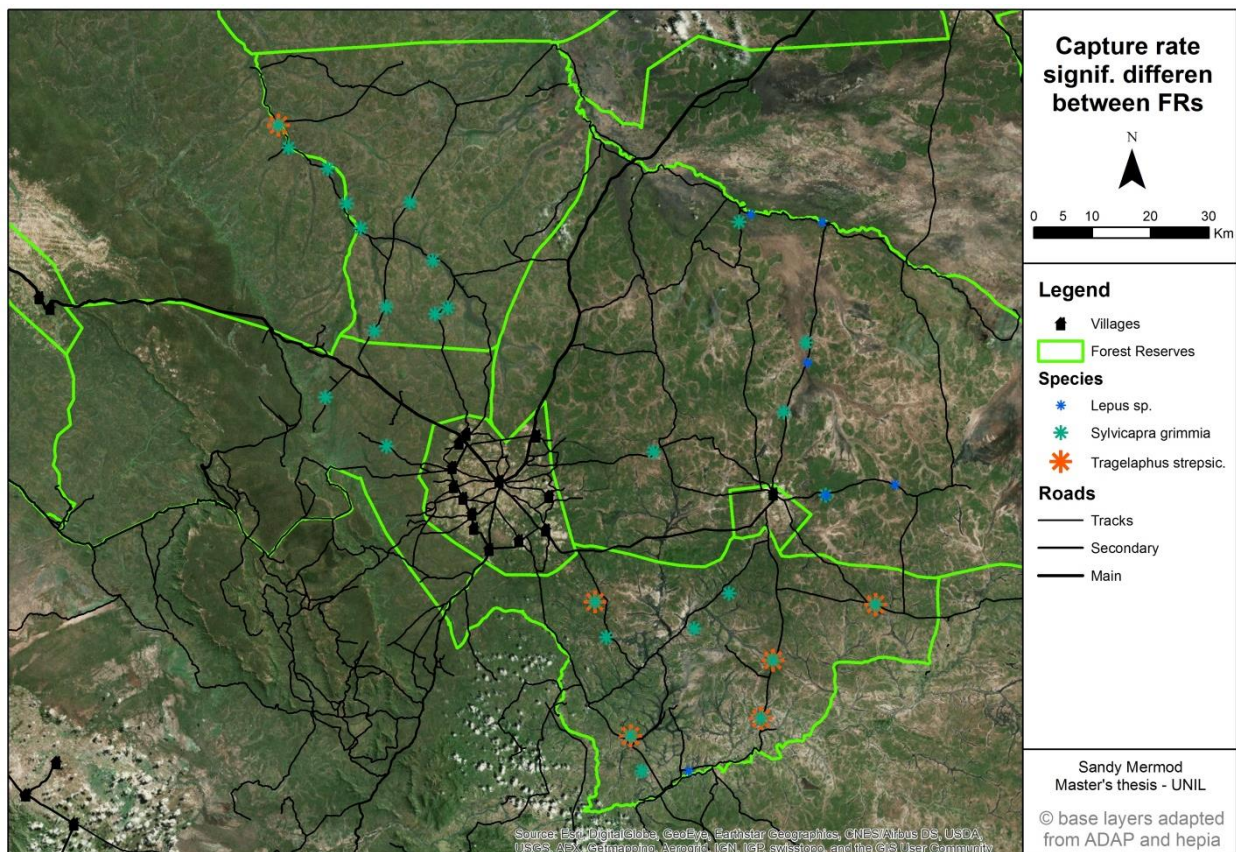


N Total	36
Statistique de test	9.305
Degrés de liberté	3
Sig. asymptotique (test bilatéral)	.026

1. La statistique de test est réglée pour les ex aequo.

APPENDIX 23 Arguments and distribution map for significant capture rates

The mean capture rate of the hare is far higher for Inyonga FRs with 0.301 (against 0 for Mlele, 0.050 for Ugalla and 0.066 for Rungwa). We could explain this important difference mostly by the ecology of the hare, and not by anthropic reason as hare is not threatened in Tanzania. Hares (especially Savannah Hare which should be the one in our area according to Foley et al., 2014) are eating grasses and thus would prefer open grassland. There were several CT sites of Inyonga FR set in mbuga, open woodlands or wooded grasslands and this can influence chances to capture hares. Moreover, hares have a small territory and if the camera is set near a den, there are many pictures of the same individual during the sampling. Concerning the common duiker, although the boxplots show spread data, the capture rates means are higher for Ugalla River (0.370) and Rungwa River (0.232) than for Inyonga (0.135) or Mlele (0.060). The common duiker is a quite common species found in all Tanzania, except in open grassland or dense forest (Foley et al., 2014). The habitats sampled in Mlele and Inyonga were a bit more open, with mbuga and wooded grassland and this could explain the difference of capture. Furthermore, like the hare, the CT sites in a duiker territory will have many pictures of the same individual. Lastly, the capture rates of the Greater Kudu are significantly higher for Rungwa River with a mean of 0.023 (representing 5 independent pictures) against 0.005 for Ugalla and 0 for Inyonga and Mlele. Greater Kudu avoids open grassland or forest and would prefer bushland or savannah woodland (Foley et al., 2014), the kind of habitats you can find along Rungwa River. However, the Greater Kudu pictures were wide spread and not limited to Rungwa River. It could not be the low altitude as we can find greater kudu on Mlele escarpment. We could maybe simply consider the low effort research as the kudu has large territories up to 25km² for female and 50km² for male (Foley et al., 2014).



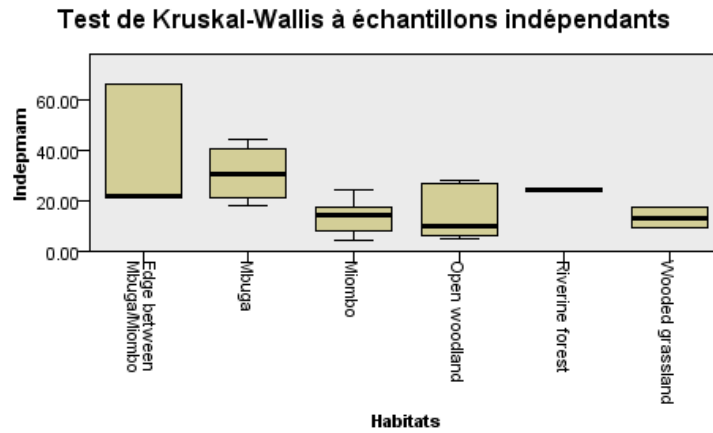
APPENDIX 24 Kruskal-Wallis test for the variable habitats

Effect of habitats on the distribution of Independent mammal pictures, number of mammals' species, species/CT days and independent pictures/CT days.

Habitats summary by Forest Reserve

Inyonga	10
Mbuga	1
Miombo	3
Open woodland	3
Wooded grassland	3
Mlele	4
Miombo	2
Open woodland	1
Riverine forest	1
Rungwa River	11
Edge between Mbuga/Miombo	1
Miombo	8
Open woodland	2
Ugalla River	11
Edge between Mbuga/Miombo	2
Mbuga	3
Miombo	5
Open woodland	1
Total	36

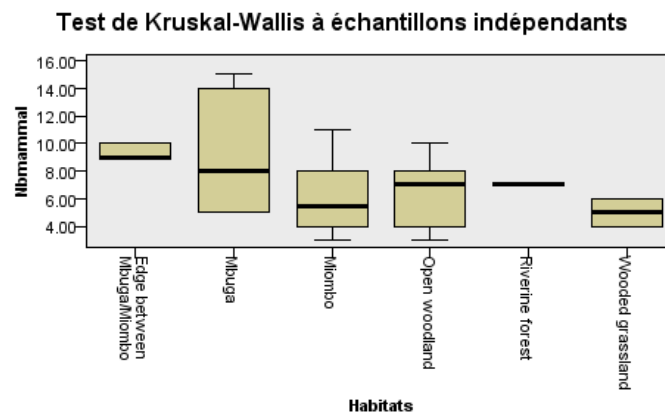
Number of independent pictures



N Total	36
Statistique de test	12.703
Degrés de liberté	5
Sig. asymptotique (test bilatéral)	.026

1. La statistique de test est réglée pour les ex aequo.

Mammal species

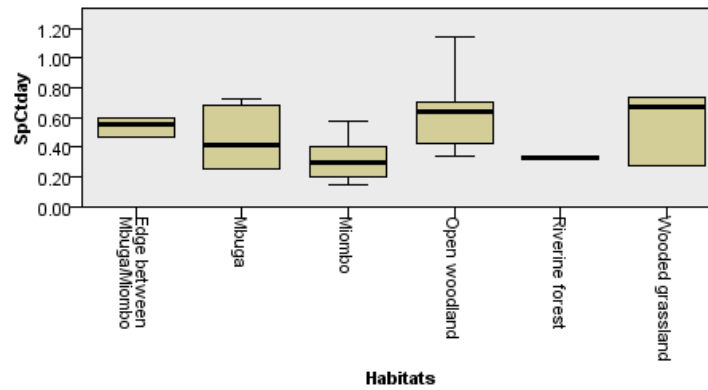


N Total	36
Statistique de test	7.714
Degrés de liberté	5
Sig. asymptotique (test bilatéral)	.173

1. La statistique de test est réglée pour les ex aequo.
 2. Aucune comparaison multiple n'est effectuée car le test général ne contient pas de différence significative entre les échantillons.

Species/CT days

Test de Kruskal-Wallis à échantillons indépendants

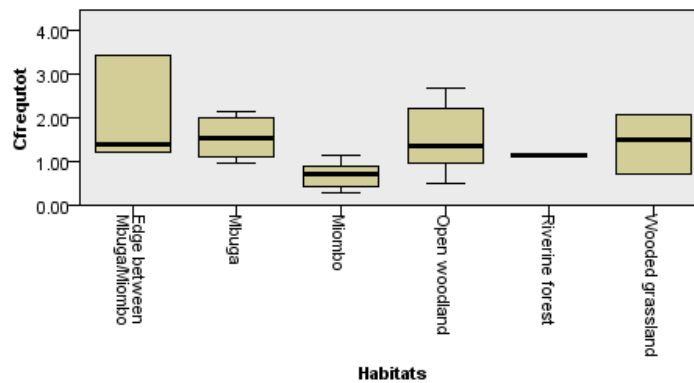


N Total	36
Statistique de test	13.513
Degrés de liberté	5
Sig. asymptotique (test bilatéral)	.019

1. La statistique de test est réglée pour les ex aequo.

Independent pictures/CT days

Test de Kruskal-Wallis à échantillons indépendants



N Total	36
Statistique de test	18.862
Degrés de liberté	5
Sig. asymptotique (test bilatéral)	.002

1. La statistique de test est réglée pour les ex aequo.

APPENDIX 25 List of species inventoried and their methods

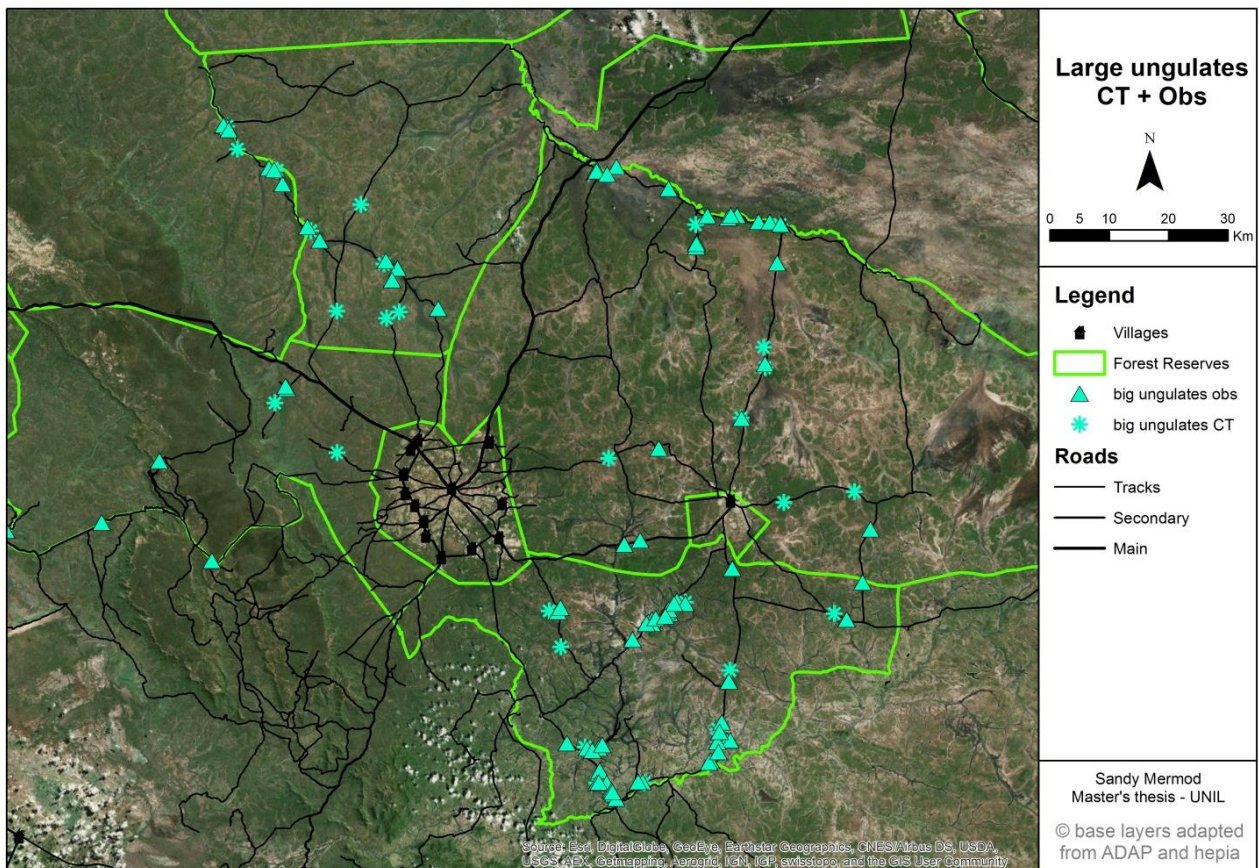
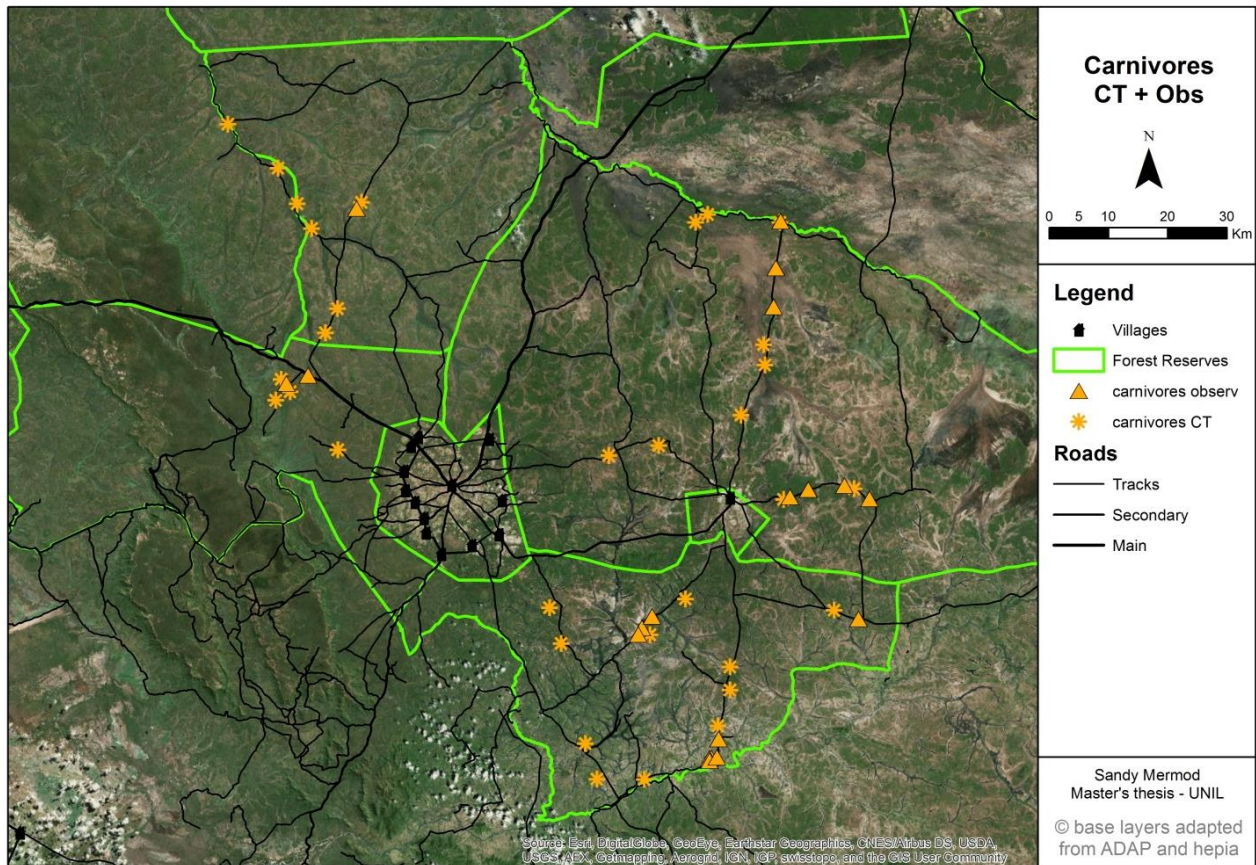
#	Species (with category of IUCN Red List)	Mlele FR		Inyonga FR		Ugalla River FR		Rungwa FR	
		Capt. Frequ.	Nb obs.	Capt. Frequ.	Nb obs.	Capt. Frequ.	Nb obs.	Capt. Frequ.	Nb obs.
1	<i>Aepyceros melampus</i>				8				12
2	<i>Alcelaphus lichtensteinii</i>	0.013	3	0.114	2	0.078	3	0.103	6
3	<i>Bdeogale crassicauda</i>	0.052		0.021		0.019		0.005	
4	<i>Chlorocebus pygerythrus</i>	0.052	1	0.050	7	0.029	1		1
5	<i>Civettictis civetta</i>	0.026		0.021		0.073		0.005	
6	<i>Crocuta crocuta</i>	0.131		0.007	1	0.015		0.005	1
7	<i>Damaliscus lunatus</i>			0.007	2	0.005	4		6
8	<i>Equus q. boehmi</i>	0.039						0.005	5
9	<i>Galago senegalensis</i>					0.005			
10	<i>Genetta angolensis</i>	0.065		0.057		0.034		0.062	
11	<i>Genetta genetta</i>			0.007					
12	<i>Genetta maculata</i>							0.015	
13	<i>Giraffa camelopardalis</i>		1	0.064	5	0.039		0.036	6
14	<i>Helogale parvula</i>				2				
15	<i>Herpestes sanguinea</i>						1		
16	<i>Hippotatamus amphibius</i> VU				2				3
17	<i>Hippotragus equinus</i>		1	0.007	5	0.019		0.021	5
18	<i>Hippotragus niger</i>	0.013		0.057	2	0.034		0.041	8
19	<i>Hystrix africaeaustralis</i>			0.029		0.005		0.010	1
20	<i>Ichneumia albicauda</i>			0.043		0.010			
21	<i>Kobus ellipsiprymnus</i>		2		9	0.122	5	0.005	6
22	<i>Lepus sp.</i>			0.171		0.053		0.041	1
23	<i>Loxodonta africana</i> VU		1		3				7
24	<i>Madoqua kirkii</i>		2	0.007	2				1
25	<i>Mellivora capensis</i>					0.010		0.005	
26	<i>Mungos mungo</i>	0.039			2	0.015		0.010	4
27	<i>Orycteropus afer</i>			0.014		0.005		0.010	
28	<i>Otolemur crassicaudatus</i>					0.005		0.010	
29	<i>Ourebia ourebi</i>				1		1	0.005	
30	<i>Panthera leo</i> VU		2		2				6
31	<i>Panthera pardus</i> NT			0.021	1	0.015		0.010	1
32	<i>Papio cynocephalus</i>		5	0.021	5	0.005		0.015	7
33	<i>Pedetes surdaster</i>	0.026		0.014		0.063		0.072	
34	<i>Phacochoerus africanus</i>	0.039	4	0.043	9	0.160	9	0.046	14
35	<i>Potamochoerus larvatus</i>	0.039				0.019		0.015	
36	<i>Raphicerus sharpei</i>			0.036		0.005		0.062	
37	<i>Redunca arundinum</i>		1	0.007	1	0.019	1	0.010	4
38	<i>Rynchogale melleri</i>			0.007					

39	<i>Sylvicapra grimmia</i>	0.065	2	0.143	2	0.360	3	0.267	8
40	<i>Syncerus caffer</i>					0.010		0.005	1
41	<i>Tragelaphus oryx</i>			0.007		0.005		0.026	
42	<i>Tragelaphus scriptus</i>	0.013	1			0.122			
43	<i>Tragelaphus strepsiceros</i>				3	0.005	2	0.026	6
Frequency for each method		0.614	26	0.976	76	1.361	30	0.949	120
Species for each method		14	13	25	22	31	10	29	25
Total species		22		34		34		37	

Others species detected (but not used for the comparison)

i	<i>Crocodylus niloticus</i>								x
ii	Doubtful genettas		x		x		x		x
iii	Doubtful mangooses		x		x				
iv	Doubtful birds		x		x		x		x
v	Francolinus sp.		x		x		x		
vi	<i>Bucorvus leadbeateri</i> (VU)				x		x		x
vii	Streptopelia sp.				x				
viii	<i>Petrodromus tetradactylus</i>				x		x		

APPENDIX 26 Distribution maps of carnivores and large ungulates



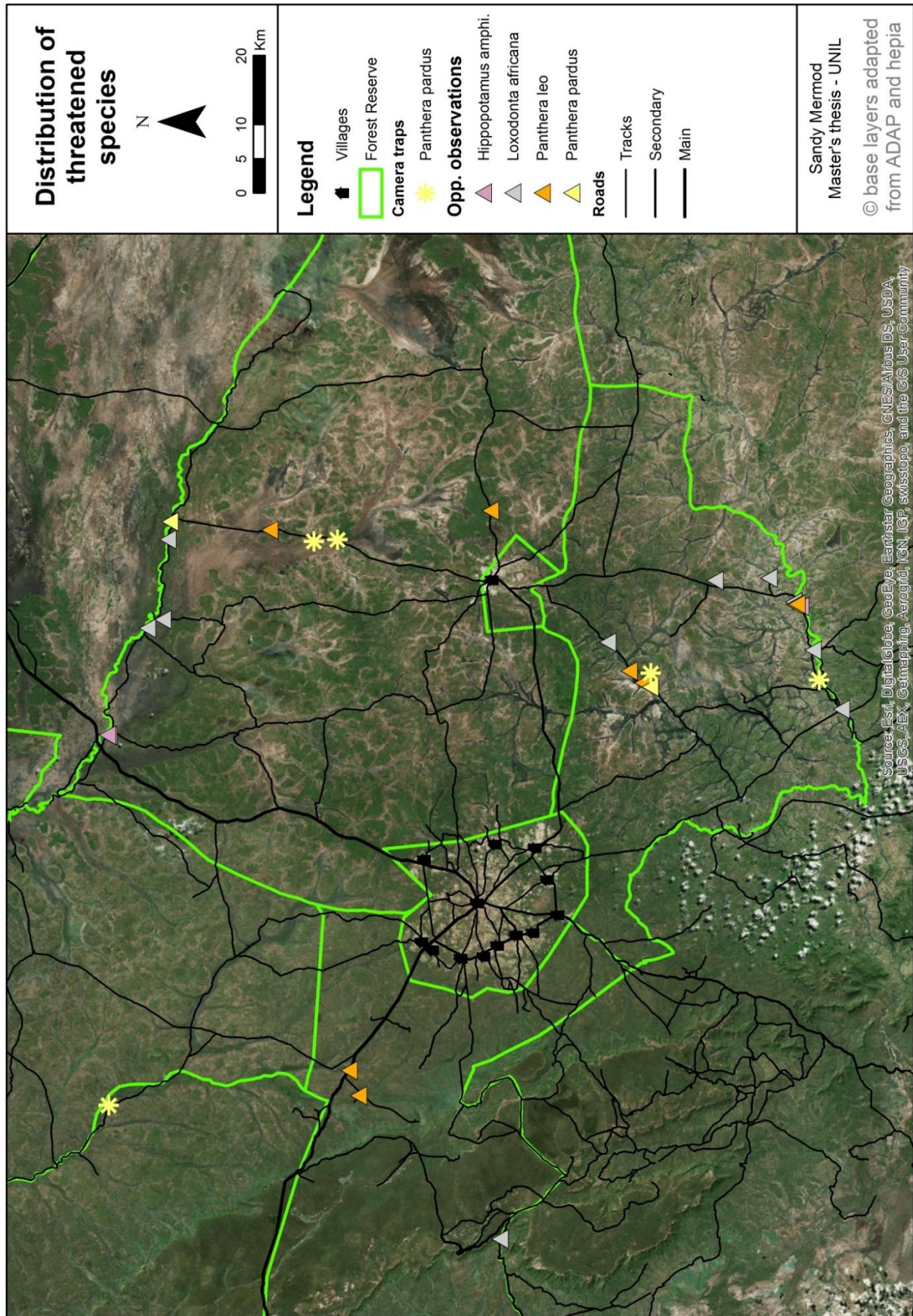
APPENDIX 27 Animals shot in Msima East, Inyonga West and Centre

For the years 2013, 2014, 2015

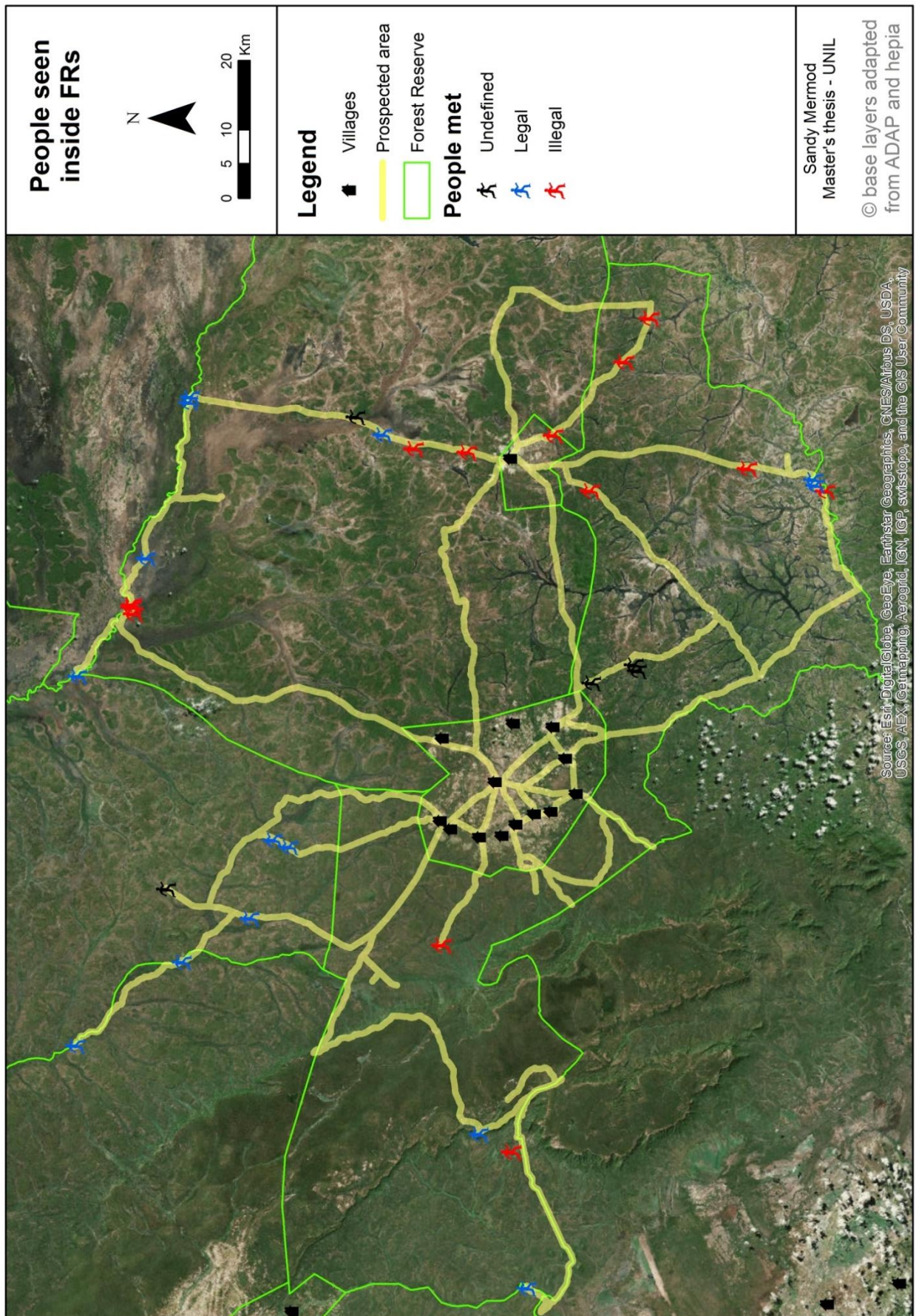
Source: Mlele District, collected by Stampfli (2016)

2015!		2014	
JULY → OCT		JULY → DEC.	
1. BUFFALO = 7		1. BUFFALO - 10	
2. HARTIBEST = 9		2. HARTIBEST - 7	MSIMA
3. WARTHOG = 2		3. TOPI - 8	BCA (E)
4. HIPPO = 1		4. ZEBRA - 2	INYONGA
5. SABLE = 3		5. WARTHOG - 3	BCA (C) (W)
6. GREATER KUDU = 1		6. HIPPO - 3	
7. ROAN = 3		7. SABLE - 4	
8. ELAND = 3		8. ROAN - 5	
9. TOPI = 4		9. ELAND - 2	
10. HYAENA = 1		10. ORIBI - 1	
11. LEOPARD = 1		11. REEDBUCK - 5	
12. BUSHPIG = 1		12. BABOON - 2	
13. REEDBUCK = 3		13. WATERBUCK - 4	
14. WATERBUCK = 1		14. BUSHBUCK - 1	
15. DEER = 1		15. IMPALA - 2	
		16. HYAENA - 1	
		17. LEOPARD - 2	
		18. LION - 2	
		19. GREATER KUDU - 1	
	<u>41</u>		<u>68</u>
<hr/>			
2013 → JULY → DEC 2013			
1. BUFFALO - 9	10. ORIBI - 4	20. IMPALA - 3	
2. HARTIBEST - 13	11. TOPI - 15	21. CROCODILE - 6	
3. ZEBRA - 6	12. LEOPARD - 5	22. JACKAL - 1	
4. WARTHOG - 5	13. HYAENA - 2		<u>119</u>
5. HIPPO - 2	14. BUSHBUCK - 2		
6. SABLE - 11	15. BUSHPIG - 1		
7. GREATER KUDU - 4	16. REEDBUCK - 10		
8. ROAN - 3	17. BABOON - 2		
9. ELAND - 2	18. LION - 6		
	19. WATERBUCK - 7		

APPENDIX 28 Distribution map of the of threatened species



APPENDIX 29 Distribution maps of people met inside the Forest Reserves



APPENDIX 30 Human activities summarized by type and by Forest Reserve

	Total obs.	People	Legal	Illegal
Inyonga	38	14	7	11
Undefined	1	1		0
Beekeeping	2	2	2	
Cattle keeping	2	0		2
Fishing	4	4	2	2
Management	2	2	2	
Poaching	4	3		4
Timbering	21	2	1	1
Clear cut	2	0		2
Mlele	16	4	3	7
Undefined	3	0		0
Beekeeping	1	0	1	
Fishing	1	0		1
Management	2	2	2	
Poaching	3	1		3
Timbering	4	1		1
Clear cut	2	0		2
Rungwa	86	10	3	37
Undefined	5	4		1
Beekeeping	9	0	1	8
Cattle keeping	17	1		17
Fishing	1	1	1	
Management	1	1	1	
Poaching	10	2		10
Timbering	43	1		1
Ugalla	12	6	5	1
Undefined	2	1		0
Beekeeping	1	1	1	
Fishing	1	1	1	
Management	1	1	1	
Poaching	1	0		1
Timbering	6	2	2	0
Total général	152	34	18	56

APPENDIX 31 Logging allowable cuts 2014-2019 for the Forest Reserves

Source: TFS (2014)

Rungwa River FR

Table 3: Annual allowable cut

Total Area (ha)	Harvestable area (ha)	Total Volume (m ³)/ha	Harvestable timber	Remaining Volume as of April 2014	ANNUAL ALLOWABLE CUT 2014/2015-2018/2019				
					Species	V (m ³)	2014/2015	2015/2016	2016/2017
401,463	361,316	46	<i>Brachystegia boehmii</i>	268,714.00	53,742.80	53,742.80	53,742.80	53,742.80	53,742.80
			<i>Julbernardia globiflora</i>	49,638.00	9,927.60	9,927.60	9,927.60	9,927.60	9,927.60
			<i>Brachystegia spiciformis</i>	167,073.37	33,414.67	33,414.67	33,414.67	33,414.67	33,414.67
			<i>Pericopsis angolensis</i>	54,974.00	10,994.80	10,994.80	10,994.80	10,994.80	10,994.80
			<i>Pterocarpus tintorius</i>	106,519.00	21,303.80	21,303.80	21,303.80	21,303.80	21,303.80
			<i>Sclerocarya birrea</i>	112,744.00	22,548.80	22,548.80	22,548.80	22,548.80	22,548.80
Total				759,662.37	151,932.47	151,932.47	151,932.47	151,932.47	151,932.47

Inyonga FR

Table 3: Annual allowable cut

Total Area (ha)	Harvestable area (ha)	Harvestable timber	Remaining Volume as of April 2014	ANNUAL ALLOWABLE CUT 2014-2019				
				Species	V (m ³)	2014/2015	2015/2016	2016/2017
578,624	520761.4	<i>Brachystegia boehmii</i>	769,004	153,800.80	153,800.80	153,800.80	153,800.80	153,800.80
		<i>Pericopsis angolensis</i>	213,801	42,760.20	42,760.20	42,760.20	42,760.20	42,760.20
		<i>Brachystegia spiciformis</i>	565,349	113,069.87	113,069.87	113,069.87	113,069.87	113,069.87
		<i>Pseudolachnostylis maprouneifolia</i>	83,221	16,644.20	16,644.20	16,644.20	16,644.20	16,644.20
		<i>Julbernardia globiflora</i>	102,005	20,401.00	20,401.00	20,401.00	20,401.00	20,401.00
		<i>Pterocarpus tintorius</i>	337,325	67,465.00	67,465.00	67,465.00	67,465.00	67,465.00
		<i>Vitex doniana</i>	153,586	30,717.21	30,717.21	30,717.21	30,717.21	30,717.21
		<i>Sclerocarya birrea</i>	140,961	28,192.20	28,192.20	28,192.20	28,192.20	28,192.20
		<i>Azela quanzensis</i>	146,512	29,302.40	29,302.40	29,302.40	29,302.40	29,302.40
Total			2,511,764	502,352.88	502,352.88	502,352.88	502,352.88	502,352.88

Ugalla River FR

Table 3: Annual allowable cut

Total Area (ha)	Harvestable area (ha)	Harvestable timber	Remaining Volume as of April 2014	ANNUAL ALLOWABLE CUT 2014-2019				
				Species	V (m ³)	2014/2015	2015/2016	2016/2017
502,461	384,615	<i>Julbernardia globiflora</i>	134,615.3	26,923.06	26,923.06	26,923.06	26,923.06	26,923.06
		<i>Pterocarpus tintorius</i>	169,230.6	33,846.12	33,846.12	33,846.12	33,846.12	33,846.12
		<i>Sclerocarya birrea</i>	407,691.9	81,538.38	81,538.38	81,538.38	81,538.38	81,538.38
Total			711,537.8	142,307.56	142,307.56	142,307.56	142,307.56	142,307.56

Mlele FR

Table 3: Allowable cut

Total Area (ha)	Harvestable area (ha)	Total Volume (m ³)/ha	Harvestable timber	Remaining Volume as of April 2014	ANNUAL ALLOWABLE CUT 2014/2015-2018/2019				
					Species	V (m ³)	2014/2015	2015/2016	2016/2017
519,295	46736.5	56	<i>Brachystegia boehmii</i>	1,189,940	237,988.00	237,988.00	237,988.00	237,988.00	237,988.00
			<i>Brachystegia spiciformis</i>	549,336	109,867.25	109,867.25	109,867.25	109,867.25	109,867.25
			<i>Pterocarpus angolensis</i>	164,996	32,999.20	32,999.20	32,999.20	32,999.20	32,999.20
			<i>Pseudolachyrostachya maprouneifolia</i>	47,584	9,516.80	9,516.80	9,516.80	9,516.80	9,516.80
			<i>Julbernardia globiflora</i>	434,921	86,984.20	86,984.20	86,984.20	86,984.20	86,984.20
			<i>Isorberlinia tomentosa</i>	427,203	85,440.60	85,440.60	85,440.60	85,440.60	85,440.60
			<i>Pericopsis angolensis</i>	122,372	24,474.40	24,474.40	24,474.40	24,474.40	24,474.40
			<i>Albizia antunesiana</i>	32,241	6,448.22	6,448.22	6,448.22	6,448.22	6,448.22
			<i>Pterocarpus tintorius</i>	167,049	33,409.80	33,409.80	33,409.80	33,409.80	33,409.80
			<i>Parinari curatellifolia</i>	34,020	6,804.00	6,804.00	6,804.00	6,804.00	6,804.00
			<i>Brachystegia bussei</i>	102,229	20,445.80	20,445.80	20,445.80	20,445.80	20,445.80
			<i>Azela quanzensis</i>	132,379	26,475.79	26,475.79	26,475.79	26,475.79	26,475.79
			<i>Swartzia madagascariensis</i>	61,326	12,265.20	12,265.20	12,265.20	12,265.20	12,265.20
			<i>Borassus aethiopicum</i>	47,584	9,516.80	9,516.80	9,516.80	9,516.80	9,516.80
			<i>Diospyros mespiliformis</i>	89,243	17,848.60	17,848.60	17,848.60	17,848.60	17,848.60
			<i>Xeroderis stuhlmanii</i>	29,067	5,813.40	5,813.40	5,813.40	5,813.40	5,813.40
			<i>Dalbergia melanoxylon</i>	32,937	6,587.40	6,587.40	6,587.40	6,587.40	6,587.40
Total			3,664,427	732,885.46	732,885.46	732,885.46	732,885.46	732,885.46	

APPENDIX 32 Licences issuance and property-rights analysis

Licenses/permits issuing authorities for main activities in FRs

Authorities according licenses	Location (contested ones in italic)	Logging	Hunting	Beekeeping	Fishing
TFS	<i>Inyonga/ Mpanda</i>	DFM (transit pass)		DFM (transit pass)	
District	<i>Inyonga/ others districts</i>	DFO ?		DBO (permit)	District Fisheries Officer (permit)
District harvesting committee (TFS, District, Villages)	<i>Inyonga/Mpanda</i>	X (harvesting licences)			
WD	Dar es Salaam		Wildlife Director (quotas)		

Tables below present the bundles of rights (based on Schlager and Ostrom, 1992) for each resource studied according to the law and the reality.

How it should be according to the law

Level	Rights	Position	Timber	Wildlife	Fish	Honey
Operational	Access and withdrawal	Authorized user	Timbermen who have a license and pay fees according to the harvest	Hunter who have a license and pay fees according to the harvest	Fishermen who pay a permit	Beekeepers who pay a permit
Collective-choice	Management	Claimant	TFS and District	WD, through District	FBD, through District	FBD, through District
	Exclusion	Proprietor	MNRT, through the director of Forestry and parliament	MNRT, through the director of Wildlife and parliament	MNRT, through Director of fisheries and parliament	MNRT, through Director of beekeeping and parliament
	Alienation	Owner	URT*	URT	URT	URT

*United Republic of Tanzania

How it is in reality (according to the field work)

Level	Rights	Position	Timber	Wildlife	Fish	Honey
Operational	Access and withdrawal	Authorized user	Legal and illegal Timbermen	Hunters, poachers	Legal and illegal fishermen	Legal and illegal beekeepers
Collective-choice	Management	Claimant	(TFS and District), Hunting societies	WD, hunting societies	(District), Hunting societies,	District, Beekeepers, Hunting societies,
	Exclusion	Proprietor	WD	WD	WD	WD
	Alienation	Owner	URT	URT	URT	URT

APPENDIX 33 Final diagram representing the SES of FRs

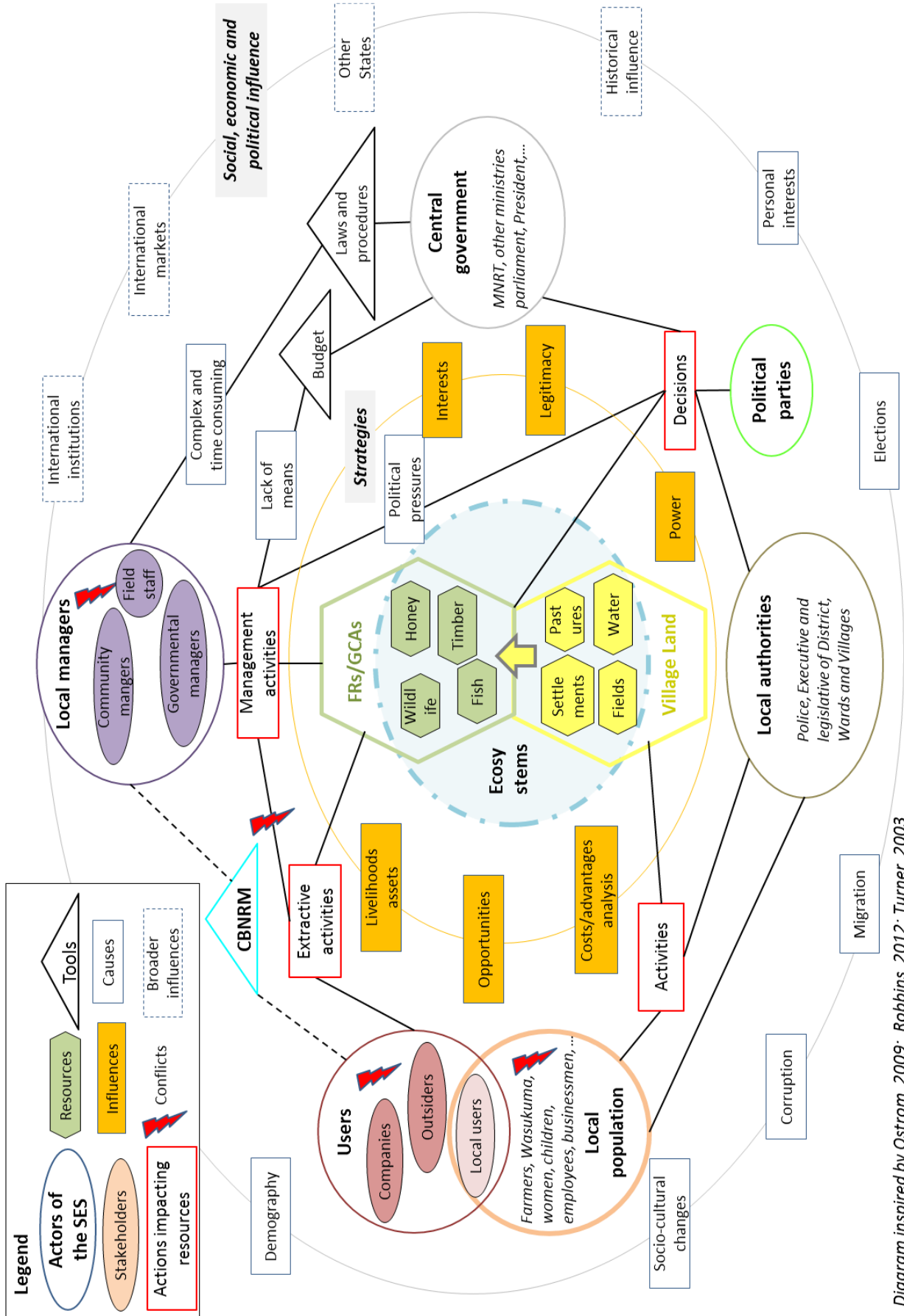


Diagram inspired by Ostrom, 2009; Robbins, 2012; Turner, 2003