National University of Rwanda

CONSULTANCY BUREAU (NUR/CB)

INVENTORY AND MAPPING OF THREATENED REMNANT TERRESTRIAL ECOSYSTEMS OUTSIDE PROTECTED AREAS THROUGH RWANDA

FINAL REPORT

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For

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ACRONYMS

ACNR : Association pour la Conservation de la Nature au Rwanda

ARECO: Association Rwandaise des Ecologistes

CBD: Convention on Biological Diversity

CIMERWA : Cimenterie du Rwanda

CITES: Convention on International Trade in Endangered Species

GIS: Geographic Information System

GPS: Global Positioning System

IUCN: International Union for Conservation of Nature

NAFA: National Authority

PA: Protected Areas

PAFOR: Projet d'Aménagement Forestier

REDEMI: Régie d'Exploitation et de Développement des Mines

REMA: Rwanda Environnemental Management Authority

SOMIRWA: Société Minière du Rwanda

EXECUTIVE SUMMARY

The remnant terrestrial ecosystems are considered as natural habitats with rich biodiversity (flora and fauna) and their extinction would result in loss of threatened species or species in extinction and the associated effects would be an imbalance of ecological functions. In Rwanda, the remnant terrestrial ecosystems are scattered across the country. Nevertheless, they are given less importance in conservation effort, given that they are located outside protected areas and some of them are less known. The inventory of remnant terrestrial ecosystems is of great importance because it constitutes the first step forward for their protection and conservation. This, study aimed at conducting an inventory and mapping all threatened remnant terrestrial ecosystems outside protected areas across the country. Field work observations and guided interviews to local communities and authorities were carried out for gathering preliminary information on location of those ecosystems, their biodiversity composition, their current management, threats on them and future perspectives in their conservation effort. Additionally, GIS based mapping techniques were performed by deriving location based information on satellite imagery and aerial photographs with 25cm accuracy. The results were obtained from four Provinces and a total of fifteen remnant ecosystems were identified and mapped including six in the Western Province, (Mukura, Nyabitukura, Shagasha, Mashyuza, Kumbya and Ntendezi Natural Forests), one in the Northern Province, (Buhanga Natural Forest), seven ecosystems in the Eastern Province (Ibanda-Makera, Nyagasenyi, Nyenyeri (MINAGRI), Bukora, Rujambara, Muvumba and Karama Natural Forests) and one in the Southern Province (Busaga Natural Forest). For each identified ecosystem, a general description of its characteristics was discussed together with its dominant and remarkable flora and fauna. In addition, the threats that are posed to each ecosystem and its current management practice were discussed as well as the importance of its conservation and suggested measures of conservation. Maps and orthophotos were also designed for each ecosystem (polygons were provided for all ecosystems and topographic maps were produced where relevant only) for visual illustration. Besides the abovementioned natural ecosystems , there were other ecosystems belonging to military domains which were not fully investigated, but whose brief description and aerial photos were included in this report, as further information on them was not accessible for security reasons. These are Gabiro, Gako and Nasho military domains; all located in the Eastern Province.

Among the investigated remnant terrestrial ecosystems, some of them were judged to deserve a special attention for their inclusion in the network of protected areas in Rwanda. These include the ecosystems located in high lands (Mukura, Nyabitukura, Shagasha, Busaga, and Buhanga) and which have the common characteristic of being the important water catchments (except Buhanga) and a refugium for high plant and animal diversities. However, by considering the Mukura natural forest which was recognized as Forest Reserve since 1951 and referring to IUCN definition of a Protected Area, the current management and conservation measures should be reviewed so to restore this ecosystem in its original status. Buhanga forest should be protected for the promotion of ecotourism, as this relict forest holds particular historic background.

With regard to low land terrestrial ecosystems (Mashyuza, Kumbya, Ntendezi, Ibanda-Makera, Nyagasenyi, Nyenyeri, Bukora, Rujambara, Muvumba, Karama and the military domains Gabiro, Gako and Nasho), they all deserve to be protected for their biological and ecological interests detailed in the results of this study, except Ntendezi forest which should not be included in the protected areas network as it is much degraded beyond restoration and because of its poorness in terms of biodiversity. On the other hand, special attention should be brought to some of these ecosystems for various reasons. It is the case of Mashyuza natural ecosystem which is a particular ecosystem by its biodiversity and its associated hot spring waters and which be considered as an area managed mainly for ecosystem protection and recreation according to IUCN classification. Another particular ecosystem is Muvumba gallery forest which. Another particular ecosystem is Muvumba gallery forest that needs to be protected as it conserves water used for the whole District of Nyagatare. A very high risk of water shortage in short term is predictable when the current rice cropping project will be implemented. There should be an agreement between all stakeholders so as to settle a friendly agriculture to environment conservation within Muvumba valley. All other dry forest ecosystems located in the Eastern Province and which were formerly connected to Akagera National Park, they should be considered as relicts ecosystems and classified, together with all other mentioned ecosystems, in the IUCN Protected Area Category IV as areas managed mainly for the sustainable use of natural resources. For the particular case of military domains which are very large ecosystems, the institutions involved in environment and biodiversity conservation should find appropriate approaches of their conservation and management.

CHAPTER 1. INTRODUCTION

1.1. Literature review

1.1.1. CONCEPTS CLARIFICATION

i. Definition of Ecosystem

The term "***ecosystem"*** was first used in 1930 by Roy Clapham to mean the combined physical and biological components of an environment. Later on, British ecologist; Arthur Tansley (1935) later redefined the term, by describing it as *"the whole system, including not only the organism-complex, but also the whole complex of physical factors forming what we call the environment".* Arthur Tansley emphasized that ecosystems could not be understood as simple natural units, but as mental isolates.

Other authors such as Odum, EP explained the Ecosystem as the complex system of plant, animal, fungal, and microorganism communities and their associated non-living environment interacting as an ecological unit. Ecosystems have no fixed boundaries; instead their parameters are set to the scientific, management, or policy question being examined (1971). Depending upon the purpose of analysis, a single lake, a watershed, or an entire region could be considered as an ecosystem. As highlighted by Odum , "*Any unit that includes all of the organisms (i.e. the "community") in a given area interacting with the physical environment so that a flow of energy leads to clearly defined trophic structure, biotic diversity, and material cycles (i.e.: exchange of materials between living and nonliving parts) within the system is an ecosystem"* (1971) . The CBD defines an "ecosystem" as a "dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit". After the World Summit in 1992 and Convention on Biological Diversity, the ecosystem was given a particular attention by commitment of ratifying countries. At the same time, the ecosystem meaning was extended by emphasizing the protection of all sensitive ecosystems, natural habitats and the maintenance of viable populations of species in natural surroundings (UNEP, 1992). This led to the political necessity to spatially identify ecosystems and somehow classify them.

ii. Types and importance of ecosystems

Ecosystems have been so far classified into two main categories namely:

1) Natural ecosystem: Terrestrial (land) ecosystem and Aquatic ecosystem. The later also is subdivide into two sub-categories i.e (i) Lentic (the ecosystem of a lake, pond or swamp) and (ii) Lotic (the ecosystem of a river, stream or spring);
2) Artificial: man-made ecosystems

Since the Convention on Biological Diversity (CBD) ratified by 192 countries, ecosystems have become particularly important and politically reflected. With the need of protecting ecosystems, the political need arose to describe and identify them efficiently. Vreugdenhil et al. (2003) argued that the ecosystems inventory and identification could be achieved most effectively by using a physiognomic-ecological classification system, as ecosystems are easily identified in the field as well as on satellite images.

iii. Ecosystem services

Ecosystem services are fundamental life-support services upon which human civilization depends and these services a can be direct or indirect realized. Some of the examples of direct ecosystem services are: pollination, wood and erosion prevention, etc. Indirect services could be among others, climate moderation, nutrient cycles, detoxifying natural substances, etc. The services and goods that an ecosystem provides are often undervalued as many of them are without market value (Costanza, R et al., 1997).

In Ecosystem and Human Well-being Report of The World Resources Institute (2005), a broad example of ecosystem services is enumerated including:

- Regulating (climate, floods, nutrient balance, water filtration)
- Provisioning (food, medicine, fur)
- Cultural (science, spiritual, ceremonial, recreation, aesthetic),

- Supporting (nutrient cycling, photosynthesis, soil formation).

From an anthropocentric point of view, some societies perceive ecosystems as production units that produce goods and services, such as, wood by forest ecosystems and grass for livestock by natural grasslands, meat from wild animals, often referred as bush meat in Africa etc. Services derived from ecosystems may include:

1) Facilitating the enjoyment of nature, which may generate various forms of income and employment in the tourism sector, often referred as eco-tourisms,

2) Water retention, by facilitating a more evenly distributed release of water,

3) Soil protection considered as an open-air laboratory for scientific research, etc.

iv. Ecosystem change, human well-being and poverty alleviation

A greater degree of species or biological diversity - commonly referred as Biodiversity - of an ecosystem may contribute to greater resilience of an ecosystem, given that there are more species present at a location to respond to a change and thus absorb or reduce its effects. This leads to the reduction of effect before the ecosystem's structure is fundamentally changed to a different state. However, this is not universally the case and there is no proof relationship between the species diversity of an ecosystem and its ability to provide goods and services on a sustainable level. For instance, humid tropical forests produce very few goods and direct services, although they are extremely vulnerable to change. While many temperate forests readily grow back to their previous state of development within a lifetime after felling or a forest fire ref, some grassland has been sustainably exploited for thousands of years (Mongolia, Africa, European peat and Mooreland communities) and this fact led to various reasons such as:

a) ***Human well-being*** depending on material welfare, health, good social relations, security, and freedom; all of these affected by changes in ecosystem services (Boer, P.,. den, and J. Reddingius. 1996).
b) ***Ecosystem services***, particularly food production, timber and fisheries, which are important for employment and economic activity. In this context, intensive use of ecosystems often produces the greatest short-term advantage, but excessive and unsustainable use can lead to loss of biodiversity richness in the long term. For instance, a country could cut its forests and depletes its fisheries, and this would only result in a positive increase of GDP, despite the loss of capital assets. As suggested by (Lawton, John H, 1994), if the full economic value of ecosystems were taken into account in decision-making, their degradation could be significantly slowed down or even reversed
c) ***Levels of poverty*** which remains high and over even one billion people have an income of less than $1 per day (World Resources Institute, 2005). Most of these people are depending to on ecosystems resources, because ecosystems support them mainly through agriculture, grazing, and hunting. The regions facing the greatest developmental challenges tend to be those having the greatest ecosystem related problems. These include some parts of Africa, Asia and Latin America.
d) Some ***ecosystem changes*** such as increased food production have helped hundreds of millions of people out of poverty, but also have negative effects. Degradation of ecosystem services is harming many of the world's poorest and most vulnerable people, and is sometimes the main factor causing poverty (Lindeman, R.L. 1942). Poverty in turn tends to increase dependence on ecosystem services. This can lead to additional pressure on ecosystems and a downward spiral of poverty and ecosystem degradation.

1.1.2. ECOLOGICAL MECHANISMS LINKING PROTECTED AREAS TO SURROUNDING LANDS

Ecological mechanisms are dynamic in their nature and this allows a narrowed link between protected areas and surrounding lands. Indeed, land use is continuously expanding and man-made activities are intensified in the unprotected areas surrounding many of the worlds' protected areas. This is also especially the case in Albertine Rift region which counts the highest densities of populations in Africa. However, several measures have been taken to reinforce Protected Areas conservation in the aforementioned region,.

Recent assessments have found that most terrestrial reserves are adequately protected within their borders (Bruner et al. 2001, De Fries et al. 2005).

Despite the high level of protection measures enforced in the national parks and other protected areas, many are not functioning as originally envisioned. Critical ecological processes such as fire, flooding, and climate regimes have been altered (Lawton et al. 2001, Pringle 2001). Exotic species are increasingly invading protected areas (Stohlgren 1998), and some native species have gone extinct in protected areas (Newmark 1987, 1995, 1996, Rivard et al. 2000, Brashares et al. 2001).

Why ecological processes are not functioning well in many protected areas, despite adequate management across their borders? A major reason would be that man-made activities are expanding and intensified around protected areas. And this is resulting in change of ecological function and biodiversity within protected areas.

In recent year, ecologists realized that human impacts on lands surrounding protected areas may cross their boundaries (Buechner 1987, Dasmann 1988, Schonewald-Cox 1988). While the land use change reduces habitats in the unprotected portion of the ecosystem, the ecosystem function and biodiversity may be degraded within the protected area. Therefore, the current concept of ecosystem management grew from the goal of managing regional landscapes to maintain the ecological integrity of the nearby protected areas (Agee and Johnson 1988, Grumbine 1994).

If the goal of the protected area is to maintain native species and the ecological processes that they require, then the spatial extent of the effective ecosystem includes the area that strongly influences these species and processes (Grumbine 1990). This area can be mapped based on the flows of materials, energy, and organisms. Watershed boundaries are often used to define the extent of aquatic ecosystems (Pringle 2001).

It has also been demonstrated that so many organisms move predictably across the landscape, for example, to gain access to seasonal resources. Ecosystem boundaries can be defined based on these movements or on the area required to maintain particular population levels of these organisms (Newmark 1985).

For the case of Rwanda, agriculture systems constitute the main element of the landscape to be well managed so as to conserve efficiently PAs. This management should include the protection of remnant ecosystems.

1.1.3. MATRIX CONSERVATION ISSUES

A landscape consists of three main components: a matrix, patches, and corridors (see the figure 1). If we understand these components and their interrelationships, we can make better management decisions at the landscape level.

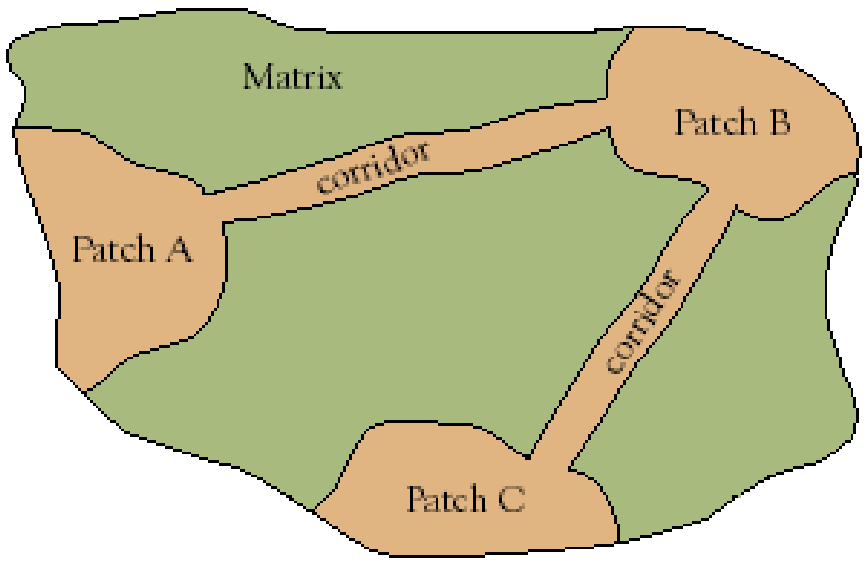

Figure 1: Landscape structure

Lindenmayer and Franklin (2002) argued there were two different, but related definitions of what constituted the 'matrix': (1) the area outside reserves, or (2) the area between patches of remnant vegetation. A key function of the matrix is to provide habitat for several species.

In the matrix, the dominant component in the landscape, is the most extensive and connected landscape type, and it plays the dominant role in landscape functioning.

If the management of a habitat is realized without considering the conservation matrix, there is a big likelihood of failure in providing what wildlife need in that area.

The concept of 'patches' is central to many ecological theories (Stephens and Krebs 1986) and conservation strategies. At the global scale, networks of large patches that are reserved from production (e.g., national parks) are widely regarded as an important backbone of successful biodiversity conservation (Diamond 1975). Similarly, at the landscape scale, patches of remnant vegetation are considered important for conservation efforts in modified landscapes (Saunders et al. 1987).

1.2. Ecosystems Status in Rwanda

1.2.1. GENERAL BACKGROUND

Rwanda is a small mountainous, landlocked country covering 26,338 km^2 with over 10 million people and an average population density of about 321 people per square km (MINICOFIN, 2003). The country is characterized by vast hills and mountains interspersed with valleys. In spite of its spatial exiguity, Rwanda is counting diversified ecosystems: natural ecosystems constituted by ombrophiles mountain forests such as Nyungwe and Volcano National Parks, Mukura and Gishwati forest reserves; gallery forests and wooded lands … (RoR, 2003). Because of its high population density, the rapid change in the state and extent of Rwanda's natural resources gives rise to a growing environmental concern. For instance, the water scarcity and other renewable resources has reached an alarming stage. Arable land, natural forests and water resource have been depleted in some areas due to mainly human activities.

Forests and natural reserves in Rwanda are subject to high human pressure and the rate of deforestation is very high. This massive deforestation combined with the abandonment and destruction of erosion control systems, particularly following the displacement of the population caused by the 1994 the genocide against the Tutsi, greatly contribute to the degradation of the bare land on steep slopes and hills. The use of marshlands and depressions of agricultural and pastoral activities after drainage, no matter how elementary or rudimentary they are, lead to the destruction of natural vegetation, causing water imbalances and affecting the survival of the fauna and flora of these ecosystems. Rwanda has varied ecosystems ranging from afro-montane in the northern and western regions to lowland forests, savannah woodlands, savannah grasslands, etc. Other significant ecosystems include volcanic hot springs and old lava flows that mainly occur in the northern and western parts of the country. Rwanda is also blessed with a large number of inland fresh water and wetland ecosystems. A wetland inventory completed by REMA in 2008 identified 101 lakes, 860 wetlands and 861 rivers in a dense hydrographic network that divides Rwanda into the Congo and Nile basins (MINIRENA/REMA, 2008). An inventory of forests with a surface of 0.5 hectares or higher and with coverage of more than 20% has also been undertaken in 2007 and indicated the Rwanda has an estimate of 240,746 hectares of forests, covering approximately 10% of national dry lands (MINIRENA, 2007). The Rwandese socio-economic structure is dominated by traditional subsistence farming. Due to high population densities, the size of farm land per household is decreasing fast and most of the soils have been exhausted. As a result, cultivation is foraying into traditional marginal areas, particularly in steep slopes, wetlands, etc. It is remarkable that suppression of fallows are leading to widespread soil degradation and frequent landslides and soil erosion due to reduction of soil coverage richness overexploitation of land use and diversity. Beside the land degradation, there are reduction of vegetation/forest cover, siltation of water bodies, frequent droughts and unreliable precipitation. These negative trends within the natural resources domain are putting severe pressure on the life-support systems of the country. Forests are a key component of the life-support system in view of both the products and services they provide but forests alone are unable to supply protection and conservation of biodiversity and ecosystems countrywide. Hence, the consideration of forest matrix and threatened ecosystems out of protected areas is of paramount importance to launch sustainable use of natural resources in and out of protected areas where biodiversity is better treated due to the statute and limitation of exploitation imposed by regulations.

1.2.2. RWANDA'S ECOSYSTEMS

Rwanda has varied ecosystems ranging from afro-montane in the northern and western regions to lowland forests, savannah woodlands, savannah grasslands, etc. Other significant ecosystems include volcanic hot springs and old lava flows that mainly occur in the northern and western parts of the country. Rwanda is also blessed with a large number of inland fresh water and wetland ecosystems.

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An inventory of forests with a surface of 0.5 hectares or higher and with coverage of more than 20% has also been undertaken in 2007 and indicated the Rwanda has an estimate of 240,746 hectares of forests, this being approximately 10% of national dry lands (MINIRENA, 2007).

Good and sustainable biodiversity conservation must be done at the landscape level. As illustrated in figure 1, landscape consists of three main components: a matrix, patches, and corridors. In a fragmented area like Albertine Rift, the dominant element is made by agriculture systems and protected areas are patches with less possibility of connection.

To connect these PAs, one must consider the several small patches of ecosystems encompassed in the matrix. These can be forests, wetlands, savannas, inselbergs, etc.

Land use has so much affected biodiversity within these protected areas that it is actually impossible to make sustainable biodiversity conservation without considering these natural ecosystems in the matrix.

Some efforts have been made to map these ecosystems on a sectoral basis but an inventory and mapping of threatened terrestrial ecosystems is still lacking.

1.3. Context of the study

The present report presents the results obtained from the Inventory and Mapping of Remnant Threatened Ecosystems throughout Rwanda. The study sites included all 4 provinces of the country. The City of Kigali was excluded as it had no data as far as this work was concerned. The Eastern Province occupies the first place in holding a big number of remnant threatened ecosystems, mainly because of its climatic and ecological uniqueness, but also due to the influence of intense anthropogenic activities around the Akagera National Park.

The objective of the survey was the identification and mapping of remnants of rare and fragile natural terrestrial ecosystems which are not part of protected areas. The ultimate goal was to encourage wise land use decisions that will ensure the continued integrity of these ecosystems.

In this report, each ecosystem is described in terms of its physical and biodiversity features, and the current status of management for each inventoried ecosystems is also provided. From the information acquired from the field investigations, issues relating to priority of conservation using criteria such us goods and services provided by the ecosystem were also addressed, as well as the threats which hang over each of investigated ecosystem. In addition, the suggested measures of setting priorities for the protection of those ecosystems were proposed. Besides, at each inventoried ecosystem a map detailing the variable attributes is attached and the map illustrates the ecosystem units.

CHAPTER 2. RESEARCH METHODOLOGY AND MATERIAL

At present, the availability of the information on threatened ecosystems is limited but, new information technologies make possible the development of more advanced systems of data gathering and analysis which can accurately and regularly inform a variety of users of the status and trends of those ecosystems.

This work was conducted in three main steps:

- Field data collection and sites materialization and
- Data organization and analysis.
- Report write-up

2.1. Data collection and sites characterization

The required data and their availability were inventoried and collected from ministries, public institutions and other relevant sources from different stakeholders to guide the consultant for achieving the first two steps. The study was conducted throughout the country. Different materials and equipments were used: transportation facilities, GPS receivers, Cameras, etc.

2.1.1. GPS DATA COLLECTION

Geographic Information systems have the unique capability to collect information over extensive areas at a repetitive basis, the spatial analysis and the mapping of events in space. GPS techniques were used for geographical coordinates' records. The handheld GPS receivers Garmin 12, Etrex 75, were used during the field data collecting for locating important features in and around the investigated ecosystems. These instruments (GPSs) proved to be strong for different field weather conditions with relative precision. The GPS records were collected using a field data sheet (see Appendix 1).

2.1.2. PHOTOGRAPHS

Photographs were taken using "***professional digital camera"*** **and** a series of pictures were taken for each site, in order to facilitate the visual illustration of site status.

2.1.3. ECOLOGICAL, SOCIAL AND BIODIVERSITY DATA COLLECTION

All ecological parameters were recorded such as the type of ecosystem, the dynamic of the ecosystem, the main threats, climatic parameters, soil and hydrological conditions, etc.

Some remnants ecosystems are still remaining stable because of traditional beliefs while others are exploited for various purposes. That is why it so important to understand social aspects linked to inventoried ecosystems for a sustainable conservation. A questionnaire to be addressed to the local community and considering all social issues was therefore made and completed by direct field observers/surveyors (see appendix I).

In terms of biodiversity richness, a rapid assessment was done for all visited ecosystems to allow understanding of the main components beyond map manufacture. This would likely enhance the capacity of decision makers to take rational decisions in terms of biodiversity conservation.

2.2. Spatial data collection and analysis

2.2.1. SPATIAL DATA COLLECTION AND ORGANIZATION

Global Positioning System (GPS), GARMIN grounds receiver were used to capture and store coordinates of each corner of identified threatened and unprotected terrestrial ecosystem. Satellite microwave radio signals capturing, Location reading and marking in GPS memoire as way points. A booklet of protocol or Tutorial as Guideline was elaborated for recording spatial and non spatial attributes of visited ecosystem and its sub-units.

Captured and saved coordinates were downloaded and transferred to Computer using DN Garmin min-software. Each ecosystem coordinates tables were organized in a simple Spatial Database (SDb) with all descriptive information as illustrated in figure no 2.

FID	X	Y	P	Sec	Ce	Location	Type_of_la	Physical	Dominant_s	Mammals	Birds	Reptiles	Amphibians	Arthro	Eco	Why_does_t
0	55847	974331	E	GA	NY	Forest contou	Forest	Wetland	Ngabikinze,Umugo	Chlorocebus aet	Inyange	Indubi	Frogs		Priv	Forest protected by the state, there are some medecinal plants used by IRST an
1	55841	974342	E	GA	NY	Forest contou	Forest	Wetland	Ngabikinze,Umugo	Chlorocebus aet	Inyange	Indubi	Frogs		Priv	Forest protected by the state, there are some medecinal plants used by IRST an
2	55823	974335	E	GA	NY	Forest contou	Forest	Wetland	Ngabikinze,Umugo	Chlorocebus aet	Inyange	Indubi	Frogs		Priv	Forest protected by the state, there are some medecinal plants used by IRST an
3	55823	974366	E	GA	NY	Forest contou	Forest	Wetland	Ngabikinze,Umugo	Chlorocebus aet	Inyange	Indubi	Frogs		Priv	Forest protected by the state, there are some medecinal plants used by IRST an
4	55788	974435	E	GA	NY	Forest contou	Forest	Wetland	Ngabikinze,Umugo	Chlorocebus aet	Inyange	Indubi	Frogs		Priv	Forest protected by the state, there are some medecinal plants used by IRST an
5	55855	974331	E	GA	NY	Forest contou	Forest	Wetland	Ngabikinze,Umugo	Chlorocebus aet	Inyange	Indubi	Frogs		Priv	Forest protected by the state, there are some medecinal plants used by IRST an
6	55856	974340	E	GA	NY	Forest contou	Forest	Wetland	Ngabikinze,Umugo	Chlorocebus aet	Inyange	Indubi	Frogs		Priv	Forest protected by the state, there are some medecinal plants used by IRST an
7	56085	974882	E	MU		Wetland	Cyperus pap	Wetland	Cyperus papyrus	Chlorocebus aet	Imisambi	Incarwatsi	Frogs		Publ	The draining of that part of the wetland is very difficult, even impossible
8	0	0	E	MU		Wetland	Cyperus pap	Wetland	Cyperus papyrus	Chlorocebus aet	Imisambi	Incarwatsi	Frogs		Publ	The draining of that part of the wetland is very difficult, even impossible
9	0	0	E	MU		Wetland	Cyperus pap	Wetland	Cyperus papyrus	Chlorocebus aet	Imisambi	Incarwatsi	Frogs		Publ	The draining of that part of the wetland is very difficult, even impossible
10	0	0	E	MU		Wetland	Cyperus pap	Wetland	Cyperus papyrus	Chlorocebus aet	Imisambi	Incarwatsi	Frogs		Publ	The draining of that part of the wetland is very difficult, even impossible
11	55664	976688	E	RU	RU	Forest contou	Forest	Hillside	Acacia	Chlorocebus aet	Isandi	Incarwatsi	Frogs	-	Publ	Local administration protection
12	55621	976703	E	RU	RU	Forest contou	Forest	Hillside	Acacia	Chlorocebus aet	Isandi	Incarwatsi	Frogs	-	Publ	Local administration protection
13	55640	976725	E	RU	RU	Forest contou	Forest	Hillside	Acacia	Chlorocebus aet	Isandi	Incarwatsi	Frogs	-	Publ	Local administration protection
14	55664	976713	E	RU	RU	Forest contou	Forest	Hillside	Acacia	Chlorocebus aet	Isandi	Incarwatsi	Frogs	-	Publ	Local administration protection
15	55701	976687	E	RU	RU	Forest contou	Forest	Hillside	Acacia	Chlorocebus aet	Isandi	Incarwatsi	Frogs	-	Publ	Local administration protection
16	55696	976676	E	RU	RU	Forest contou	Forest	Hillside	Acacia	Chlorocebus aet	Isandi	Incarwatsi	Frogs	-	Publ	Local administration protection
17	55758	976624	E	RU	RU	wetland cont	Urukangaga(	Wetland	Urukangaga(Typha	-	-	-	-		Publ	Providing water for irrigation of rice plantationin the down wetland
18	55764	976640	E	RU	RU	wetland cont	Urukangaga(	Wetland	Urukangaga(Typha	-	-	-	-		Publ	Providing water for irrigation of rice plantationin the down wetland
19	55817	976631	E	RU	RU	wetland cont	Urukangaga(	Wetland	Urukangaga(Typha	-	-	-	-		Publ	Providing water for irrigation of rice plantationin the down wetland
20	55826	976617	E	RU	RU	wetland cont	Urukangaga(	Wetland	Urukangaga(Typha	-	-	-	-		Publ	Providing water for irrigation of rice plantationin the down wetland
21	55824	976610	E	RU	RU	wetland cont	Urukangaga(	Wetland	Urukangaga(Typha	-	-	-	-		Publ	Providing water for irrigation of rice plantationin the down wetland
22	58085	977606	E	NDE	KIY	Patch	wooden sav	Depressi	Imishami	Chlorocebus aet	Isandi	Incira	Frogs		Priv	These are the parts of private ranches that have not been exploited
23	58143	977638	E	NDE	KIY	Patch	wooden sav	Depressi	Imishami	Chlorocebus aet	Isandi	Incira	Frogs		Priv	These are the parts of private ranches that have not been exploited
24	0	0	E	NDE	KIY	Patch	wooden sav	Depressi	Imishami	Chlorocebus aet	Isandi	Incira	Frogs		Priv	These are the parts of private ranches that have not been exploited
25	0	0	E	NDE	KIY	Patch	wooden sav	Depressi	Imishami	Chlorocebus aet	Isandi	Incira	Frogs		Priv	These are the parts of private ranches that have not been exploited
26	57572	977830	E	NDE	KIY	inside the for	Forest	Hillside		Antelopes,	Isandi,					

Figure 2: Sample of SDb

2.2.2. SPATIAL DATA ANALYSIS AND OUTPUT VISUALIZATION

The spatial datasets (Shapefiles) were converted in the same spatial referencing system in order to allow further integration and analysis. Using Local projection system for allowing the overlap with others spatial data of the Country (Administrative boundary, drainage network, load network and others geographic layers) and integrated in ArcMap graphical user interface as Points maps, to be used in creating polygon and polyline layers which should have column containing the information on the Area and Perimeter of each investigated ecosystem. Polygon features illustrating the ecosystem extent were also created and displayed in administrative maps of the concerned area.

2.2.3. DATA VISUALIZATION AND PRESENTATION

Mapping and cartographic norms were applied in designing appropriate symbology and scale. Throughout the mapping process, tasks undertaken included data acquisition; processing and visualization are summarized in the figure 3:

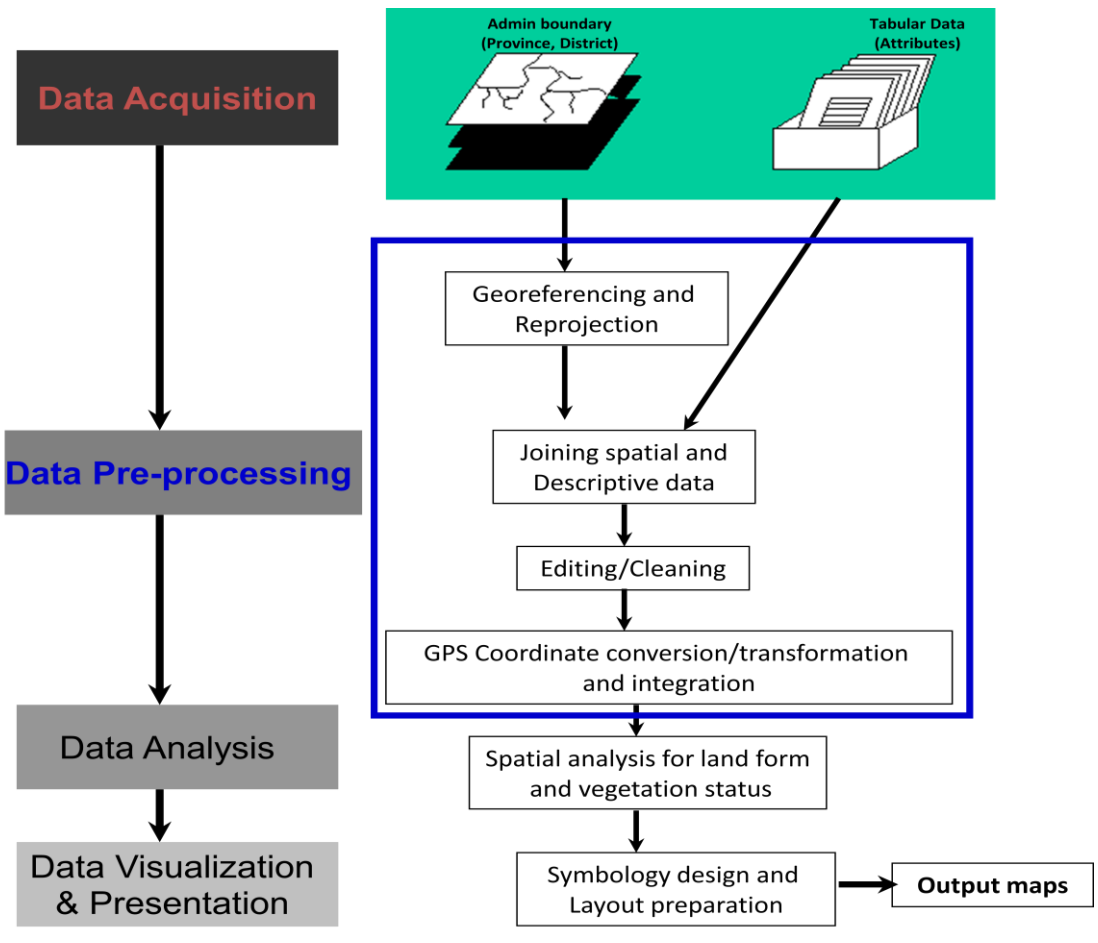


Figure 3: Flowchart of activities to undertake

i. Map scale

Having various size of ecosystem, from 3 to more than 1000 hectares and with different features clusters, it was challenging to keep the some scale for all maps. Bearing in mind that a clear visualization was needed and taking reference on topographic maps with 1/50 000; the scale for our maps was varying from 1/3000 to 1/20 000. That makes all maps being in A3 format.

ii. Symbology

All feature clusters or types were identified and given adequate and homogenized symbols using cartographic rules and ESRI palette. Thus, Forest status or types were clustered in 11 classes with selected symbols as follow:

Nr	Vegetation status	Homogenized cluster	Symbol from ESRI palette
1	Riparian Forest	Riparian forest	Leaf green background color in an Magrove symbol
2	Wooden savannah / dry savannah with trees	Wooden savannah	Olivenite green as background of vineyard
3	Encroached forest by Settlement/ Village/ City /recreation zone	Encroachement of village	Burnt Umber color
4	Closed forest; Dense forest	Closed forest	Fir green
5	Open forest/ secondarized forest	Open forest	Right green
6	Encroached forest by Agriculture, livestock grazing	Encroachment of Agriculture	Open pasture as symbol from main palette
7	Bare soil, cleared area	Bare soil	Cordovan brown
8	Degraded area within the ecosystem by Mining activity	Mining area	Interbedded sand stone and siltone
9	Amashyuza hot spring	Water	Blue color of water from main palette
10	Grassland	Grass land	Lemon grass symbol
11	Shrub	Shrub land	Glacier with Quetzel green

iii. Additional features for detailed description of the area

Where applicable others layers was added or presented as a separate map. Those layers are: socio-economic infrastructures such as roads; biophysical features such as lake, rivers, wetland, etc. In most cases, the land form was treated as a separate topographic map.

iv. Map layouting and exportation

In ArcGIS environment, six gold cartographic rules were respected and all maps were layouted using large scale in A5, A4 and A3 format and exported as jpeg format for being integrated in report. Forest layers in GIS format as shapefile were also handled with the report.

CHAPTER 3. RESULTS

A. WESTERN PROVINCE

3.1. Mukura Natural Forest

Mukura Natural Forest is located in the Western Province. It is extending between, Rutsiro (Mukura and Rusebeya Sectors) and Ngororero (Ndaro and Bwira Sectors) districts, at an elevation value ranging between 2300-2700 m. The mean of annual rain fall in regions around Mukura Forest is estimated at 1500 mm, while the mean annual temperature is estimated to be 15^{o} C. Mukura Natural Forest was established as natural reserve in 1951 with a total area of 3,000 ha. The forest is surrounded by agriculture lands, private pine plantations, scattered pine plantation as buffer zone, and other physical features such as rivers and roads.

As pointed out by local people, this forest used to be managed by white people (Maurice in 1960s and Agnes from 1970s until in 1990s). Subject to intense human pressure over the years in the form of agriculture encroachment, illegal cutting, grazing and more recently amputation of its part for resettlement (150 families were settled in the zone previously occupied by the forest), Mukura has been reduced to a series of small disjointed forest relicts in remote valleys and on steep slopes that are difficult to access. Consequently, many of Mukura's previously important flora and fauna, particularly birds, have disappeared. Since its establishment in 1951 until 1990s, the area occupied by Mukura was intact (2000 ha). During the 1994 genocide against the Tutsi and the associated aftermath such as the resettlement of the returned refugees, Mukura forest was so much jeopardized and about 20.15% of its size was lost. The current estimated area occupied by the forest is around 1597 ha.

Photo 1: Mukura Forest Reserve: settlements and farmlands in one side of the former forested area

Mukura Forest is a habitat of diversified flora represented by all vegetation layers. The predominant species are among others, *Psychotria mahonii, Macaranga kilimanscharica, Psydrax parviflora, Syzygium guineense, Rytiginia kigeziensis, Neoboutonia macrocalyx, Rapanea melanophroides, Xymalos monospora, Peddiea rapaneoides Galiniera saxifraga, Vernonia lasiopsis Chassalia subchreata, Hagenia abyssinica, Maesa lanceolata, Olinia rochitiana, Symphonia globulifera Dracaena afromontana, Maytenus acuminata* and *Vernonia kirungae*.

In terms of fauna, the forest possesses the common mammal species including *Funisciurus pyrrhopus*, *Heliosciurus ruwenzorii*, *Thryonomys swinderianus Canus mesomeras* and *Herpestes urv*a. The most common bird species are *Tauraco johnstoni, Apalis personata*, *Cinnyris regia, Zoothera tanganjicae, Bradypterus graueri, Parus fasciiventer Colius leucocephalus*, *Francolinus nobilis*, *Macronyx croceus* and Injongo [rare species]). In addition, the forest shelters various reptiles including the most known snakes called *Bitis arietans*.

Mukura forest is also the reserve of water, medicinal plants and a source of firewood to the local people. It plays a big a role of local water catchment, because a great number of rivers take their source either in it or its immediate surroundings. The main permanent

springs and streams having the source in Mukura Natural Forest are Ntaruko, Ndaba and Rutanzongera to name a few. However, with the disappearance of some parts of the forest,, many of these springs have apparently become seasonal. Mukura forest also acts as a sponge, absorbing excess water and preventing runoff and erosion, and then stabilizing agriculture in surrounding areas. Equally, Mukura forest is rich in wildlife and ecologically important for people living nearby in particular and for the whole country in general.

Despite legal distribution of farming land authorized by the Government, encroachment of the forest continues to reduce the size of the reserve by conversion of natural forest into agriculture land, livestock grazing in and around the forest.

Photo 2: Agricultural and pastoral activities close to Mukura Forest Reserve

Other illegal activities such as firewood collection, honey gathering, tree felling, snare and mining are also threatening the forest integrity at a great extent. It was remarked that the unauthorized mining is ranked on the top of all mentioned menaces. Indeed, Mukura forest is renowned to be rich in mines especially cassiterite and columbite-tantalite. Local people used to enter the forest for looking for mines so that they can sell them to a mining company known as RAP. Despite the effort of the authorities of suspending temporally the mining activities, these illegal activities are still experienced. As pointed out by the officer of NAFA in Mukura Sector, people are often captured in the forest. They are handed over to authorities but, they are inexplicably released after. Even during our survey, four people were caught in *flagrante delicto*.

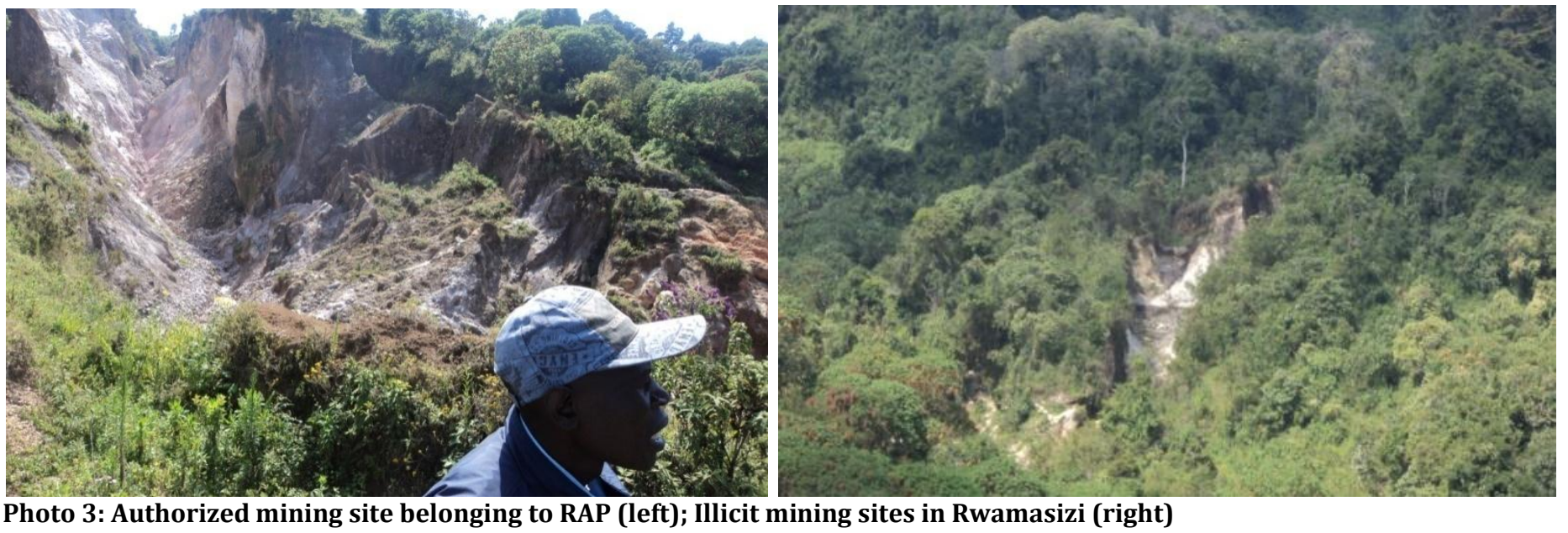


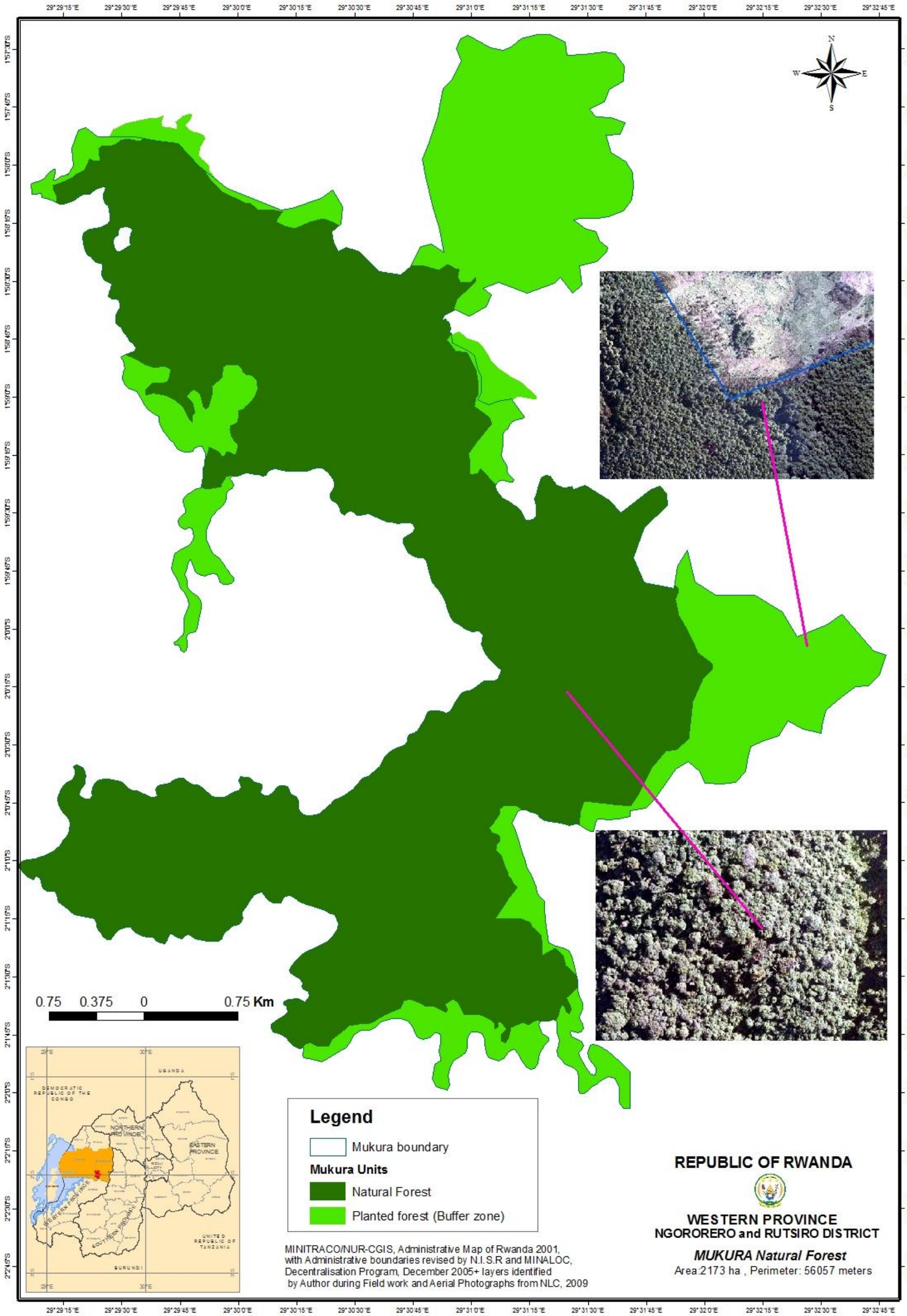
Photo 3: Authorized mining site belonging to RAP (left); Illicit mining sites in Rwamasizi (right)

Mukura Forest faces many and heavy threats that need appropriate measures for its protection. This requires an integral approach from the surrounding communities, the local Government, NGOs and other stakeholders involved in conservation and development. It was observed that the proposed measures for forest protection are not sustainable. For instance, the demarcation features put in place by ARECO RWANDA NZIZA, a local NGO working in environment domain, were uprooted in some areas. Therefore, this rebellious behavior

should be hindered by adequate measures such as the establishment of tough pillars, fences and long-lasting buffer zone in order to limit the accelerated encroachment.

As part of the conservation endeavors, NAFA helps a lot in the protection of the ecosystem in collaboration of local people and military defense. Furthermore, ARECO RWANDA NZIZA has set up the boundary stones around the forest and contributed in the establishment of the buffer zone to limit the encroachment. ARECO RWANDA NZIZA has also elaborated some projects of modern bee farming and craft making outside the forest for local youth and women as an alternative income generating activity, in order to reduce pressure on the forest. For the need of forest restitution, some *Eucalyptus sp* were planted to replace the lost parches within the forest. This is a good initiative but potentially unsustainable, given that *Eucalyptus sp* could cause other challenges of invasiveness in the future.

In order to strengthen these undertaken protection measures, some strategies should be developed for emergency activities such as resettlement of refugees in order to limit the impacts of resettlement on the environment. With the intention of mitigating the effects of illegal activities in Mukura Natural Forest, more effort should be put on increasing the awareness and sensitization of the local communities about the importance of protecting this ecosystem.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NORTHERN PROVINCE
EASTERN PROVINCE
KIGALI CITY
WESTERN PROVINCE
SOUTHERN PROVINCE
UNITED REPUBLIC OF TANZANIA
BURUNDI
Legend
Mukura boundary
Mukura Units
Natural Forest
Planted forest (Buffer zone)
MINITRACO/NUR-CGIS, Administrative Map of Rwanda 2001,
with Administrative boundaries revised by N.I.S.R and MINALOC,
Decentralisation Program, December 2005+ layers identified
by Author during Field work and Aerial Photographs from NLC, 2009
REPUBLIC OF RWANDA
WESTERN PROVINCE
NGORORERO and RUTSIRO DISTRICT
MUKURA Natural Forest
Area:2173 ha , Perimeter: 56057 meters

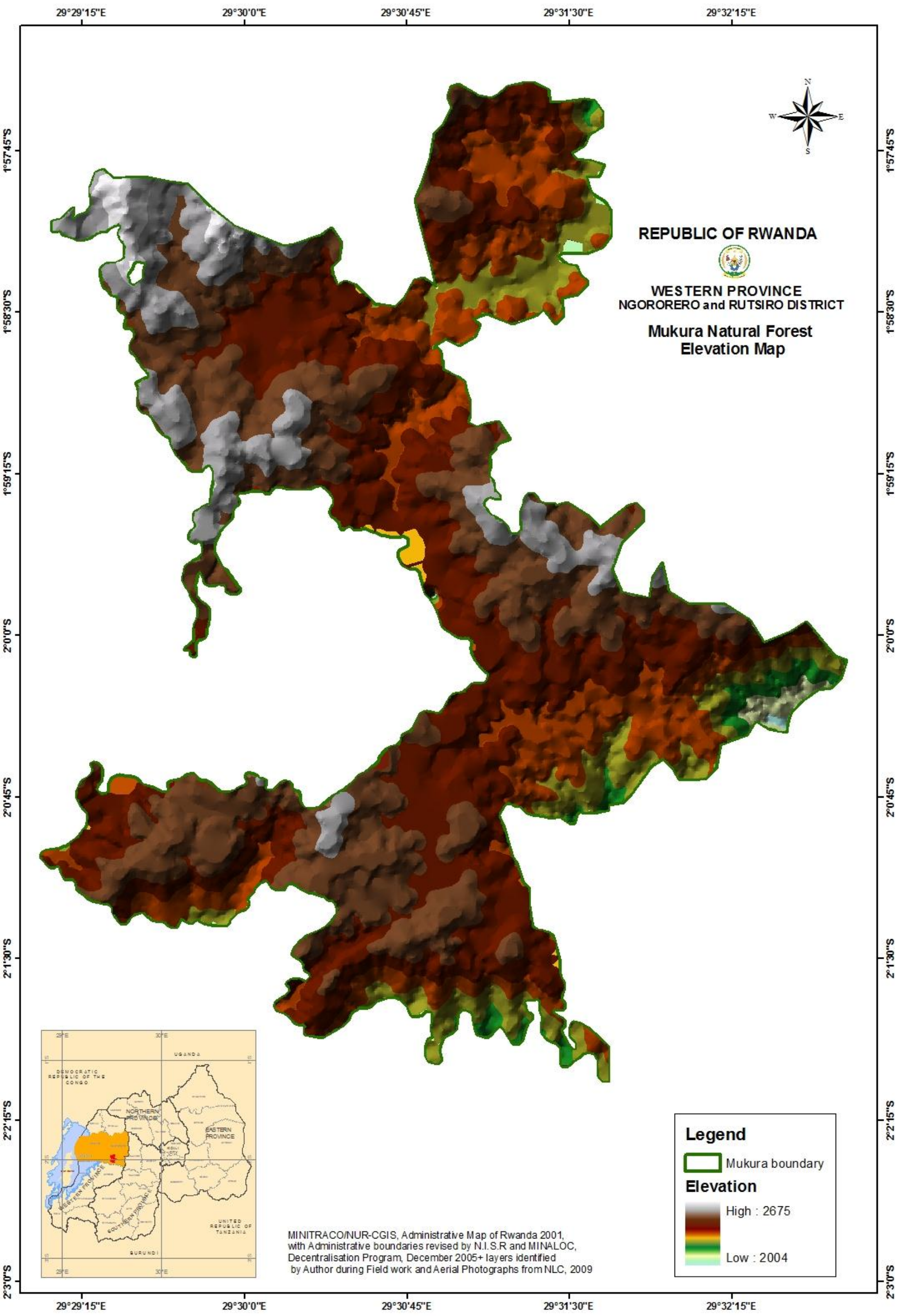

Figure 4: Mukura Natural Forest

3.2. Nyabitukura Natural Forest

Nyabitukura, also known as Sanza forest, is a relict forest located in the Western Province, Ngororero District, Muhororo Sector, Sanza Cell and Nyagisagara village (in the former Kibirira commune of Gisenyi Prefecture). The forest is perched on the hill of Uwintobo between 1600 and 1950 m of altitude and is skirted downwards by the Satinsyi River. Nyabitukura was much degraded by anthropogenic activities including wood cuts, illicit farming and pastures, illicit mining, etc. The most invaded area by illicit mining activities (mainly cassiterite and coltan mining) is the central part of the forest.

Photo 4: Nyabitukura forest

In terms of biodiversity, the most common tree species are *Syzygium parvifolium, Macaranga kilimandscharica*, *Pittosporum mildbraedii, Myrica kandtiana, Dodonea viscosa, Psychotria mahonii, Polyscias fulva, Neoboutonia macrocalyx, Myrianthus holstii*, *Galiniera saxifraga, Rhus vulgaris* and *Albizia gummifera* (close to the river) and some exotic species such as *Alnus glutinosa, Pinus patula, Grevillea robusta* and *Eucalyptus div. sp.* which makes the belt of this forest over a width of about 10 m. Some characteristic species of a secondary forest are also frequent. This is the case of *Maesa lanceolata, Xymalos monospora.* The understorey and herbaceous layers comprise *Acanthus pubescens, Clerodendrum rotundifolium, Sericostachys scandens, Eragrostis racemosa,* ….

The animal diversity is very low, as no mammals and no reptiles are known to live in that forest. This was also confirmed by local people. We assume, even though, that some amphibians could be only found near Satinsyi River. However, some common birds were observed (*Scopus umbretta)*.

Nyabitukura Forest is a source of firewood, medicinal plants, edible fruits and honey for local communities. In addition, the forest provides other ecological services such as water catchment, given that many water streams take source from this forest. The forest also contributes in protecting Satinsyi River. Nyabitukura could be considered as natural laboratory for scientific research as there is no study conducted on its flora and fauna.

The main threat of Nyabitukura forest is the illegal mining of columbite-tantalite conducted in its central part. This activity stretches up outwards and violates the forest integrity. The investigations revealed that the mining activity started many years ago, in the 1930's. From that period, MINETE had the right of exploiting the site, and later on the right was handed to SOMIRWA until 1994. Between 1995 and 1997, REDEMI was exploiting the site, and after it the mining had officially stopped. Nevertheless, local people are still anarchically invading this forest, and this is leading to the destruction of the forest biodiversity.

Photo 5: Recent (left) and former mining sites (right)

As Uwintobo hill is rich in water streams, the people involved in these mining activities deflect stream channels in order to feed the mining sites. Many holes dug inside the forest for canalizations also deteriorate the forest biodiversity. In addition to mining and tree cutting, people invade this forest for honey gathering as stipulated by local people and by direct observations. Another serious threat to Nyabitukura Forest is the encroachment by local farmers who have the field crops near the forest. The present buffer zone is seemingly violated, and many clearings are visible within it.

For the safety of Nyabitukura ecosystem, appropriate and solemn measures should be taken by the local authorities in charge of its management. Although a big step was achieved such as establishment of a buffer zone to fight against agricultural encroachment, it is obvious that Nyabitukura forest management is not yet adequate enough. This buffer zone should be reinforced, and the mining activities should be fully stopped for ecosystem and biodiversity conservation purposes. However, it is important to note that the smallness of this forest, the acidification of the substrate and the pressure of the population in search of land and mining make its conservation crucial.

According to the information provided by the environment and forest officers of Muhororo Sector, the current management of Nyabitukura forest is assured by the local administration at sector and district levels. Some government and private projects also are contributing to the preservation of the forest. Typical example is the establishment of the buffer zone of *Alnus glutinosa* by PAFOR in 2007. These efforts should be supported for preserving this valuable ecosystem.

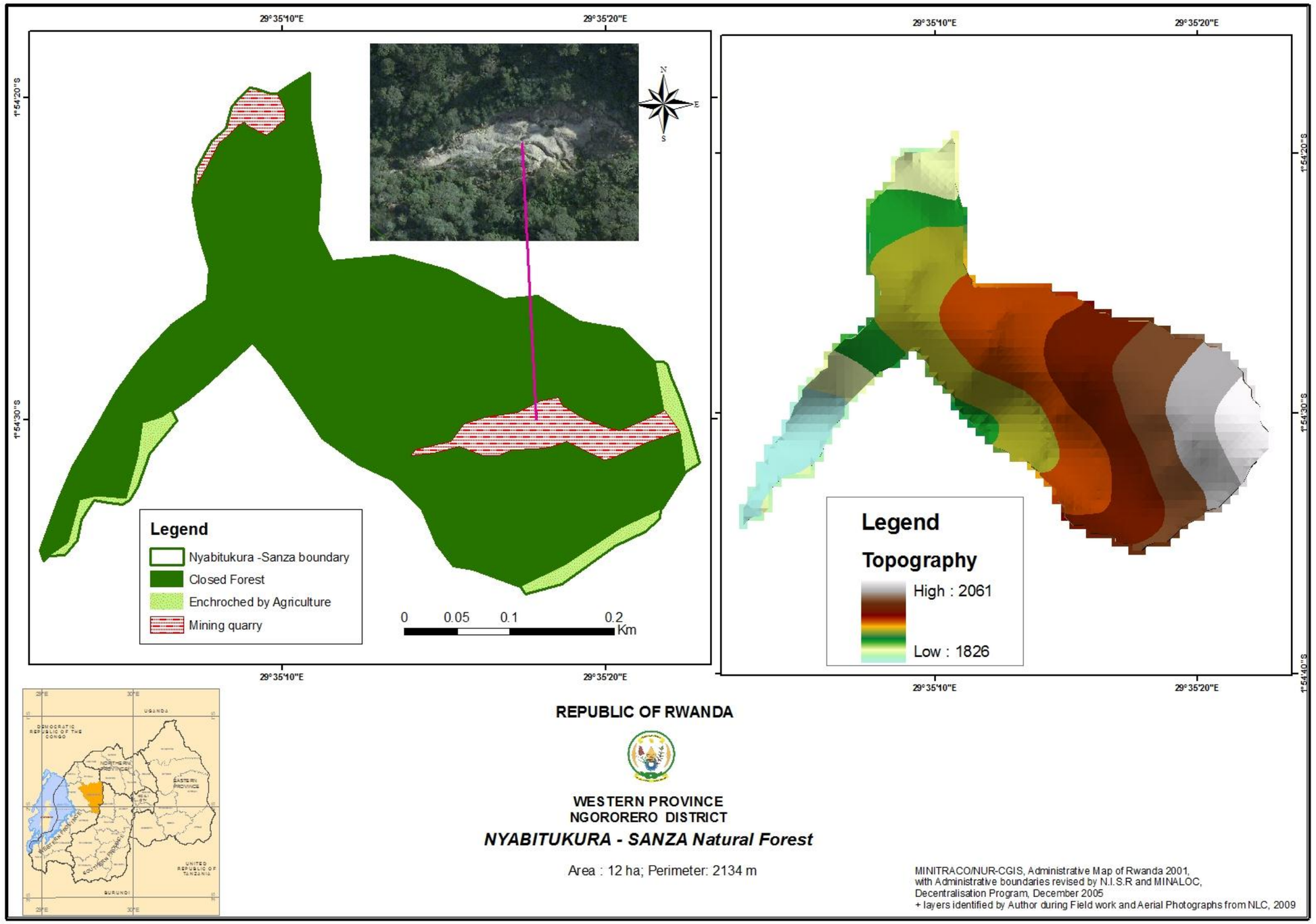

Figure 5: Nyabitukura Natural Forest

3.3. Shagasha Natural Forest

This ecosystem is a montane forest covering an area of 6 ha at an altitude of 1950m. It is located in a depression encompassed in tea plantations near Shagasha Tea Factory, in Rusizi District, Giheke Sector and Shagasha Cell. It is a secondary forest dominated by tree species such as *Macaranga kilimandscharica* and *Maesa lanceolata.* Some primary tree species are still visible especially along the stream crossing the forest. This is the case for of *Newtonia buchannani* and *Strombosia scheffleri.* The forest belongs to Shagasha tea farmers' cooperative (COOPTHE-SHAGASHA) and it has been protected because it harbors the water sources that supply almost 100% of the water used in the factory.

Photo 6: A part view of Shagasha Natural Forest

Shagasha Forest is also characterized by native tree species such as *Syzygium guineense, Albizia gummifera, Dichaetanthera corymbosa, Anthocleista grandiflora*, etc. on which are pending several epiphytes like orchids, mosses, ferns and lichens. Despite its smallness, Shagasha forest is very similar to Nyungwe forest on its western part and looks like very rich in terms of plant diversity. Besides this richness, this small forest contains also some endangered species like *Cercopithecus l'hoesti*, also found in the Eastern side of Nyungwe forest. According to local communities, it has been reported that there is also a small population of *Cercopthecus dogetii* in that forest. These primates are very isolated from other groups found in Nyungwe forest and need special attention for their protection to avoid genetic drift. As Shagasha Forest is a small and isolated forest, it is also necessary to make a special attention to its carrying capacity in relation with the growth rate of the primates having their ecological niche in it. Therefore, there is a need for further studies aiming strategies and priorities of conservation of that forest.

The centre part of the forest is occupied by a swamp considered as location of water source. Due to shortage of agricultural land, people started cultivating the northern part of the central swamp; which would, at the end, clog up the water sources and jeopardize the ecological benefit of the forest. Hence, protection measures are needed in order to stop those agricultural activities practiced in the central swamp. In addition, both plant and animal diversities need further inventory for better documentation.

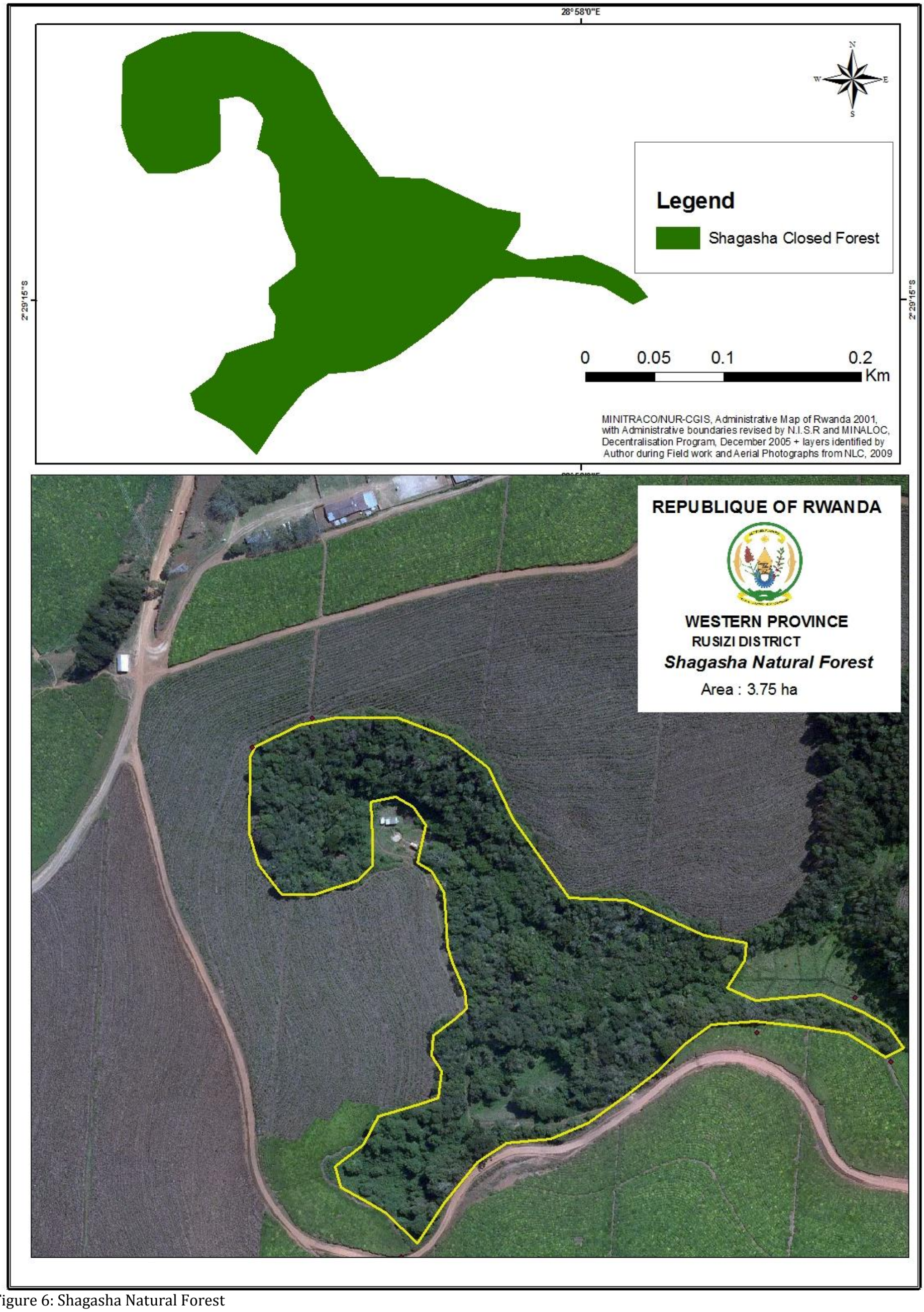

Figure 6: Shagasha Natural Forest

3.4. Mashyuza Natural Forest

Mashyuza Forest is a patch of approximately 6 ha of natural tree and shrub species covering a hillside above the extent of the famed Bugarama geothermal water sources (commonly known as Amashyuza). It is located in Rusizi District, Nyakabuye Sector, at an elevation varying between 1181m and 1213m. The soil of Mashyuza Forest is humid at the south-western part of the hillside. The remaining parts of the forest cover a stony, sandy and fairly dry black soil. The east-southern side of the hill harbors the source of geothermal water whose natural heat is slightly above 60^0C. In the north, there are cassava plantations. Mashyuza is considered by local people as containing healing properties that can treat fracture and bodily fatigue. In the northern part of the forest, mining quarry site providing the raw materials for the local cement factory, (CIMERWA Ltd). In the west-southern area, there are gardens laid out by CIMERWA Ltd for amenity purposes.

Photo 7: Mining site of CIMERWA Ltd. above Mashyuza forest

Mashyuza Forest is a small ecosystem protecting several sources of water feeding the large and hot spring zones. The partial forest removal on the western part has caused hot spring withdraw. Mashyuza Forest is likely useful for water retention. The forest is composed by two parts: hill side which remain almost intact and the flooding plain severely disturbed. That forest has survived mainly because it has been protected by CIMERWA Ltd. Its hill side is stony and cannot be cultivated whereas the flooding plain has been almost destroyed. Some *Ficus* trees remain scattered in the flooding zone because religious rituals are associated to them.

Mashyuza Forest is dominated by *Anthocleista schweinfurtii, Bridelia micrantha* and *Entada abyssinica* covered by dense liana on the hill side. In the flooding seasonal, some remnant forests can be observed mainly dominated by *Ficus sycomorus* and *Sterculia tragacantha.* The latter species is a rare species in Rwanda and is only found in Mashyuza Natural Forest.

Photo 8: Mashyuza forest on hill side (left); *Sterculia tragacantha* tree (right)

Besides *Ficus* trees, some orchids can be observed in the forest such as *Aerangis kotschyana* considered as a savannas and dry forests orchid. Downstream to Mashyuza hot spring, a rare and local endemic plant is represented by small population (less than ten individuals) and deserves high priority of conservation in situ or ex-situ. This rare species is known under the name of *Nymphaea thermarum*.

Photo 9: *Aerangis kotschyana*(left); *Nymphaea thermarum* (middle and right)

Furthermore, MASHYUZA forest is home to a great number of animals such as small mammals, doves, crested birds and a lot of snakes. It is also home to big lizards such as *Varanus niloticus*.

Beyond agriculture encroachment, the main threat to Mashyuza Forest comes from *Lantana camara* invasion. Two patches at East and West parts are thus invaded and dominated by the abovementioned invasive plant which is appearing as a closed bush. Most of species met on these two parts of the forest seem to be an indicator of disturbance. This is due to the influence and pressure induced by the bordering crop fields and mining sites.

Due to the forest scarcity of in this region, the query of firewood is a potential cause that can induce people in deforestation. The following protection measures are suggested for this ecosystem conservation:

- Stopping cultivating and digging the mining quarry in close areas surroundings the forest;
- Expanding the forest by restoring its former size;
- Eliminating the exotic species which are scattered at the periphery of the forest.

Even though threats to Mashyuza Natural Forest are invading its integrity, the opportunity of Mashyuza forest restoration could be implemented. As CIMERWA, Ltd has fenced a significant perimeter, it is possible to restore that ecosystem with native plants mainly *Ficus* and *Sterculia tragacantha* given that these species are faster growing and the restoration could not take more that five years

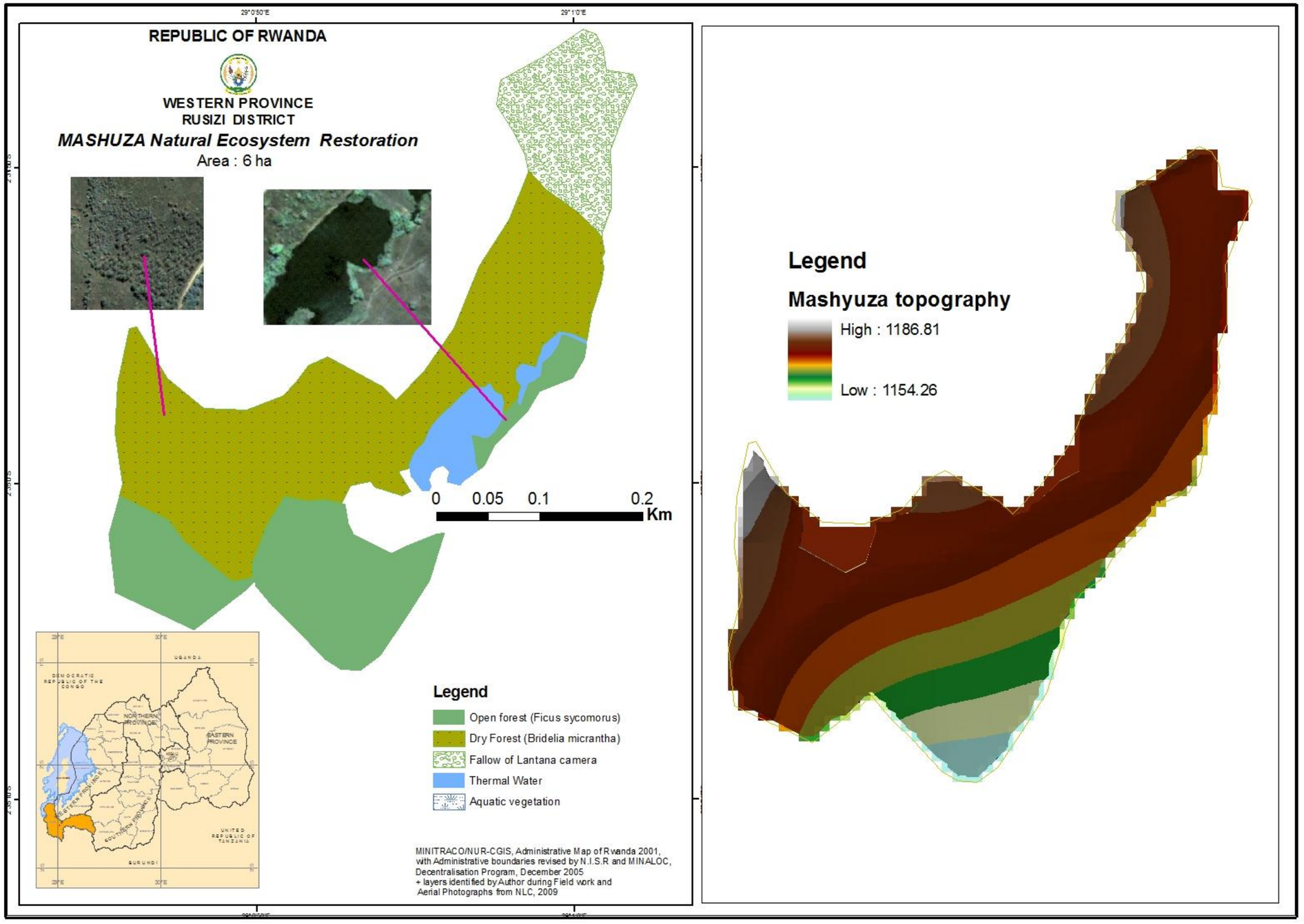

Figure 7: Mashyuza Natural Forest

3.5. Kumbya Peninsula

KUMBYA is a peninsula in Lake Kivu and harbors a natural forest of about 6 ha, on a black, sandy and stony soil. It is located in Nyamasheke District, Kanjongo Sector, Kigoya Cell, at an elevation of 1465-1487m. The Western part of Kumbya is located in Kirehe Island while the eastern side is linked to the mainland by a narrow portion of land.

Kumbya peninsula is owned by Methodist church. This peninsula was entrusted to Methodist missionaries since 1944. From that time, the Methodist continued to manage Kumbya, and it was given a status of a "retreat center" as several people visit the place frequently for retreat due to its quietness and beauty sight of Kivu Lake.

It is a peninsula dominated by bush and forest vegetations. The main characteristic of the forest is the presence of *Phoenix reclinata* palms mixed with impenetrable vegetation dominated by *Rhoicissus revoilii* and *Rhus natalensis* on the shoreline of the peninsula. Some terrestrial orchids can be observed closer to the shore but cannot be identified because they were not in their flowering stage during this survey.

Some zones of the shore, on rocky areas, no other plant can grow there unless *Ficus cyathistipulata* making closed canopy above the the lake. This *Ficus* produces fruits favored by many birds occurring in that area. Kumbya peninsula is also home of water birds species. It is the case of *Phalacrocorax carbo*, *Ceryle rudis, Nettapus auriatus* and *Ispidina picta*.

Photo 10: *Phoenix reclinata* (left); *Ispidina picta* (right)

In sum, Kumbya forest can be considered as a very good reservoir of birds using at once the forest for nesting and Kivu water for feeding and resting. It is privileged area for birds watching.

However, like many other remnant terrestrial ecosystems in Rwanda, Kumbya forest does not lack threats. Most of the retreat houses are built in the central part of the forest. This means that there is an impact due to various human activities from local people and visitors as well as encroachment, as long as some activities such as agriculture are also done within the ecosystem. Moreover, the abundance of species like *Microglossa pyrifolia* is an indicator of great disturbance

For a better management of this forest, it is suggested that there should be a regulation about the presence of retreating people so to prevent influence of side anthropogenic influence on biodiversity. It is also important to make a full inventory of the peninsula's biodiversity so as to know what should conserved and protected and develop appropriate conservation strategies.

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REPUBLIC OF RWANDA

WESTERN PROVINCE
NYAMASHEKE DISTRICT

KUMBYA Natural Forest

Area : 10 ha; Perimeter: 2881 m

0 0.05 0.1 0.2 Km

Legend

- Bare and Build up Area
- Closed Forest

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MINITRACO/NUR-CGIS, Administrative Map of Rwanda 2001,
with Administrative boundaries revised by N.I.S.R and MINALOC,
Decentralisation Program, December 2005

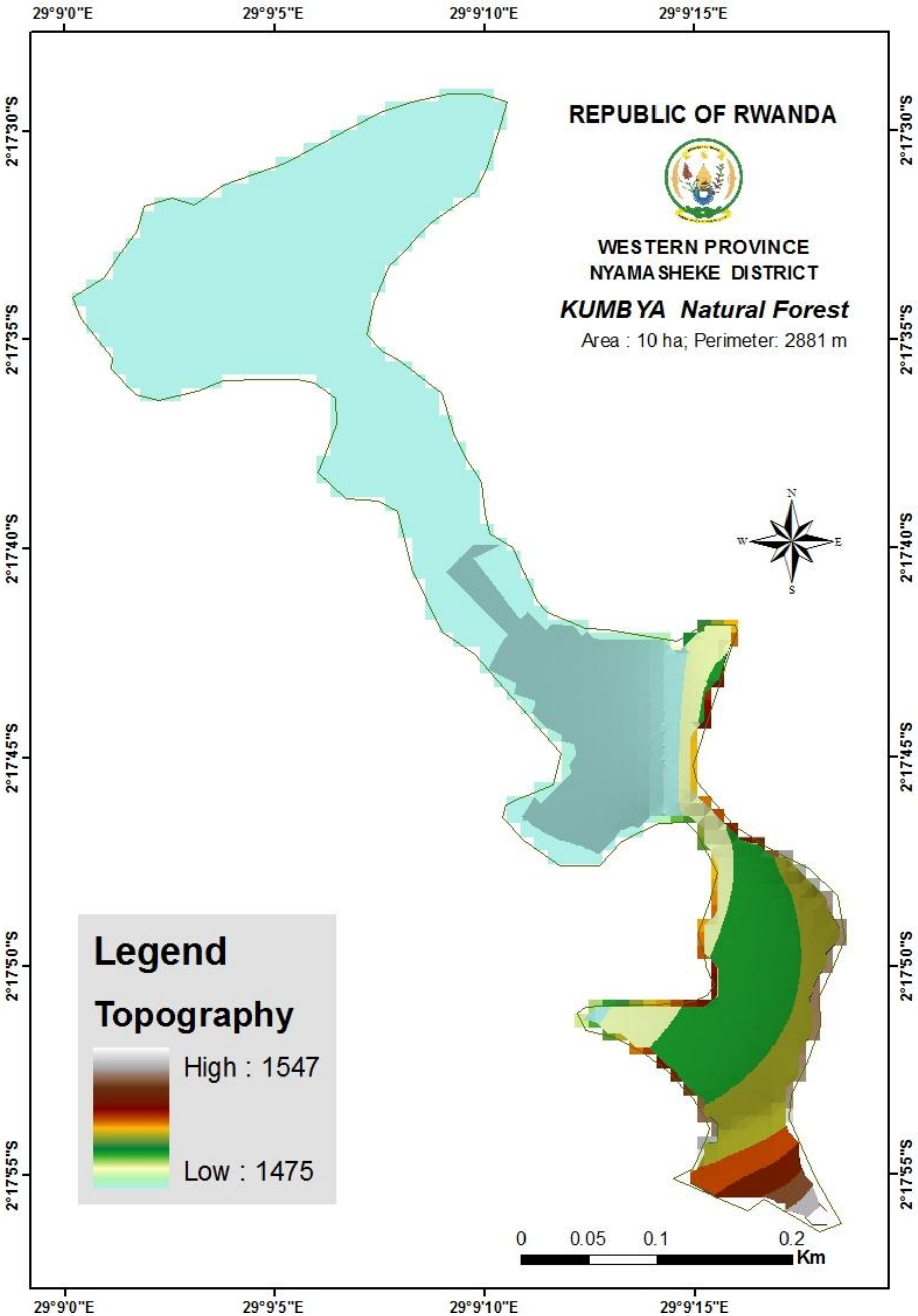


Figure 8: Kumbya Natural Forest

3.6. Ntendezi Natural Forest

This ecosystem is a regenerating riparian forest on two hillsides of about 4 ha at an altitude of 1580m, located approximately at five meters (5m) from the paved road along a stream called Cyongoroka in Nyamasheke District, Ruharambuga Sector, Kamabuye Cell. It is a disturbed forest dominated by shrubs of *Harungana madagascariensis*. Some patches made by mountain forest are visible especially along the stream. It is much degraded ecosystem due mainly to human activities consisting in tree felling and agriculture encroachment.

Ntendezi forest is owned by ISAR Ntendezi which assures its management. However, no special management of the forest is known. The forest is only preserved from cultivation by local community and can expand if the actual situation is maintained.

The predominant tree species in this ecosystem are *Bridelia brideliifolia* and *Anthocleista schweinfurtii* surrounded by dense vegetation of *Harungana madagascariensis* and *Acanthus pubescens*; the latter being an indicator of disturbance. This forest is poor in animal species.

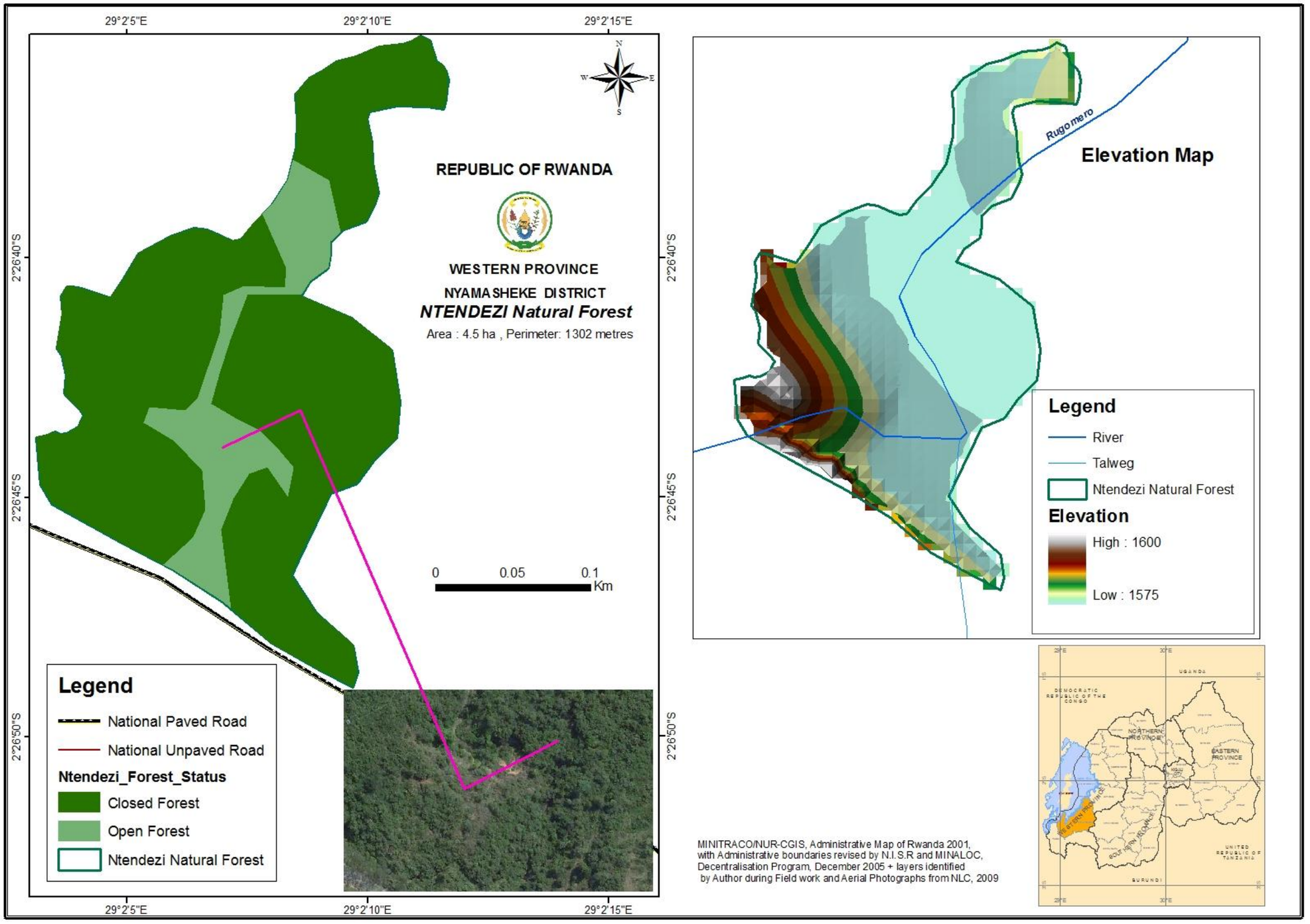


Figure 9: Ntendezi Natural Forest

B. NORTHERN PROVINCE

3.7. Buhanga Natural Forest

The remnant forest of Buhanga also called Gihondohondo is located in Northern Province at 7 km from Musanze District administrative center. It is a site of depression tectonics, originally corresponding to the former Nyabarongo Valley and is bounded on the East by Bugarura Sector and on west by the escarpment fault of Buhoma (Nyabihu District).

Buhanga relict forest is a secondary forest composed of a rich biodiversity. The vegetation climax calls back to the vegetation in Mukura Forest Reserve, Nyungwe and Volcanoes National parks. The vegetation is dominated by *Ficus* trees associated with *Dracaena steudneri.* The presence of non indigenous and crop trees like *Eucalyptus maidenii, Cupressus sp., Persea americana, Grevillea robusta, Pennissetum purpureum* are indicators of human activity in Buhanga for many years.

Some plant species of *Ficus divsp, Dracaena steudneri, Rhus vulgaris and Rhus natalensi*s, … provide fruits that Buhanga has became a souhaitable habitat of insects and birds. Other available plant species are *Elatostema monticola*, *Impatiens burtonii var.burtonii, Leucas deflexa, Parietaria debilis*, *Ranunculus bequaertii*, *Rumex bequartii*, *Pentas lanceolata*, *Pentas zanzibarica var. rubra*, *Smithia elliotii var. elliotii***,** etc.

The oviparous fauna is impressive in its variety. Some animal species threatened with extinction appear from time to time in this ecosystem. Such include the porcupine, the jackal, the partridge, and leopard. For Mammals, dominant species are the Porcupine (*Hystrix africae australis*) and Rock Hyrax (*Procavia johnstoni)*.

Bird species of Accipitridae, Nectariniidae, Hirundidae, Picidae, Ploceidea and Turdidae families are abundant. Two migratory species, African Pitta (*Pitta angolensis*) and Wahlberg's Eagle (*Aquila wahlbergi*) and four species endemic to the Albertine Rift, three of them species of Nectariniidae Family, were recorded.

Photo 11: *Pitta angolensis* (left); *Aquila wahlbergi* (right)

The main habitat of birds Buhanga is constituted by big and tall trees, shrubs and undergrounds. Big and high trees include species of *Ficus*, *Erythrina* and alien species like Eucalyptus, Cypress and *Grevillea robusta* mainly found around the forest in cultivation land.

For reasons of culture or adherence to the traditions, Gihondohondo has not yet been cleared but its borders are threatened today. The site is marked by the presence of giant *Ficus sp* and old houses used as places of spiritual investiture for the various monarchs of

Rwanda. The monarchs were required to make the pilgrimage before they took office. It is said that the forest is home to a snake (*Python*) with extraordinary power. This snake is a spiritual guardian of the place and sometimes it blocks the road to any unwanted incursion. Local people have long revered this sacred place so far and ensure its ecological integrity.

This forest should promoted and be subjected to well defined status of conservation. In fact, the rational exploitation of tourism in Rwanda is an economic imperative for the country's development. Despite the immense tourism potential, the tourism industry in Rwanda is limited in its operation to visit national parks. It is therefore a monotone tourism product that could become an ephemeral face of modern tourism; increasingly demanding in visitors' tastes and cultural aspirations and scientists.

With its touristic assets, Buhanga mini Park presents natural and cultural opportunities for the promotion of scientific cultural and ecological tourism. It is with a greatest originality by the fact that it is seen by history and folk traditions as the cradle of Rwandan civilization.

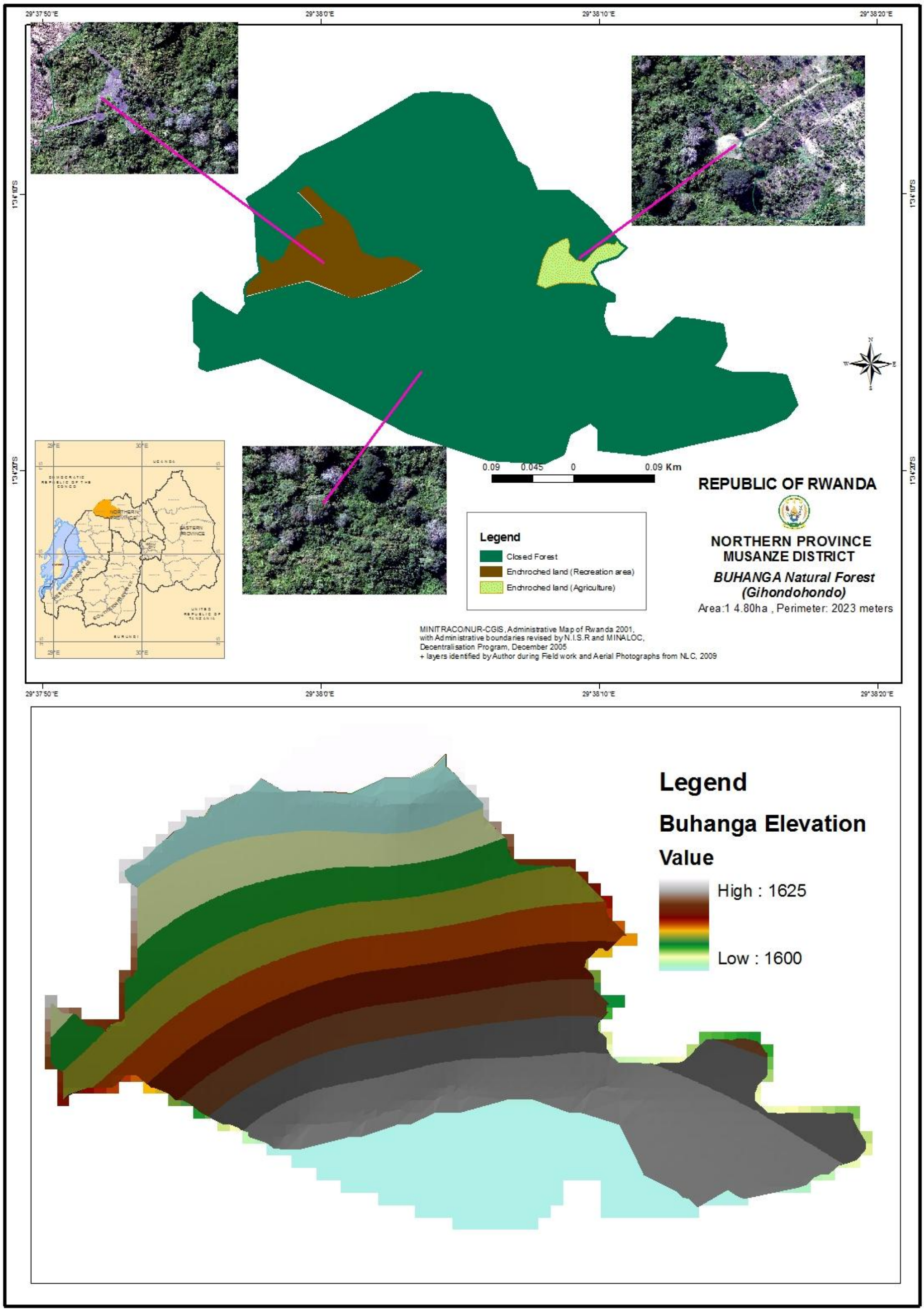


Figure 10: Buhanga Natural Forest

C. EASTERN PROVINCE

Fragmentation is a widespread phenomenon that almost invariably associated with frontier expansion in both tropical and temperate regions (Harris, 1984). It is known that fragmentation is more problematic in areas with extensive and rapid land use change due mainly to agriculture under the tropics and where protected area networks underrepresent natural landscape heterogeneity.

For the case of Eastern Province, the main landscape was initially dominated by savannas. Very recently, a very large part of that landscape has been converted to agriculture and husbandry farms. The most destructive land use type remains conversion to agriculture while husbandry farms can allow persistence of some forms of biodiversity. In fact, after the 1990s liberation war and the 1994 genocide against the Tutsi, much of the land of the Akagera National Park was allocated as farms and settled by former refugees. Some of those farms were cultivated or transformed in husbandry, but others still manifest some features of the Park to which they belonged. Nevertheless, they are scattered and belong to private people who make use of them for different purposes, and we excluded them from the report. Those ecosystems are Cyunuzi forest, Kiyovu ranches, Mpanga ranches, Nyamugali–Nyakabingo forest and Kiyanzi forest.

3.8. Ibanda-Makera Natural Forest

This remnant forest is located in the depression of the Akagera River in Eastern Province, Kirehe District, Mpanga sector, Nasho cell. It is a gallery forest associated with woodland and savannah in the East and papyrus swamp in the South. Ibanda-Makera gallery forest is crossed by a stream (Nyamporogoma) which makes this forest a water catchment for local people. The forest has been under high human pressure and consequently is degraded with large areas of bush, thicket and woodland. Only a small remnant mature forest patch still exists. The South of Ibanda-Makera is contiguous with the papyrus swamp which extends to the Akagera River.

Photo 12: Ibanda_Makera gallery forest

Regarding plants, Ibanda-Makera gallery forest is mostly dominated by *Vepris nobilis*, *Ficus vallis-choudae, Dracaena afromontana, Markhamia lutea*, *Bridelia micrantha*, *Allophylus africanus, Phoenix reclinata, Grewia trichocarpa, Lagenaria abyssinica, Paullinia pinnata*, *Tacazzea apiculata.* The more central portion is a swamp dominated by *Cyperus papyrus.* The edge of the forest contains a combination of *Crossopteryx febrifuga* and *Securidaca longepedunculata*,.

The growth of Orchid species in Makera: *Eulophia guinensis, Platylepis glandulosa* and *Cytorkis aquata* indicates that the forest remains less disturbed. Other species are *Platylepis glandulosa* and *Malaxis weberbaneriana.*

Given that this forest is located along the Akagera River, aquatic wildlife is well represented. The species of *Hippopotamus amphibius, Hylochoerus meinertzhageni, Potamochoerus porcus* and *Felis aurata* were reported to be found. Primates are also visible: *Papio anubis, Cercopithecus miti* as well as many snakes.

Regarding birds, the most significance record is a rare Purple-banded Sunbird (*Cinnyris bifasciatus)*. Different migratory bird species were also recorded i.e. *Campephaga flava*, *Oxylophus levaillantii* and *Cuculus solitaries, Ceuthmochares, Acrocephalus scirpaceus* and *Merops apiaster.*

Photo 13: *Cinnyris bifasciatus* (left above and below); *Merops apiaster* (right)

The importance of Ibanda Makera forest is that it contains many endemic and rare species. Added to this is the fact that many of these species are used in traditional medicine essentially *Blighia unijugata, Grewia forbesii, Rhus vulgaris*, *Ficus acuta* and *Ficus thoningii*.

This forest gallery used to be home to different species of mammals, including big mammals. Nowadays, illegal activities such as poaching, grazing, medicinal plant collection and wood cutting for different uses especially for firewood and cultivation constitute the major threats to those species whose the number is declining. In addition, the fact that Makera forest is surrounded by agricultural lands has led to many trails being made inside the forest. The high human presence inside the forest has resulted in increased levels of threats to the biodiversity of this ecosystem. Therefore, appropriate measures should be taken in terms of establishing a buffer zone to stop encroachment, and a legal framework should be developed to prevent and hinder illegal activities.

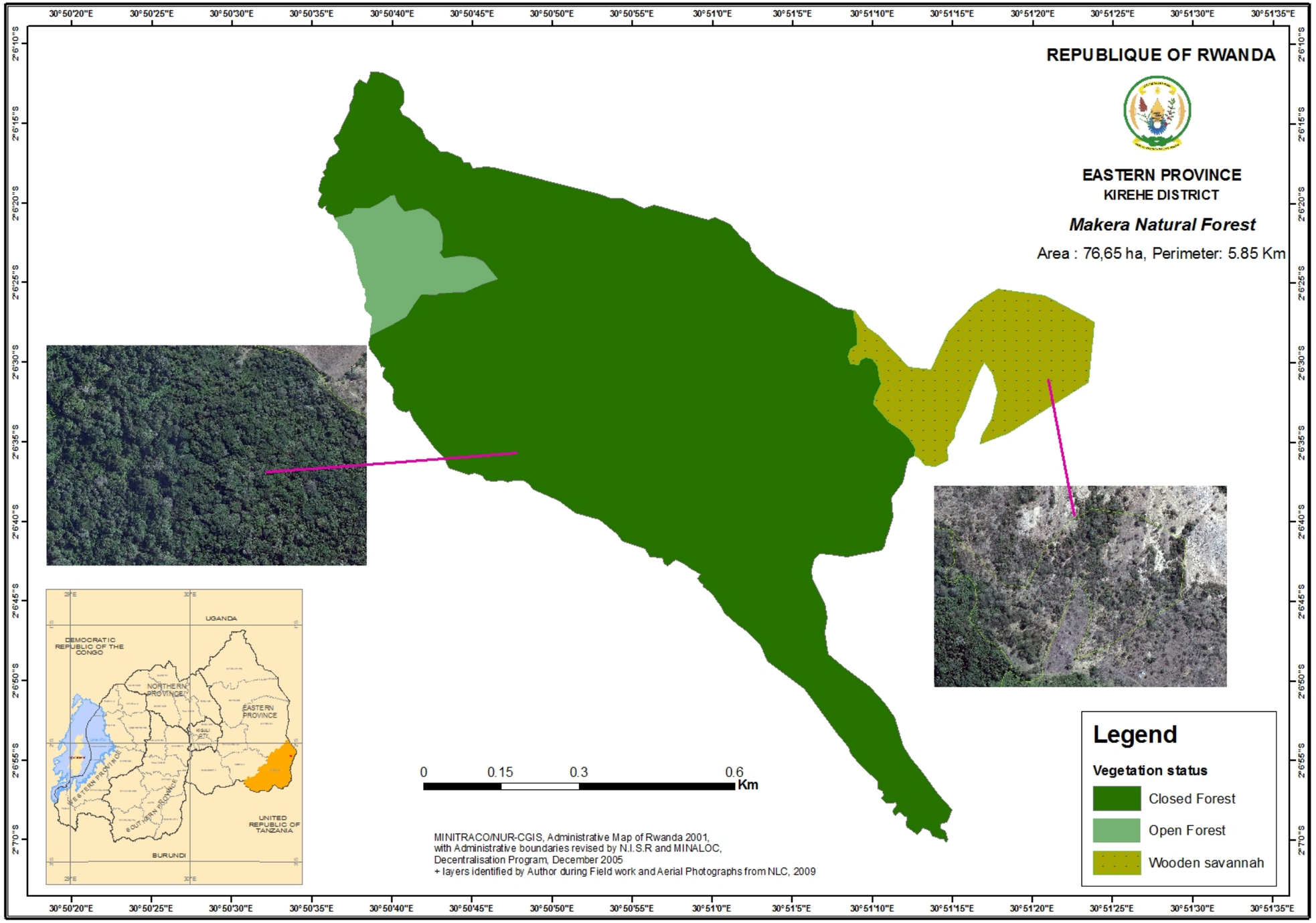


Figure 11: Ibanda-Makera Natural Forest

3.9. Nyagasenyi Natural Forest

Located in Eastern Province, Nyagasenyi natural forest (also known as Bishop Kayinamura forest) falls under Kirehe District, Gahara Sector. It is shared between 2 cells: Nyagasenyi in the North and Nyakagezi in the South. It covers 4 villages: Gatare and Nyamisagara (North), Rwambanda (East) and Mukundanyi (Mukundanyi). In the Western part, it is associated with a wetland which is connected to Cyunuzi wetland in East and Rwagitugusa wetland in the North which in turn is connected to Akagera wetland in the extreme South. The remnant forest is now under destruction by being cleared for agriculture.

Nyagasenyi Natural forest is owned by Catholic mission of Gahara. It has been preserved because it was useful to local community for its richness in medicinal plants.

Photo 14: Nyagasenyi Natural Forest

It is a small but very useful forest to biodiversity conservation. It hosts very rare tree species in the region like *Anthocleista grandiflora* and *Syzygium cordatum*, also known to be medical. The forest contains also various species like *Blighia unijugata*, *Trimeria grandiflora*, *Zanthophyllum chalybeum, Clausena anisata* and *Bridelia micrantha.* The piedmont levels were dominated by a ticket of sub shrubs of *Cordia Africana, Albizia sp.* and *Acacia divsp.* covered by lianas like *Paulinia pinnata, Tacazzea floribunda, Ficus asperifolia, Rhoicissus tridentata* and *Neorautanenia mitis.* Other remnant species are represented by *Sapium ellipticum, Maesa lanceolata, Mitragyna rubrostipulata*, *Blighia unijugata* and *Albizia gummifera.*

The forest is especially known for its richness in reptiles particularly venomous snakes like cobras, *Naja melanoleuca* and *Naja nigricollis* and mambas represented by *Dendroaspis jamesoni kimosae*. Nyagasenyi forest is also home to very big snakes like *Pithon sebae*. This carnivorous snake is generally fed on small mammals found in the swamp or in the forest like monkeys.

Monkeys dominating the forest are composed by *Cercopithecus dogetii* populations. This species is normally found in Nyungwe National Park and it is the only area in eastern province that it is recorded. Within Nyagasenyi forest, these monkeys are mainly fed on fruits of *Syzygium cordatum* while in Nyungwe they have a large array of food sources due to the high plants diversity of the park. These monkeys attract tourists in the sector but they are threatened by the smallness of the forest beside agriculture encroachment. They are

also isolated from any other population in Rwanda (Nyungwe populations) and can suffer in long term from genetic drift. Moreover, the carrying capacity of Nyagasenyi forest looks like very limited. In long term, these monkeys should also suffer from mass effect. Ecologically, beyond the biodiversity richness, Nyagasenyi forest protects water source for Rwagitugusa swamp. It plays the role of water cleaner and retention before it is drained into the swamp.

In sum, Nyagasenyi forest is a remnant valley forest in eastern province which is intermediate between low land and mountain forests. So many mountain and low land plants and animal species have found refugia in that small forest. It is a unique forest of that kind in the region and should get more attention in terms of restoration and conservation.

Nyagasenyi forest is very important for Rwanda traditional life. The information provided by local people revealed that this ecosystem used to be a site for the preservation of medicinal plants that were harvested and used by Bare traditional healing clinics.

Till now, no ongoing conservation measure concerns Nyagasenyi forest. It is subsisting because it is a property of Catholic Church in Gahara which does not need to exploit it. However, with the development of geranium (*Pelargonium graveolense*) plantation which is commercial, the whole ecosystem (forest and associated wetland) is expected to be jeopardized at the expense of economic income to the local population.

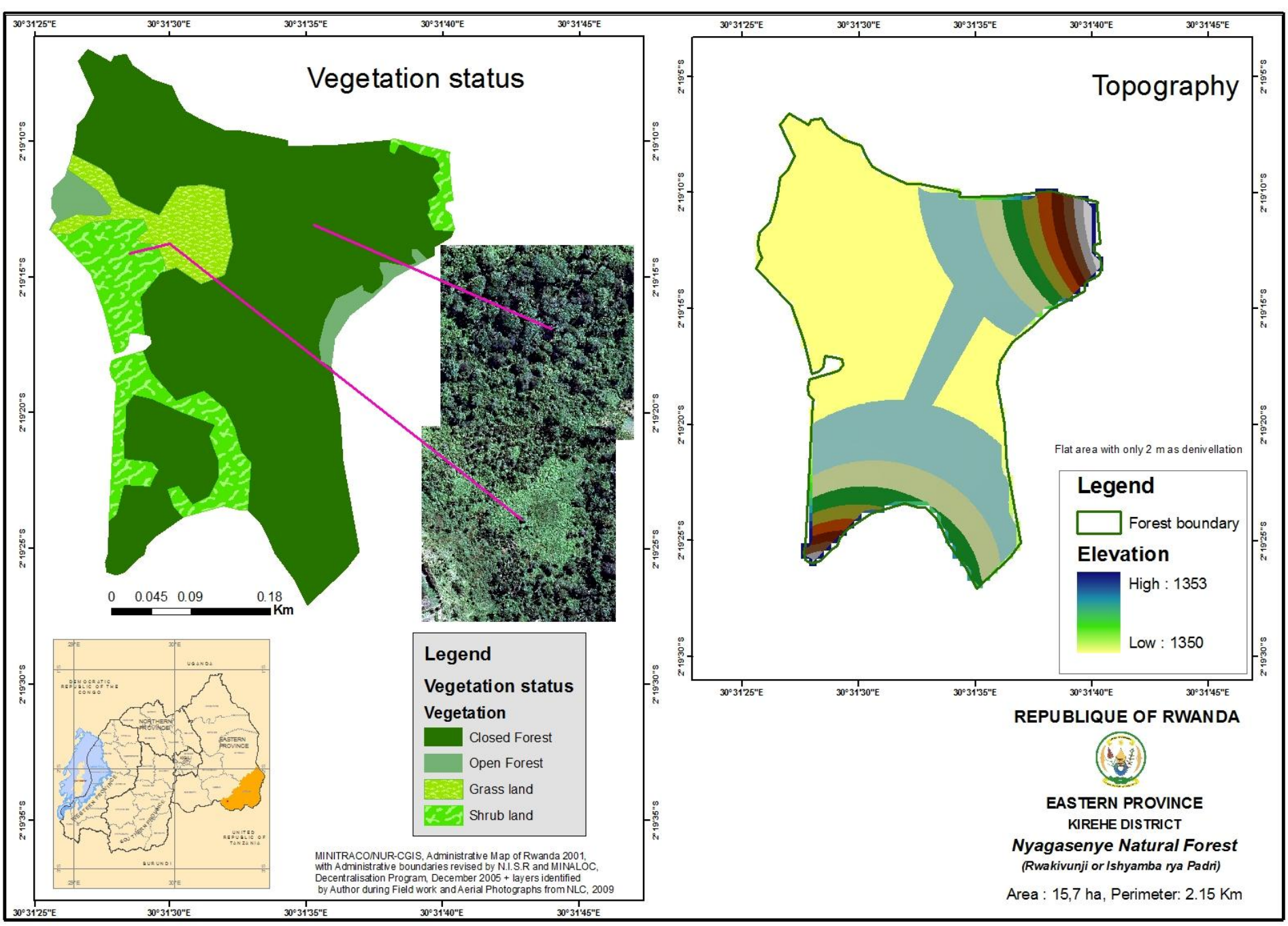


Figure 12: Nyagasenyi Natural Forest

3.10. Nyenyeri Natural Forest

This large farm of more than 200ha is situated along Akagera River from Munini to Mwoga cells located in Eastern Province, Kirehe District in Mahama sector. It is commonly called MINAGRI farm because it belongs to the Ministry of Agriculture and Animal Resources. It is a highly disturbed forest due to intensive husbandry activities, and is characterized by xerophytic vegetation scattered in a wide open shrub savanna. The forest is delimited in the east by Akagera River which constitutes the border with the neighboring Karagwe District in Tanzania. The geological structures of the Nyenyeri forest are quartzite ridges which bear the same pattern along the Akagera River towards Rusumo in the South.

Photo 15: Vegetation and quartzite rocks in Nyenyeri forest

The vegetation of Nyenyeri forest is essentially Soudano-Zambezian. Dry forest patches and semiarid savannas are made up of mostly deciduous and broad-leaved species, dominated by *Acacia-Combretum* association, often accompanied by *Euphorbia candelabrum*, interspersed with grassland. Other species are *Acacia senegal, Acacia sieberiana, Albizia petersiana* and *Lannea sp.* as well as *Hymenocardia acida, Crossopteryx febrifuga, Piliostigma thonningii, Acacia gerrardii* and many *Aloe* species*.* Short grasses comprise mostly *Panicum maximum, Hyparrhenia fiiapendula, Hyparrhenia lecomtei, Eragrostis racemosa,* and *Sporobolus stefianus.* It is also important to mention the presence of *Lantana camara* which has invaded a big part of the forest edges.

The fauna of this forest is mostly dominated by rabbits. Among the birds, *Francolinus nobilis*, *Streptopelis senegalensis*, *Colius striatus* and other water bird species were recorded. Some reptiles (*Naja melanoleuca* and *Python sebae)* were recorded.

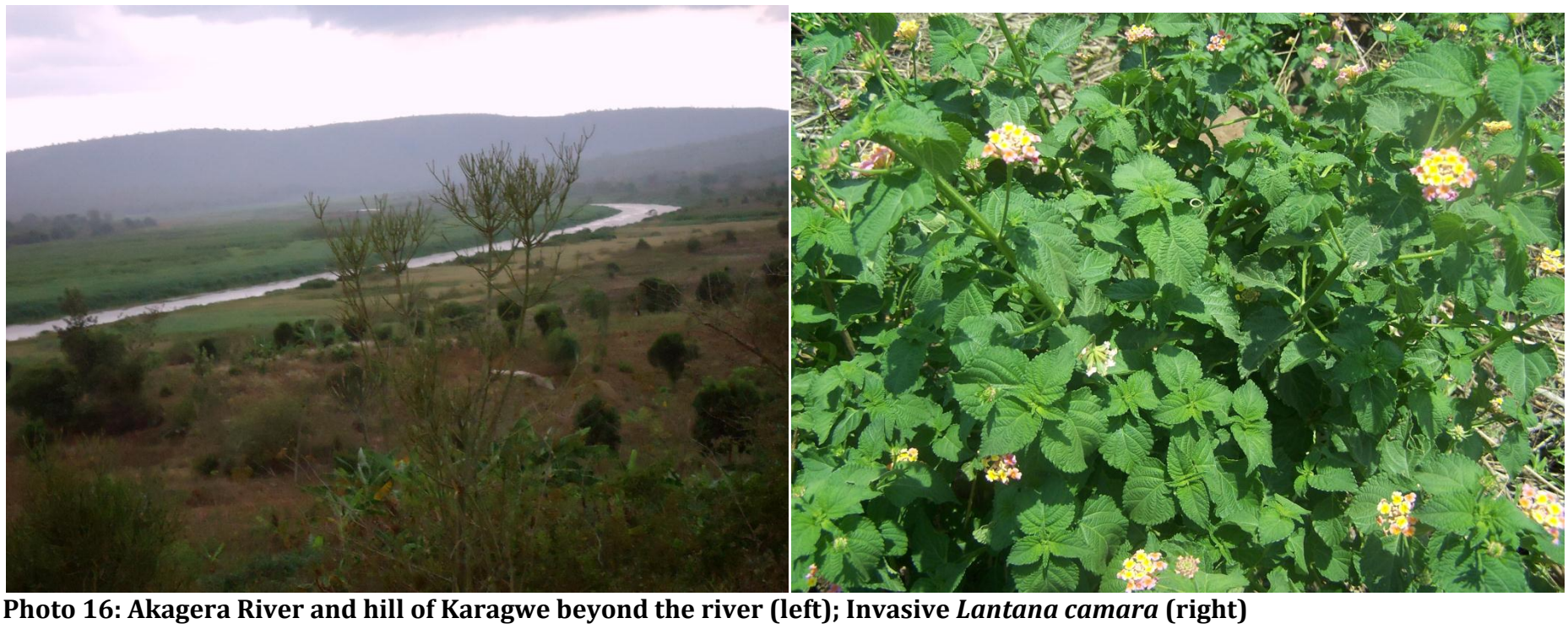


Photo 16: Akagera River and hill of Karagwe beyond the river (left); Invasive *Lantana camara* (right)

Nyenyeri forest allows farming activities, firewood collection and constitutes a land reserve (the government uses this farm as transit site for cows given to people in GIRINKA Program). Although belonging to Nyenyeri, there is no management policy known for its protection, because people continue to cut trees and the intensive cattle rising contributes to its degradation.

Proper mechanisms of conservation should be developed for the integrity of this remnant ecosystem. Indeed, this forest serve as a buffer zone to the Akagera River and the associated wetland which is now cultivated at a very great extent (in contrast to the Tanzanian side). In addition, the local population informed the researchers that some hippos from the swamps of Akagera River often come up in the forest for grazing. Therefore, the protection of the forest should serve as a secure refugium to this semi-aquatic species.

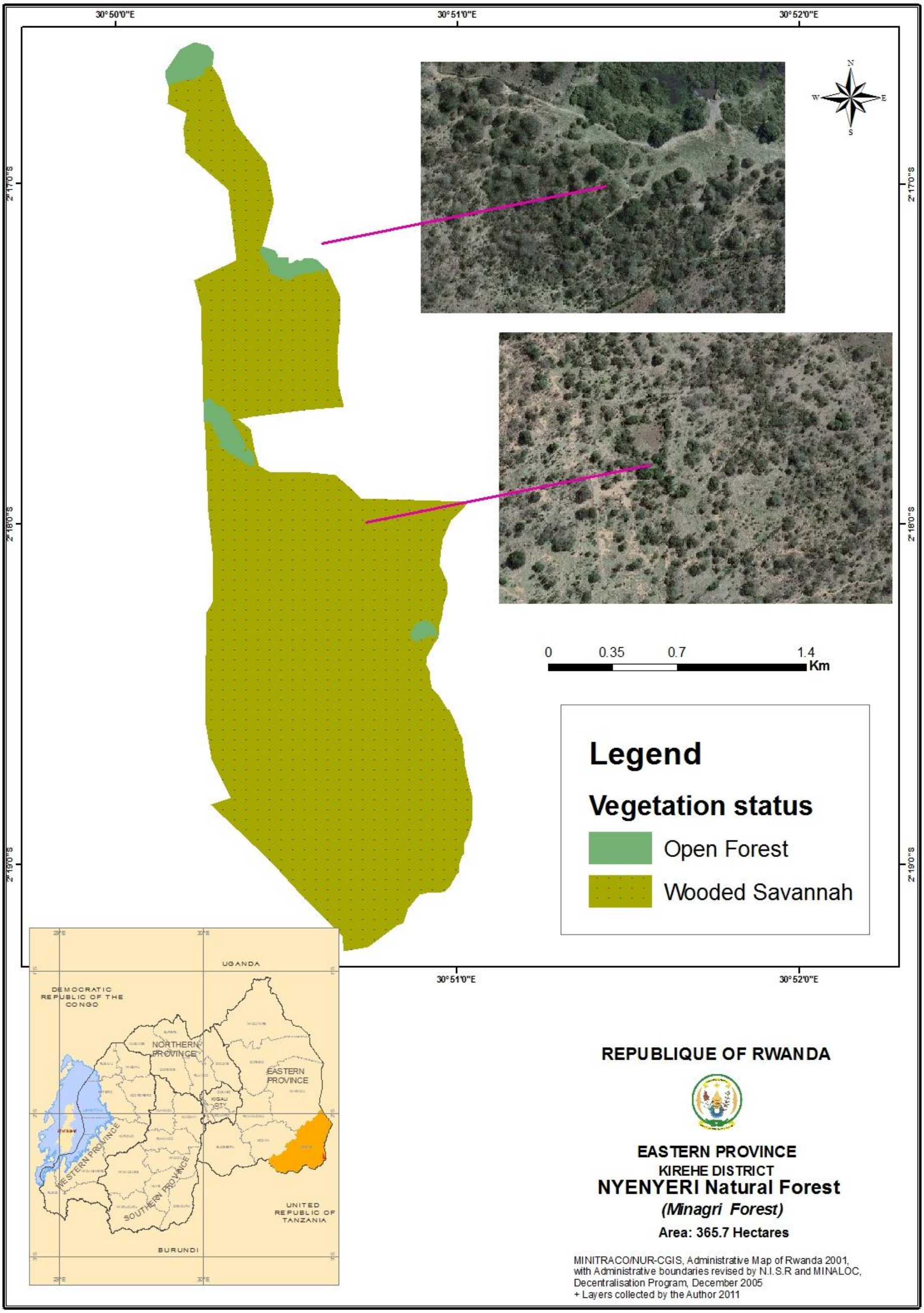


Figure 13: Nyenyeri (MINAGRI) Natural Forest

3.11. Bukora Natural Forest

Bukora forest is located in Bweramana village in the Eastern Province, precisely in Kirehe District, Nyamugali sector, Bukora cell and covers about 4.5 ha of area. Bukora is a disturbed semi-arid open forest characterized by scattered patches of tree groves. The soil is granitic characterized by many granitic 'kopje' spread in the area and many termites' nests. This forest is profoundly marked by human presence and the traces of agro-pastoral occupations can be easily observed. Currently, Bukora is occupied by private farmers who keep their herds in the forest and assure its protection and management.

Photo 17: Bukora Natural Forest

Bukora is rich in biodiversity and hosts many plant and animal species. Among the plants, some indigenous fruit trees including *Pappea capensis, Rhus natalensis, Lannea fulva, Strychnos lucens, Annona senegalensis* and *Parinari curatellifolia* are dominant. Other dominant plant species include *Pericopsis angolensis*, *Combretum collinum, Ozoroa insignis, Acacia brevispica, Markhamia obtusifolia, Erythrina abyssinica, Maytenus senegalensis, Grewia similis, Asparagus africanus, Ficus sp*., etc. The parasitic epiphyte *Tapinanthus myrsinifolius* is also abundant. In addition, orchid species belonging to *Bulbophyllum*, *Cyrtorchis, Polystachia* and *Tridactyle* genera are also very dominant. In the pile of rocks there is a distinctive leafless flora dominated by *Sensevieria cylindrica* and *Scadoxus multiflorus* which is a rare species.

Photo 18: *Sensevieria cylindrica* (left); *Scadoxus multiflorus* (Right)

The fauna is dominated by mammals including rabbits, *Dendrohyrax arboreus* and *Philantomba monticola*. Other mammals include *Canis mesomelas*, *Panthera pardus* and *Cephalophus silvicultor*. With regard to birds, *Bubucus ibis*, *Streptopelis senegalensis*, *Francolinus nobilis*, *Lagonostica rhodopareia* are found. Reptiles which find their refuge in the rocks include *Thelotornis capensis*, *Naja melanoleuca* and *Bitis arietans.*

Photo 19: *Dendrohyrax arboreus*;

Photo 20*: Cephalophus nigrifons* (above)*; Bitis arietans* (below)

Bukora forest is a particular ecosystem as far as habitat is concerned. In fact, its granitic features allow this ecosystem to be a refuge to different mammals and birds mentioned above and which need this kind of habitat to survive. In order to preserve this ecosystem from current threats consisting mainly in tree felling for firewood, hunting and agricultural and pastoral activities, there is a need of establishing a co-management system between private farmers and local government.

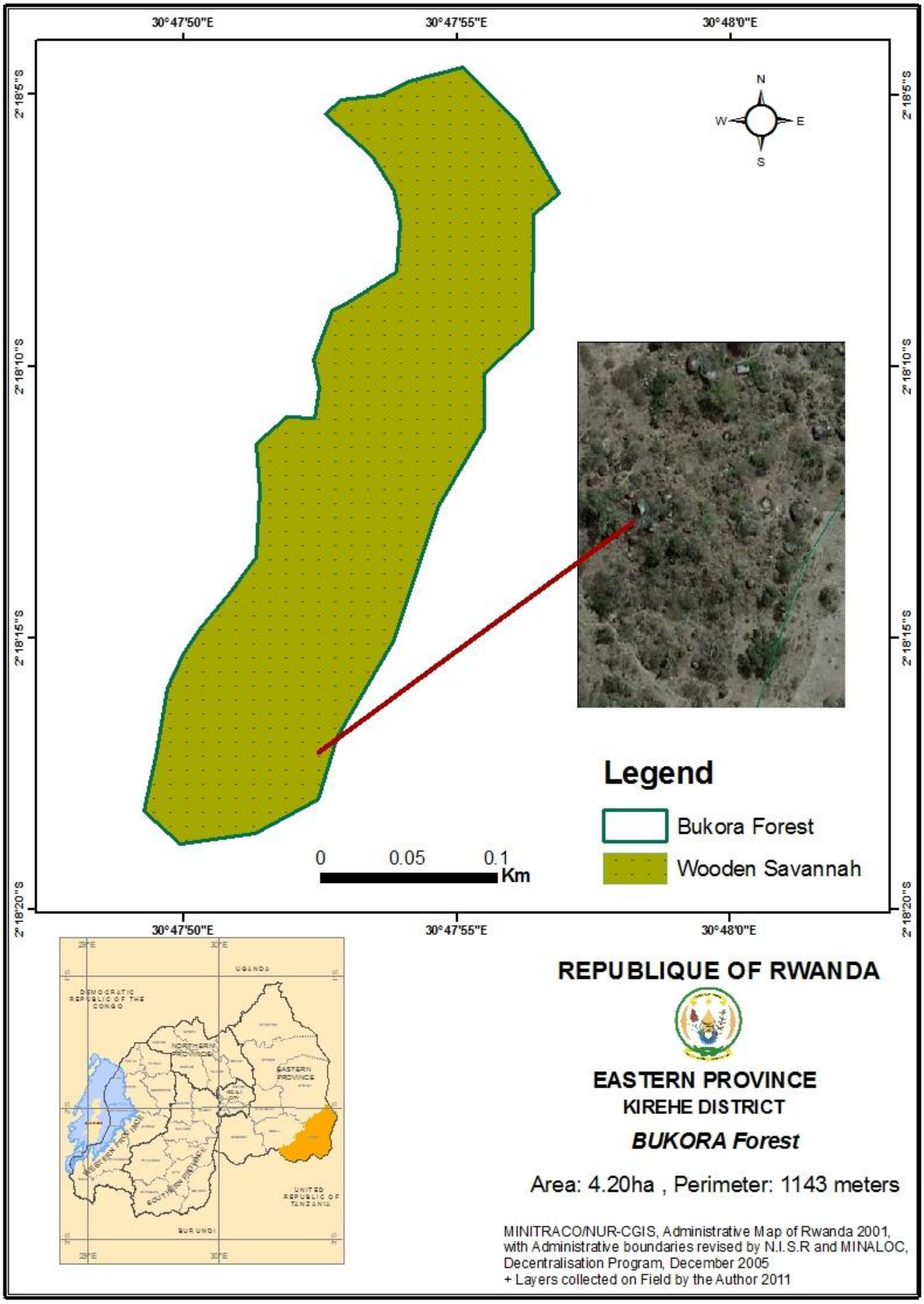


Figure 14: Bukora Natural Forest

3.12. Rujambara Natural Forest

Rujambara forest (also known as Rugomero) has been protected but not officially since 80's by local administration of that time. Since then, it has been considered by local community as a protected area, reason why it is till now existing. It is surrounded by agriculture systems and is not connected to any other similar ecosystem. It is a quite isolated ecosystem for many species. However, within areas of extensive agriculture, remnant ecosystems constitute refugia for many plant and animal species.

With regard to vegetation and plant diversity, Rujambara forest is an amazing ecosystem in the sense that it hosts both mountain plants species like *Prunus Africana* and *Pittosporum spathicalyx* and low land species like *Acacia polyacantha* and *Vangueria volkensii. Prunus Africana* is a very much sought-after species due to its pharmacological properties especially in treating prostate cancer. It is now under CITES protection. Many epiphytes orchids can also be observed on oldest trees of *Pterygota mildbraedii* and *Acacia polyacantha*. The most common orchids are represented by *Tridactyle anthomaniana* and *Aerangis ugandensis*.

Rujambara accommodates also the former biodiversity of the region such as large reptiles like *Pithon Sebae, Varanus niloticus,* cobras like *Naja melanoleuca* and *Naja nigricollis,* and other very big snakes known by local people under the name of Muzehe (old in Swahili).

Photo 21: *Aerangis ugandensis* (left); *Naja nigricollis* (right)

It also shelters some mammals especially monkeys like *Chlorocebus aethiops* which form very large populations totalizing more than four hundred individuals. This number is too high that actually local community has started to complain because those animals use to come out the forest and destroy surrounding crops of rice, sweet potatoes, maize…

Many birds' species have also found refugia within Rujambara forest. Most the birds species encountered in that ecosystem are dominated by generalist species-species with ability to survive in disturbed habitats. However some particular birds'species like migratory birds have also been observed: *Cuculus solitarius, Merops apiaster, Lanius collurio and Lanius minor.*

Photo 22: ***Chlorocebus aethiops*** **(left);** ***Cuculus solitarius*** **(right)**

Rujambara forest plays not only a biodiversity reservoir but also a very important ecological role in terms of erosion control and water sources used for domestic purposes by local communities. East province is known to be dry and water shortage is a common phenomenon in the region. All swamps have been drained causing water loss on a very high speed. Some dams have been built to irrigate rice crops and because of pesticides and many other fertilizers used in those swamps, water has become undrinkable. Rujambara water sources can therefore be considered as a gift from heaven for local communities.

However, it is on another side a very threatened forest due mainly to agriculture encroachment, poaching and removal of plants biomass for various purposes. Albeit delimited by *Draceana steudeneri* markers, it is not enough to prevent encroachment. There is an urgent need to establish this forest as a protected area co-managed by local community as far as most of the people are aware of the importance of that ecosystem.

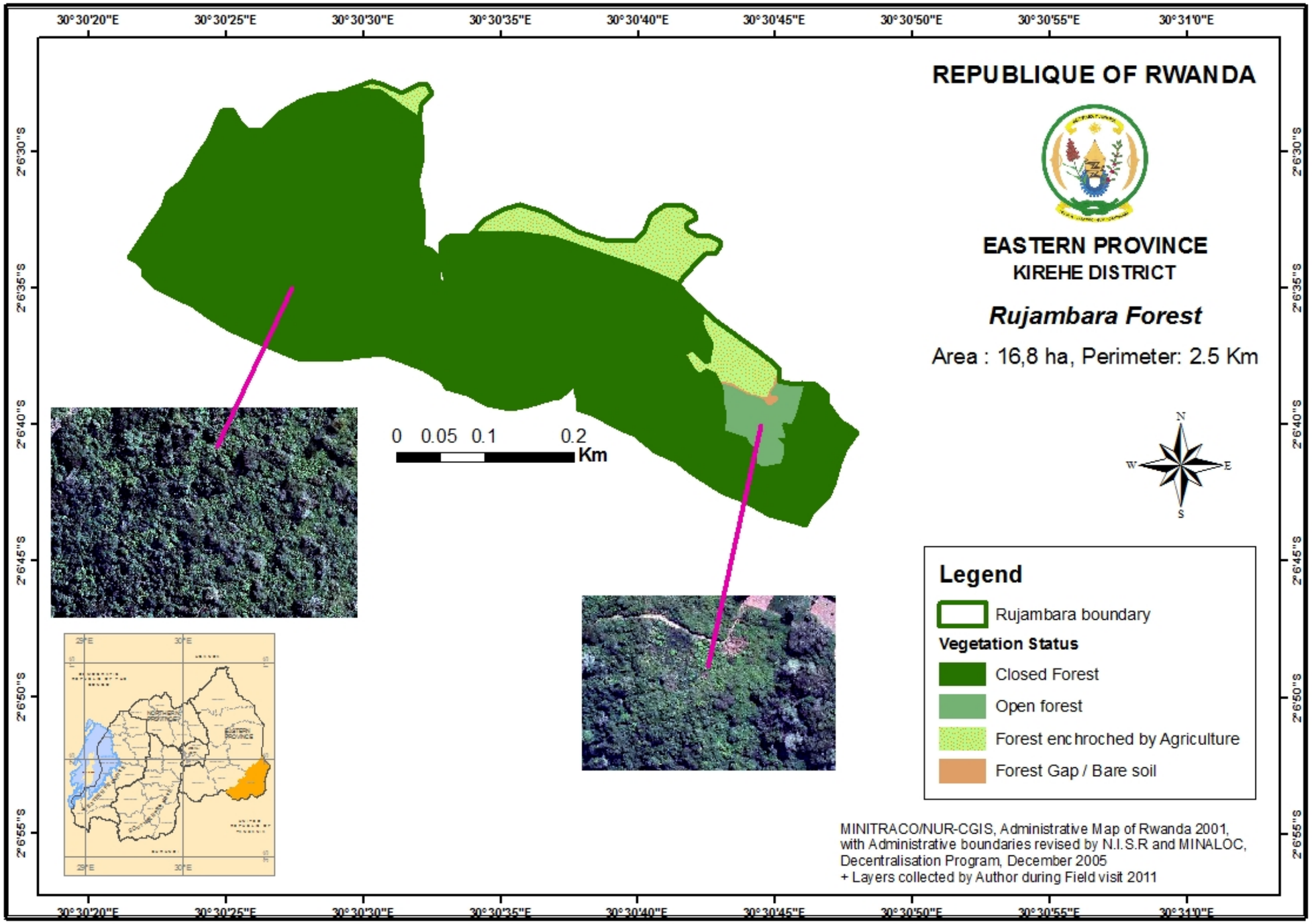


Figure 15: Rujambara Natural Forest

3.13. Muvumba Natural Forest

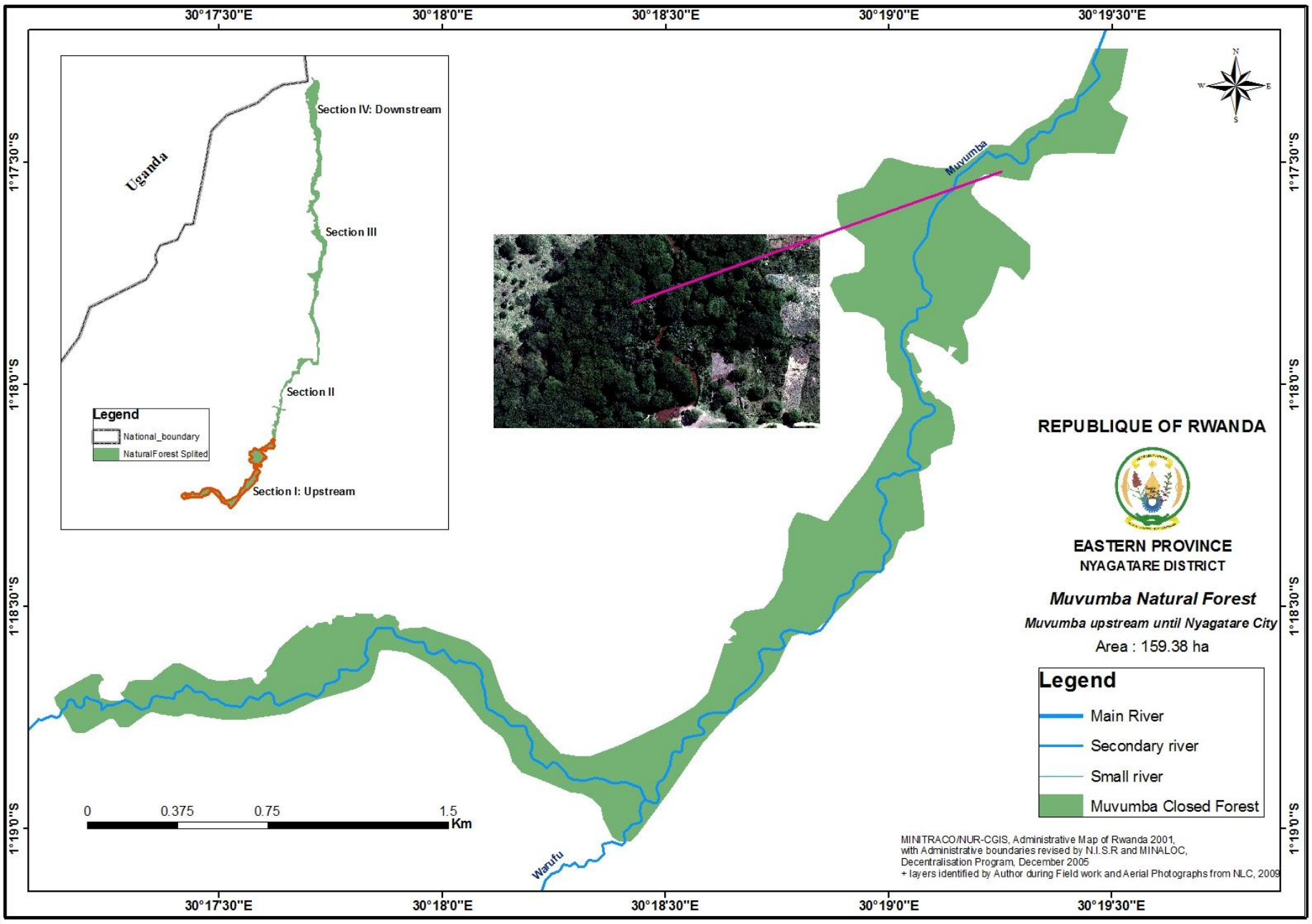
Muvumba gallery forest is located in Eastern Province, in Nyagatare District. It is extended in Karama, Gatunda, Tabagwe, Nyagatare, Rwempasha, Musheri and Matimba sectors. The forest covers Muvumba River. The later takes its source in south-western highlands of Uganda. The forest shelters a relict gallery forest constituted mainly by *Acacia kirkii*. The later species is endemic to Rwanda and it is not occurring elsewhere in the Great Lakes Region.

Photo 23: *Acacia kirkii* vegetation alongside Muvumba River

Apart from predominant *Acacia kirkii*, some accompanying species like *Pavetta ternifolia*, *Dovialis macrocalyx* and *Acanthus pubescens* have been observed during field trip in the region.

The fauna living in Muvumba Forest are mainly mammals such as Velvet monkeys, Baboons and antelopes, as well as reptiles such as *Naja nigricollis, Naja melanoleuca*, *Thelothornis*, *Trachylepis varia* and *Trachylepis striata*. Muvumba Forest accommodates also various birds species and the most dominant birds species are *Anastomus lamelligerus*, *Leptoptilos crumenofurus*, *Falco concolor* and *Balearica regulorum*. The latter is threatened and endangered species and therefore deserves special protection. In fact, it is a bird species related to wetlands and which is now restricted in some areas remaining intact.

Muvumba River and its gallery forest face various threats. The predominant *Acacia kirkii* species are threatened to extinction because of anthropogenic activities such as farming, settlement, firewood collection and agriculture. Considering agriculture itself, there is currently a project of rice cultivation along Muvumba valley. Muvumba River was deviated towards its original source to allow irrigation of rice crops developed in the river's flood plain. As a result of irrigation design, several derivation branches from the main river channel will be formed. This will increase not only the distance covered by Muvumba route, but also the water will lack shadow protection as it would be the case in the natural conditions. This situation will dramatically cause water loss because it is likely that evaporation rate will get increased. Without any mitigation measure, there is a big likelihood that in the nearest coming future, water shortage will be a serious problem in the region. Rice crops yield would be likely good for the first three to five years but the valley should be abandoned due to water shortage for irrigation scheme. Other negative effects would be also the severe disturbance of biodiversity conservation and local habitants' livelihood as Muvumba River is the main stream in the region. However, some conservations efforts are being undertaken for the protection and conservation of this precious ecosystem. Typical, example of deployed conservation measures, of Muvumba gallery forest project are being implemented by a non-governmental membership association called ACNR (Association pour la Conservation de la Nature au Rwanda). This project aims at enhancing the value and conservation of Muvumba relict forest by raising awareness on its importance amongst local communities (ACNR, 2010).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Uganda
Section IV: Downstream
Section III
Section II
Section I: Upstream
Legend
National_boundary
NaturalForest Splited
Muvumba
Warufu
0
0.375
0.75
1.5
Km
REPUBLIQUE OF RWANDA
EASTERN PROVINCE
NYAGATARE DISTRICT
Muvumba Natural Forest
Muvumba upstream until Nyagatare City
Area : 159.38 ha
Legend
Main River
Secondary river
Small river
Muvumba Closed Forest
MINITRACO/NUR-CGIS, Administrative Map of Rwanda 2001,
with Administrative boundaries revised by N.I.S.R and MINALOC,
Decentralisation Program, December 2005
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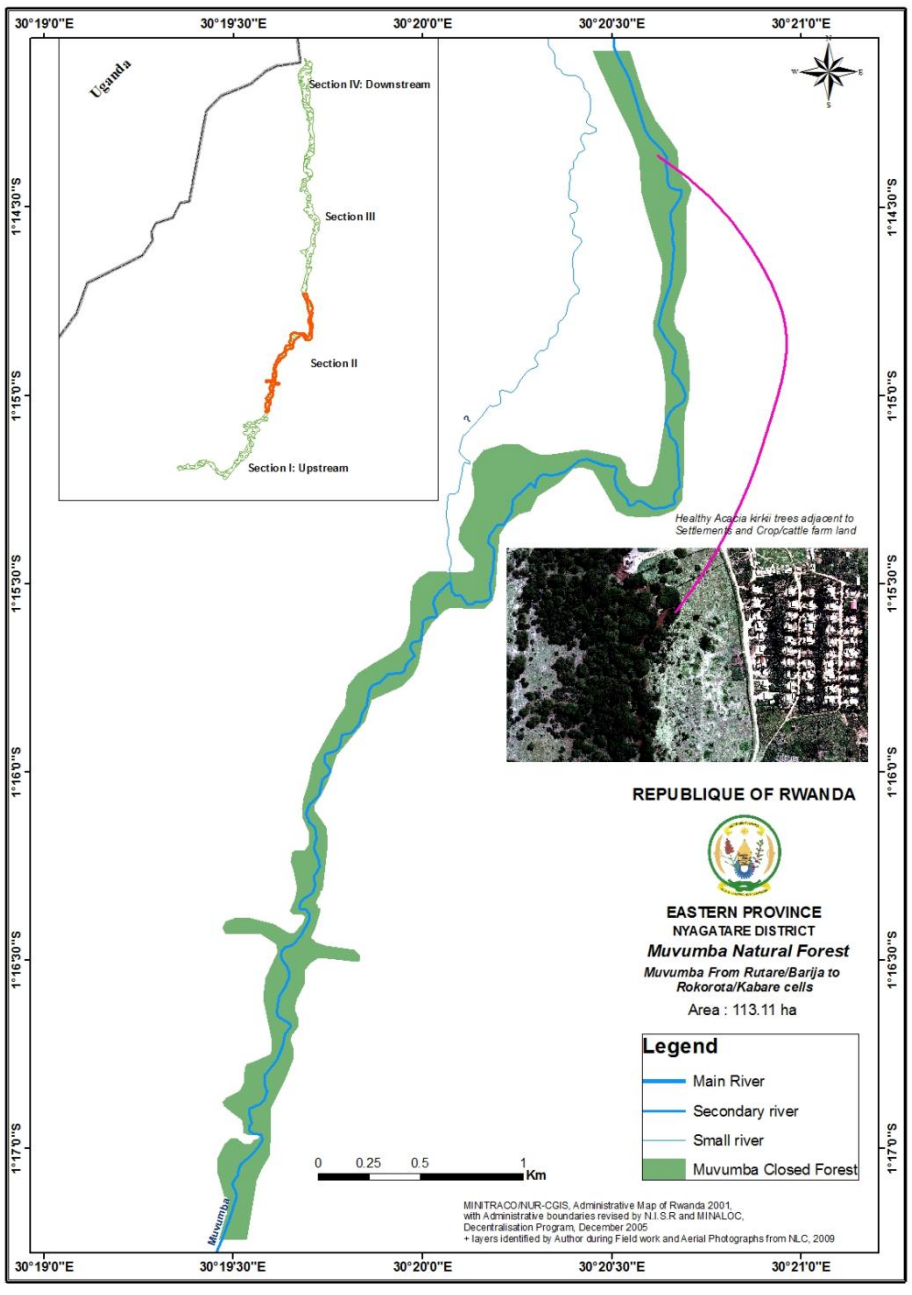
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1°16'30"S
1°17'0"S
Uganda
Section IV: Downstream
Section III
Section II
Section I: Upstream
Healthy Acacia kirkii trees adjacent to
Settlements and Crop/cattle farm land
REPUBLIQUE OF RWANDA
EASTERN PROVINCE
NYAGATARE DISTRICT
Muvumba Natural Forest
Muvumba From Rutare/Barija to
Rokorota/Kabare cells
Area : 113.11 ha
Legend
Main River
Secondary river
Small river
Muvumba Closed Forest
0
0.25
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Km
Muvumba
MINITRACO/NUR-CGIS, Administrative Map of Rwanda 2001,
with Administrative boundaries revised by N.I.S.R and MINALOC,
Decentralisation Program, December 2005
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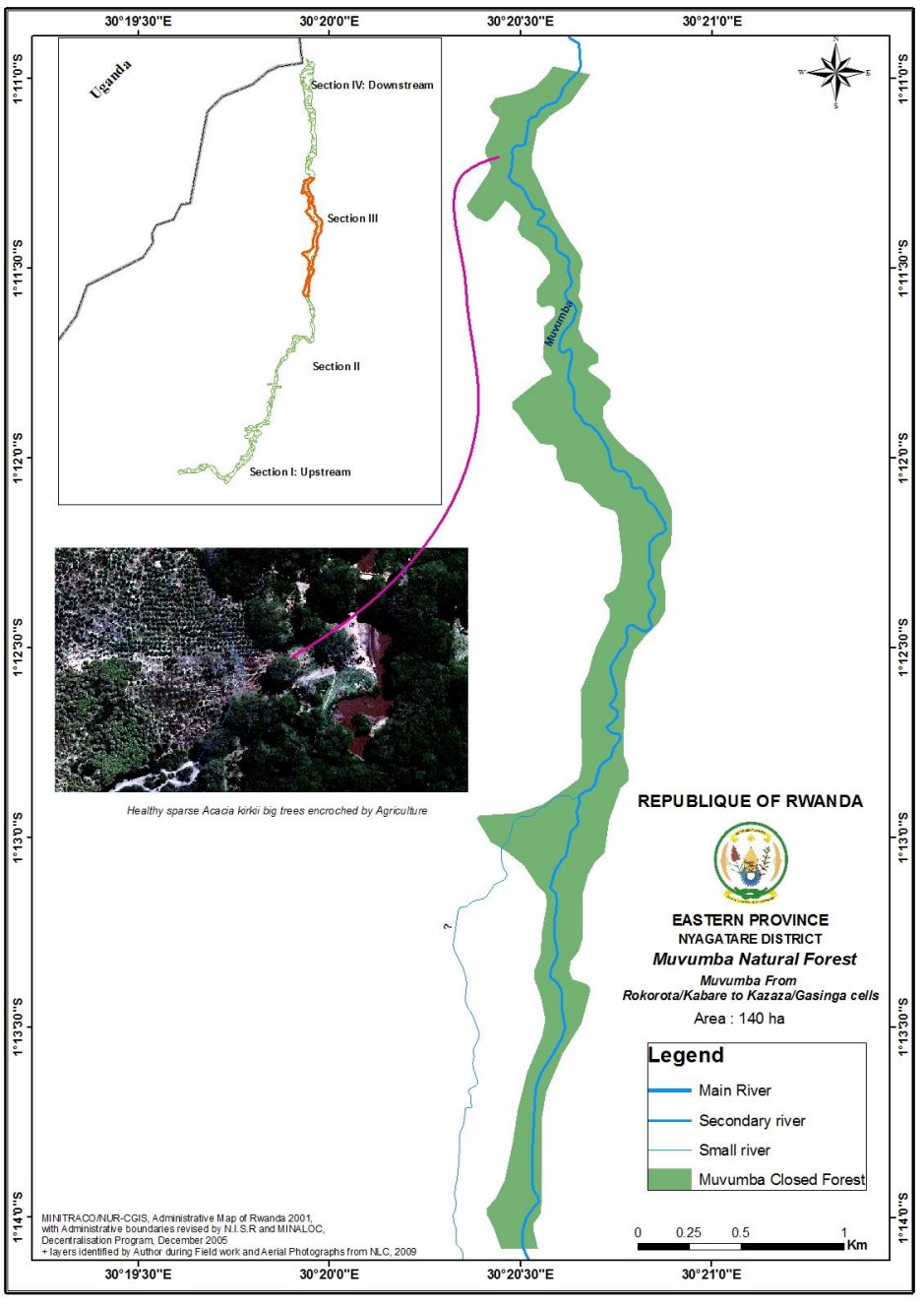
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1°14'0"S
Uganda
Section IV: Downstream
Section III
Section II
Section I: Upstream
Muvumba
Healthy sparse Acacia kirkii big trees encroched by Agriculture
REPUBLIQUE OF RWANDA
EASTERN PROVINCE
NYAGATARE DISTRICT
Muvumba Natural Forest
Muvumba From
Rokorota/Kabare to Kazaza/Gasinga cells
Area : 140 ha
Legend
Main River
Secondary river
Small river
Muvumba Closed Forest
0
0.25
0.5
1
Km
MINITRACO/NUR-CGIS, Administrative Map of Rwanda 2001,
with Administrative boundaries revised by N.I.S.R and MINALOC,
Decentralisation Program, December 2005
+ layers identified by Author during Field work and Aerial Photographs from NLC, 2009

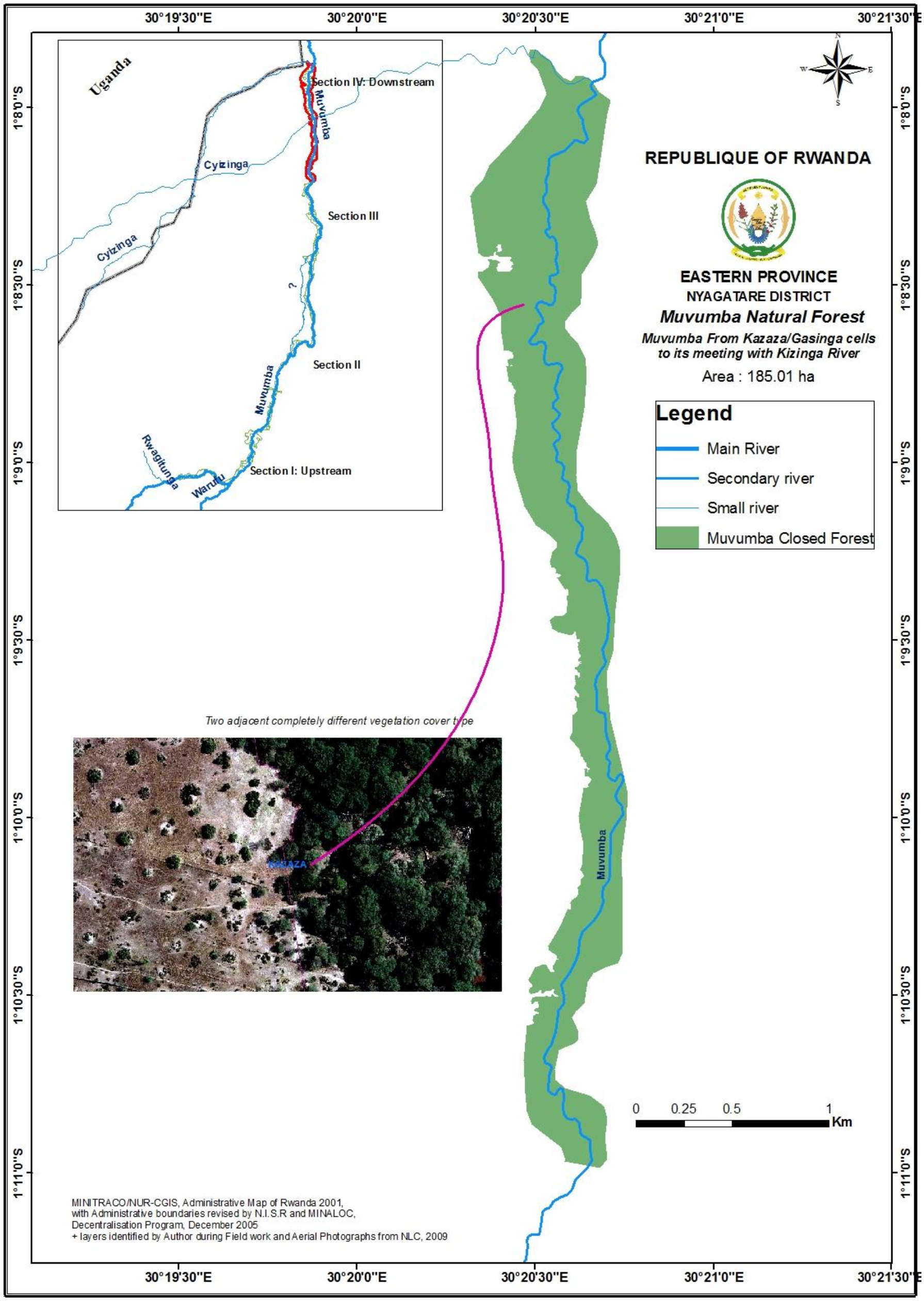


Figure 16: Muvumba Natural Forest

3.14. Karama Natural Forest

Karama Forest (commonly known as ISAR KARAMA Forest) is located in Gashora Sector within Bugesera District in the Eastern Province. It is shared between Mwendo and Ramiro Cells, at an altitude of 1337 m. Karama Forest is a natural dry forest characterized by diversified habitats. The main patterns are composed of xerophytic plants and tiger bushes. The forest is bordered by Kirimbi and Gaharwa Lakes in the South-eastern side, where the gallery forest is dominant. This forest makes part of the Bugesera savanna relicts and is adjacent to Gako military domain, separated by the tarmac road in the West. The forest covers about 80% of the total area (about 1000 ha), while 20% is used for agroforestry, husbandry, agriculture, etc. The forest is under the management of former ISAR KARAMA (now RAB KARAMA) where different research activities of agriculture and cattle breeding are conducted.

Photo 24: A general view of Karama Natural Forest (above and left below); Kirimbi Lake (right below)

Karama forest is rich in plant diversity dominated by trees and shrubs of *Rhus natalensis, Grewia similis, Grewia bicolor, Acokanthera schimperi, Vepris nobilis, Afrocanthium lactescens, Psydrax schimperiana, Euphorbia candelabrum, Osyris lanceolata, Olea europea* var. *Africana, Pappea capensis, Euclea schimper, Haplocoelum foliorosum, Ozoroa insignis, Dichrostachys cinerea, Strychmos lucens, Markhamia obstusifolia, Boscia angustifolia* var. *corymbosa, Acacia hockii, Acacia gerardii, Capparis tomentosa, Carissa eduli, Maytenus senegalensis, Lannea fulva, Combretum molle, Gardenia ternifolia, Flacourtia indica, Scutia myrtina, Ximenia caffra* (preferred edible fruit tree), *Kigelia africana, ….* Most of these species are used for various purposes particularly in traditional medicine.

This forest is also rich in orchid species among which *Microcoelia* is the dominant genera. Some herbaceous species characteristics of low altitude savannas and xerophyllous forest are also abundant. Some of them are *Themeda triandra*, *Hyparrhenia filipendula, Sporobolus pyramidalis, Loudetia simplex, Asparagus africanus, …* Alongside the Kirimbi Lake, many species of *Cyperus sp*. are observed.

Photo 25: ***Ximenia caffra*** **(left above);** ***Microcoelia globulosa*** **(right above);** ***Kigelia Africana*** **(below)**

Concerning the wild fauna, the forest is home to mammals like rabbits, *Chlorocebus aethiops* and *Herpestes ichneumon.*

Karama forest plays an important role as a refuge to many grassland and woodland snakes. These include *Naja nigricollis*, *Naja melanoleuca, Vipera aspic* and *Opheodrys vernalis*. On the side of the lakes, there live also snakes related to areas of permanent water like *Python sebae*.

Photo 26: *Python sebae* killing an antelope (left); *Naja nigricolis* (right)

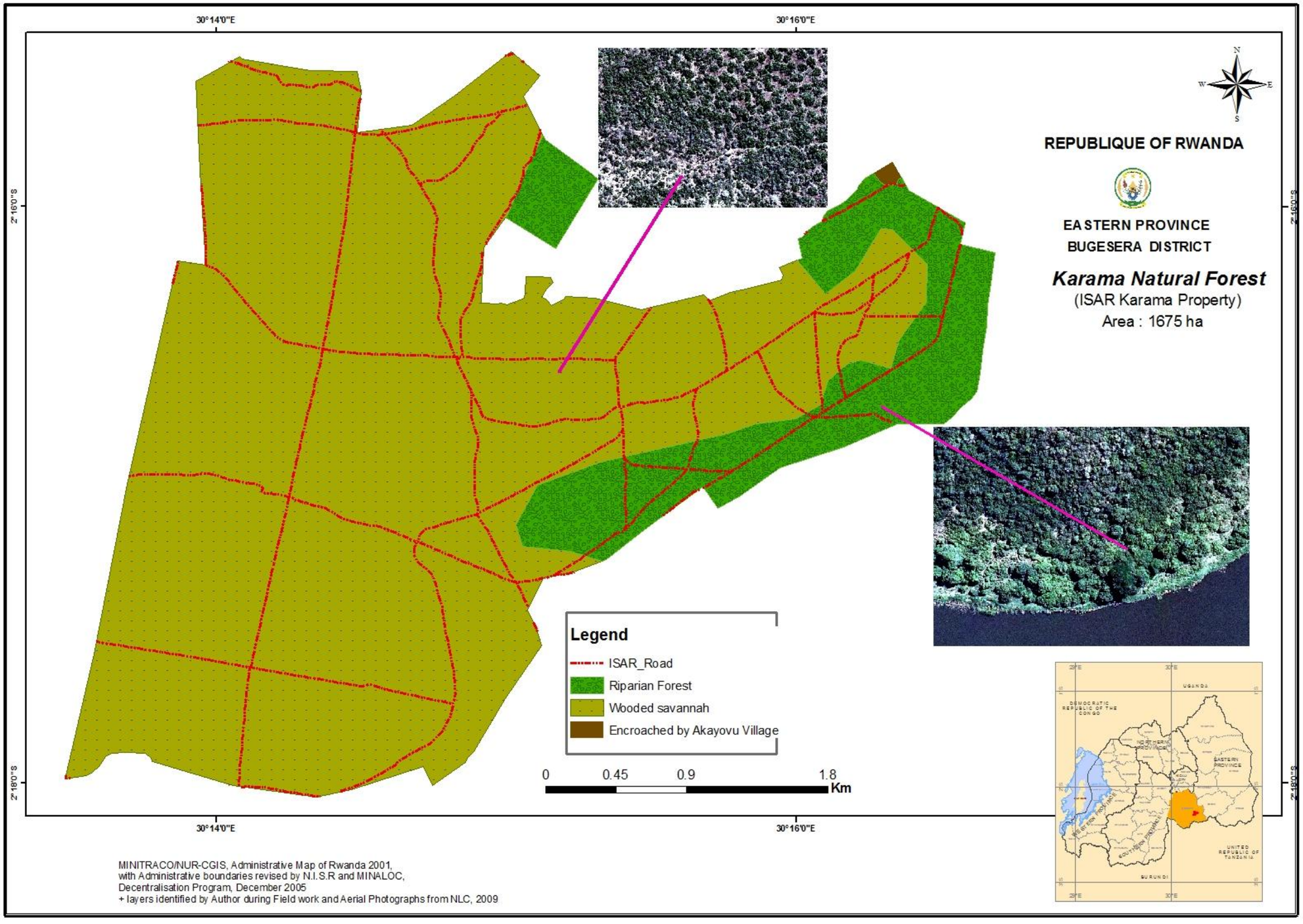
Some bird species were also recorded (*Ceuthmochares aereus*, *Streptopelis senegalensis*, *Lamprotornis purpuropterus, Francolinus nobilis*, *Bulbucus ibis*, *Pycnonotus barbatus*, *Ceryle rudis* and *Cossypha caffra*).

Photo 27: *Lamprotornis purpuropterus* (left); *Ceryle rudis* (Right)

Karama forest plays a big role by providing edible and medicinal plants. Indeed, several plant species that it hosts are used to manufacture drugs by traditional healers to cure certain particular affections of which bites of the snakes relatively frequent in this area.

Furthermore, the forest plays a paramount ecological role in preventing erosion and eutrophication of surrounding aquatic systems. It also contributes in climate mitigation by reducing evaporation on water surface. The forest also serves as food source and habitat for different animal as well as bird nests for bird species. Karama contributes in general in the maintenance of the ecological balance of the Bugesera region (rainfall regulation, soil cover and improvement …).

Among the threats posed to this ecosystem, the population pressure which rely highly on the forest for their subsistence ranks the first. Some of activities are agriculture, hunting, firewood collection, charcoal making that lead to the forest degradation. The agro-pastoral encroachment and fire wood collection are the essential challenges to this ecosystem. To prevent these threats, RAB is currently delimitating the forest by establishing a buffer zone. The institution contributes also in sensitizing people about its protection. It was observed, however, that the poaching activities are far from stopping, which might be due to the big size of the forest and means limitations of controlling (an example is that people continue to cut trees and burn charcoals).


30°14'0"E
30°16'0"E
2°16'0"S
2°18'0"S
N
W
E
S
REPUBLIQUE OF RWANDA
EASTERN PROVINCE
BUGESERA DISTRICT
Karama Natural Forest
(ISAR Karama Property)
Area : 1675 ha
Legend
ISAR_Road
Riparian Forest
Wooded savannah
Encroached by Akayovu Village
0
0.45
0.9
1.8
Km
MINITRACO/NUR-CGIS, Administrative Map of Rwanda 2001,
with Administrative boundaries revised by N.I.S.R and MINALOC,
Decentralisation Program, December 2005
+ layers identified by Author during Field work and Aerial Photographs from NLC, 2009

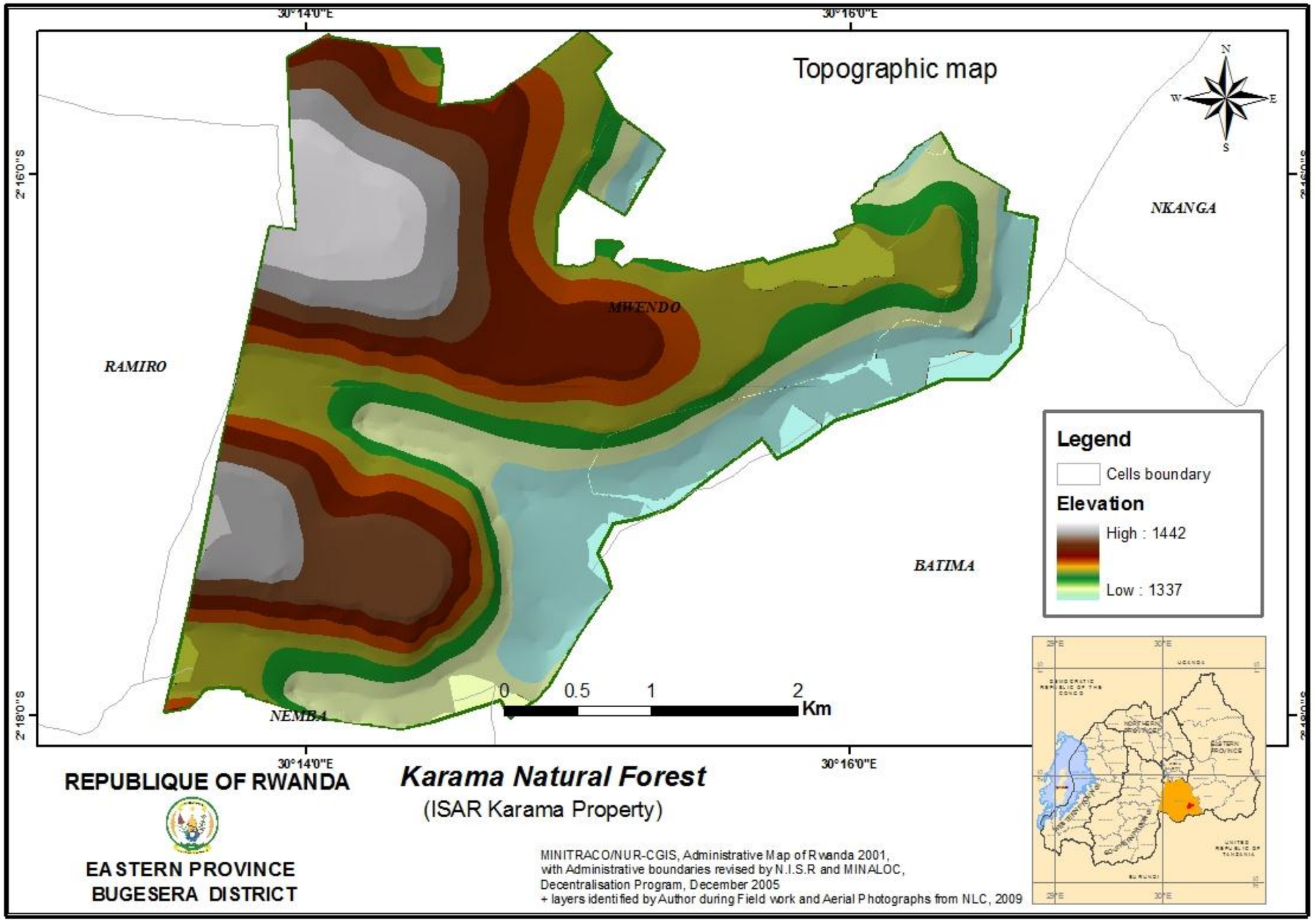


Figure 17: Karama Natural Forest

3.15. Gabiro, Gako and Nasho military domains

1) Gabiro

Gabiro military domain is located in Gatsibo District, Kabarore Sector in the Eastern Province. It is in continuity with Akagera National Park through Rwimbogo sector in its eastern part. It is generally divided into two main vegetation types of planted forest dominated by *Eucalyptus* species and wooded savannah dominated by A*cacia* species. This natural forest provides habitat to a large fauna of birds, mammals and snakes.

2) Gako

Located in Bugesera District, Mayange Sector in the Eastern Province, Gako military domain shares the same topographic, ecological and biodiversity features with the neighboring Karama natural forest. Indeed, these two natural forests look pretty alike besides that Gako is bigger than Karama in terms of area, and of course flora and fauna diversity.

3) Nasho

Nasho forest and related ranches and farms are located in Kirehe District, Mpanga Sector in the Eastern Province are characterized by rocky soil, sharp slopes and the scarce of water that constitute an obstacle to the population to inhabit and cultivate in those areas. These hills conserved the natural vegetation composed by dense shrubs characteristic of dry forests. According to local population the landscape shelters also some bird species, small mammals *Papio anubis, Cercopithecus doggetti*, *Chlorocebus aethiops*, ... as well as many snakes.

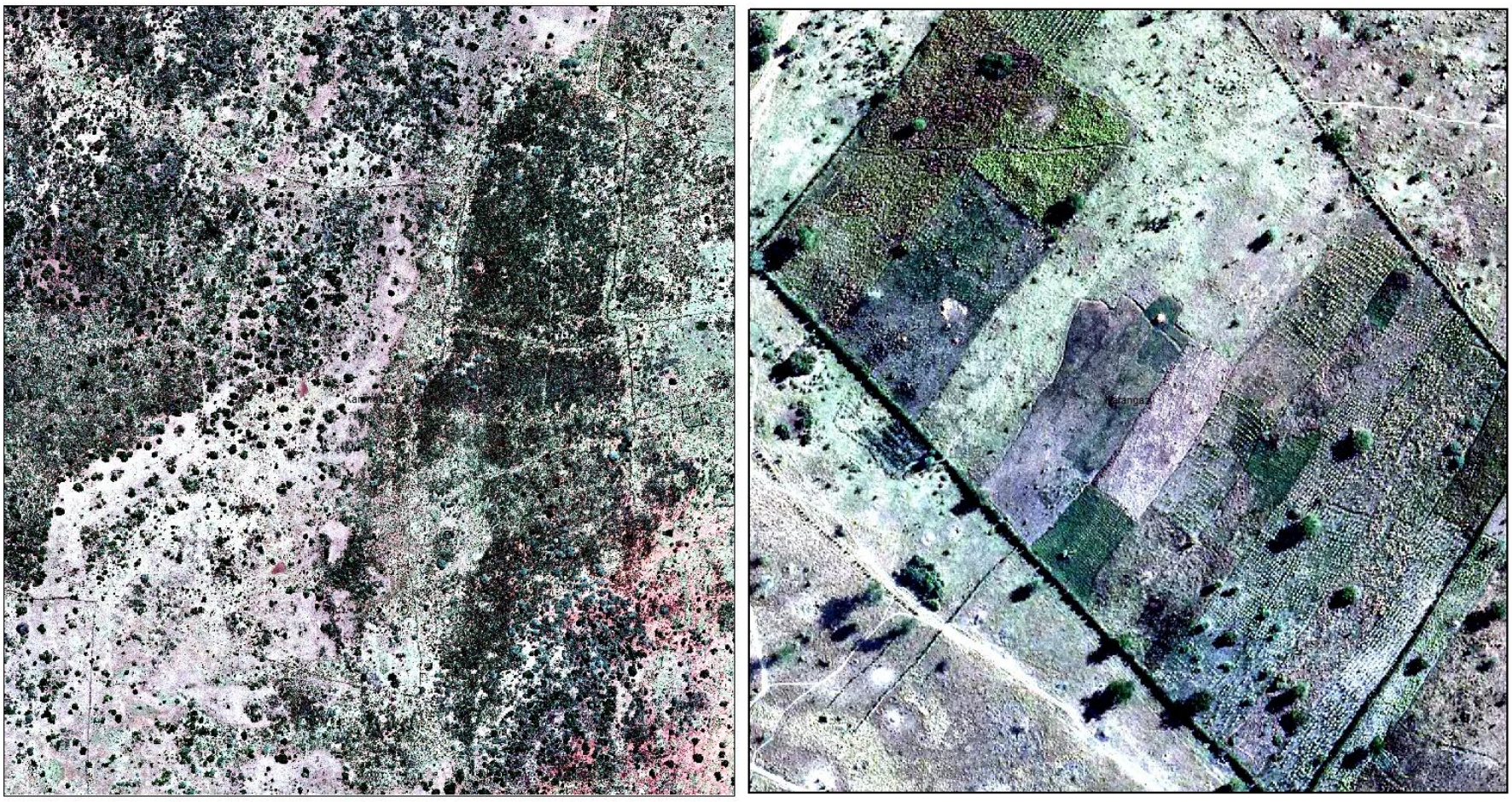


Figure 18: Gabiro Military Domain

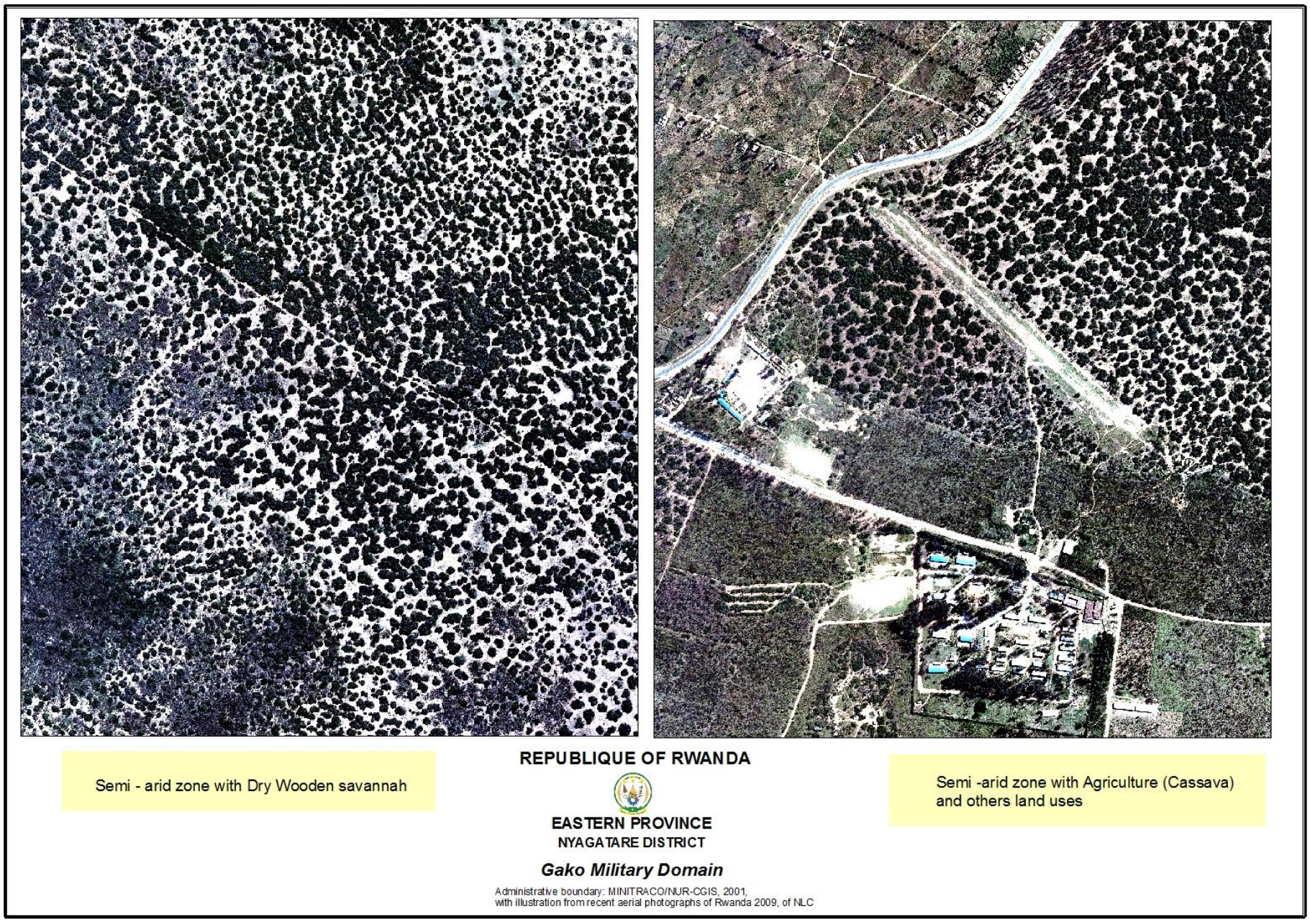


Figure 19: Gako Military Domain

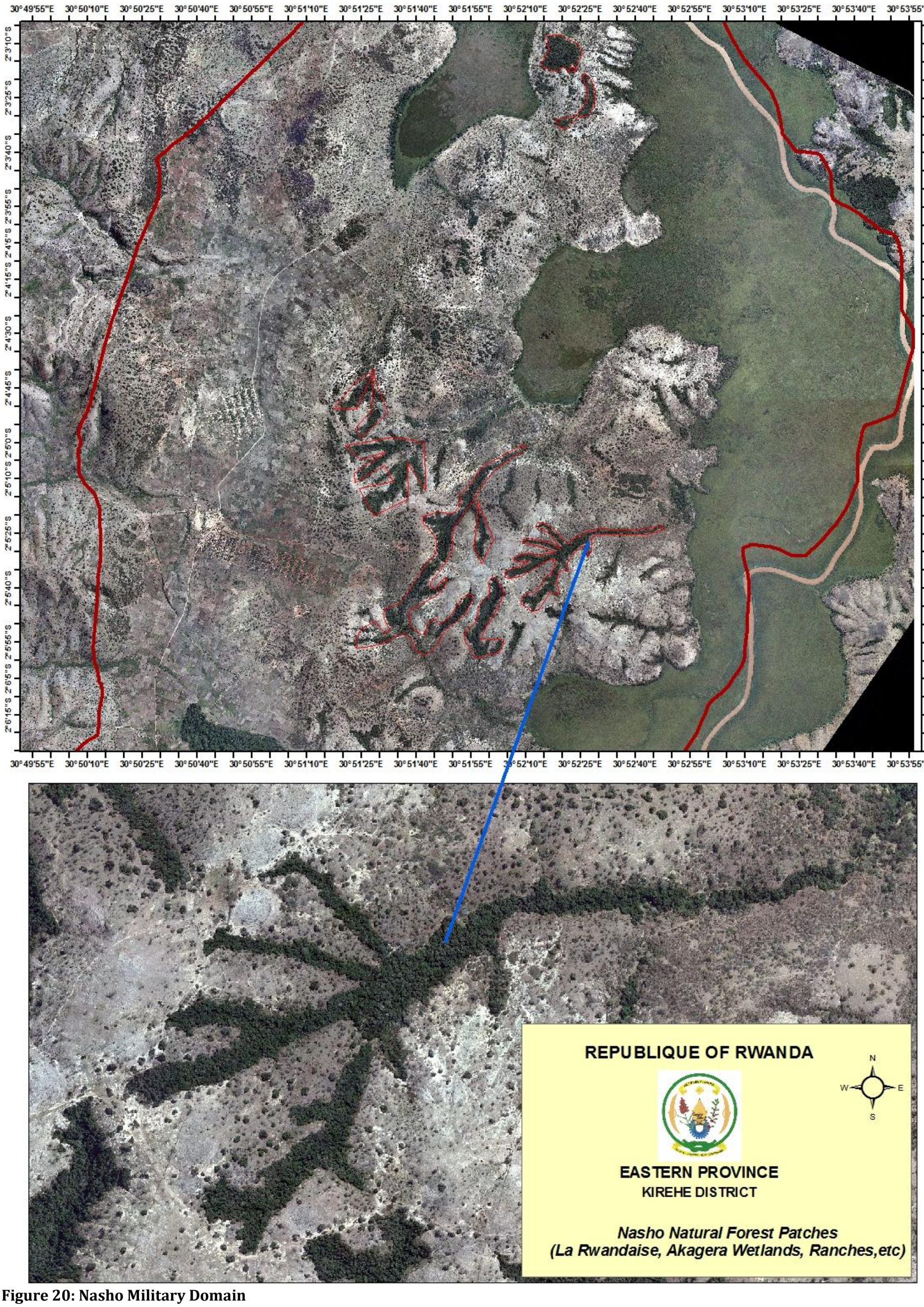


Figure 20: Nasho Military Domain

D. SOUTHERN PROVINCE

3.16. Busaga Natural Forest

This montane rain forest is located in the Southern Province, Muhanga District, Rongi Sector and Ruhango Cell. The forest has an estimated area of 151 ha, at an elevation of 1900-2000m. In its pristine condition it was a thick forest but over the years it has undergone significant degradation. Busaga is limited at the north by Sumo stream and the chains of Ndiza in the West.

The dominant plant species are *Macaranga neomildbraediana, Maesa lanceolata, Dombeya torrida, Chrysophyllum gorungosanum, Albizia gummifera, Xymalos monospora, Dracaena afromontana, Ficus toningii, Ficus oreodryanum, Tabernaemontana stapfiana*, *Myrianthus holstii*, *Albizia gummifera, Neobutonia macrocalyx, Dalbegia lacteal, Polyscias fulva, Bersama abyssinica, Sercostachys scandens, Mimulopsis violacea, Chassalia subochreata, Clutia abyssinica* and *Vernonia lasiopus.*

Photo 28: Busaga Natural Forest

The forest is also habitat to animals including *Cercopithecus doggetti, Cephalophus nigrifrons* and *Profelis auratua* endemic to central Africa, and some jackal species. Busaga also hosts some birds like Turaco and many species of reptiles such as *Bitis arietans* and *Thelotornis capensis*.

Photo 29: *Cercopithecus doggetti* (left); *Profelis aurata*(right)

This forest provides benefits to the local population as a source of firewood, medicinal plants, honey etc. Besides, Busaga holds a cultural interest because it was considered as a sacred forest in the past years. This forest was used by the kings of Rwanda who performed cultural rituals to reinforce their power and to strengthen the army before starting a war against other kingdoms. The forest was also used by kings and chiefs to ensure their family's wellbeing. In addition, there is a myth that the forest is habitat to animals and plants

fetishes which protect the forest from destruction and these are the same species which were sought by the kings of Rwanda for their rituals. In addition, this relict forest plays an ecological role in that it contributes in the protection of the frequent soil against erosion in the region of steep mountains of Ndiza.

As far as threats are concerned, the most important is the agricultural encroachment where people cultivate to the close surroundings of the forest. Another concern is about the digging of the clay for tiles making. Consequently, many trees are cut to make space and others fall down progressively increasing the encroachment to the forest.

Photo 30: Crop fields near and inside the forest (left); Clay digging for tiles making

The plantations of the *Eucalyptus* around the forest also put a big pressure on the natural vegetation inward the forest, and reduces the diversity of the understorey vegetation.

In the objective of protecting Busaga forest, the local administration had put a live fence of *Caesalpinia decapetala* around the forest to limit the poachers, but the fence is currently completely destroyed. Currently, a project called APEIRWA which aims at protecting Busaga forest has put in place a nursery of *Grevillea robusta* and *Alnus glutinosa* for the restoration of the buffer zone. APEIRWA also plans the cultivation of *Agave sisalana*, *Juncus sp* and *Bambusa vulgaris* species to protect the forest and to contribute to the improvement of local people livelihood in a "Agaseke Project" (a handicraft women association).

APEIRWA uses local guards to protect the forest against poachers which used to disturb it by hunting, and to sensitize local people to limit the encroachment on the forest.

Photo 31: Nurseries for buffer zone and fields prepared for Agave and Juncus planting

Although much work was done to conserve Busaga forests, some crucial issues are still to be tackled. In fact, the current guarding system seems to be inefficient, as long as guards are not paid, therefore not motivated. It is important to guarantee effective protection

of Busaga forest by introducing a kind of professional forest eco-guards so as to ensure law enforcement or alternatively, provide monetary incentives to communities that contribute the most to protect, conserve, and manage threatened ecosystems. It is advisable that the activities of tile making should be stopped as soon as possible, and much effort should be put on stopping the ongoing encroachment by farming activities as well as poaching, by putting in place formal conservation policy to that invaluable ecosystem.

Another important point is the management of the *Eucalyptus* species of the buffer zone which should be harvested or even uprooted to avoid their invasion in core area and the drying out of Sumo stream.

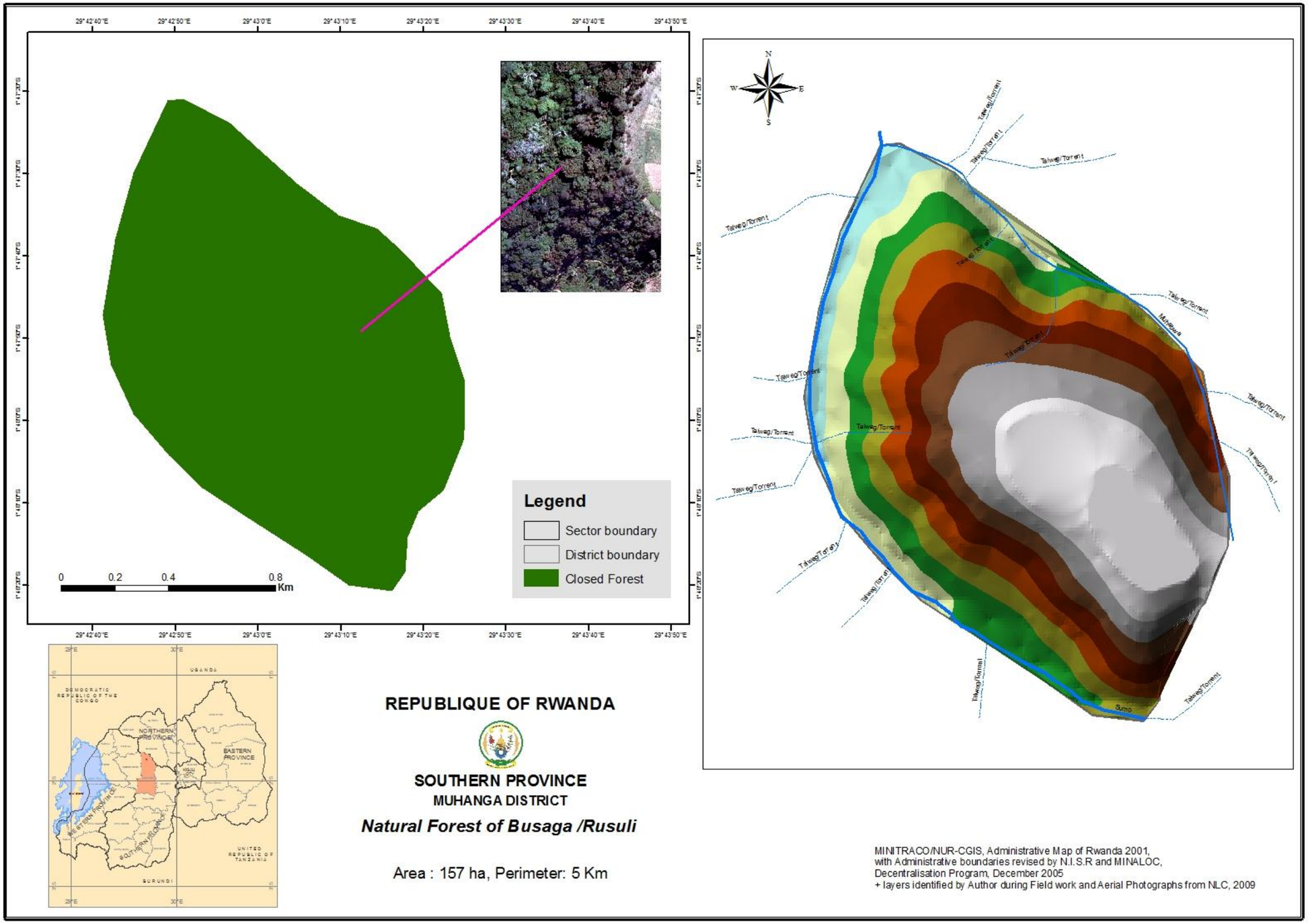


Figure 21: Busaga Natural Forest

CHAPTER 4. IMPORTANCE OF CONSERVATION AND RECOMMENDATIONS

Since 20th century, protected areas have become a cornerstone in global conservation strategy. The number of protected areas is continuously increasing. Since 1975, the total number of protected areas has globally doubled (Ervin 2003a). Despite the deployed efforts in protection and conservation matters, many of suggested measures are not functioning as originally envisioned. Critical ecological processes such as fire, flooding, and climate regimes are also being altered (Lawton et al. 2001, Pringle 2001). Invading species are increasingly menacing other animal and floristic species in protected areas (Stohlgren 1998). Some of the native species have gone extinct in protected areas (Newmark 1987, 1995, 1996). Conservation societies are asking themselves why many of ecosystems in protected areas not functioning well, despite adequate management within their borders. A major reason behind may be that anthropogenic activities especially expansion and intensification of agricultural activities and other land use types in areas surrounding protected areas. And this situation is resulting in change in ecological function and biodiversity reduction within protected areas. Therefore, conservation measures are great of importance for not only losing the fauna and flora richness, but also fighting against imbalance of energy flux within ecological niches and then for not provoking disturbance of normal ecological processes and functions

4.1. Why is it important to conserve natural ecosystems outside protected areas?

While analysis the conservation measures as envisioned by various nations, ecosystems in protected areas are more secured from legal regime point of view. However, the ecosystems located outside protected areas are less given importance despite their richness in term of flora, fauna and cultural heritage. Additionally, the fates of biodiversity in protected areas and in surrounding landscapes are inextricably linked (Schelhas & Greenberg 1996). Moreover, particular types of agriculture, agroforestry, fallow vegetation, and forest patches surrounding protected areas can support not only significant levels of biodiversity (Daily *et al.* 2001, 2003), but also provide valuable ecosystem services, such as carbon sequestration and hydrological protection (Montagnini&Nair 2004).

However, threats on those ecosystems (particularly those outside protected areas) are weighting much because of lacking proper regulatory framework and monitoring system in favor of their integrity. For instance, most of protected areas in tropical regions are embedded within a matrix of heterogeneous land uses and are often directly or indirectly affected by forest fragmentation, road construction, agrochemicals, hunting, cattle grazing, agricultural incursions, fire, invasive species, over-harvest of non-timber forest products, logging, and mining (Janzen 1983, Schelhas&Greenberg 1996).

4.2. To which remnant terrestrial ecosystems in Rwanda a high conservation priority is given and why?

Among the abovementioned remnant terrestrial ecosystems, some of them deserve a special attention for their inclusion in the network of protected areas in Rwanda. In this sub-section, the relevant reasons for turning these ecosystems are discussed.

With regard to low land ecosystems, a special mention is given to Mashyuza Natural Forest due to its uniqueness in Rwanda, as it forms the Northern continuation of Rusizi plain in Burundi and such ecosystem does not exist elsewhere in Rwanda. Moreover, Mashyuza Natural Forest hosts particular species that do not exist elsewhere in Rwanda such as *Sterculia tragacantha* and endemic species that cannot be met anywhere else in the world. This is the case of *Nymphaea thermarum*.

Furthermore, Mashyuza Forest contributes enormously in protecting the water sources feeding the hot spring located in the downward plain. This hot spring is very attractive and potentially important for recreation, scientific research and income generation from tourism. According to IUCN protected areas categories, Mashyuza ecosystem fits better to the category II: area managed mainly for ecosystem protection and recreation. Prior to all conservation measures, the ecosystem needs restoration and reforestation in some of its zones where the former vegetation was cleared.

Beside Mashyuza Natural Forest the low land remnant terrestrial ecosystems located in Eastern province deserve protection for various reasons. Muvumba gallery forest needs to be protected mainly because it considered as water reserve used by important local communities in a big part of Nyagatare District. By analysis the drainage system and by having a look of rice scheme developed in the flood plain, a high risk of water shortage in short term is predictable when the rice cropping project will be implemented. Therefore,

there should be a synergy among all stakeholders involved in managing and developing Muvumba marshland for developing user friendly agriculture for environmental conservation within Muvumba Valley.

Bukora Natural Forest and all other dry forests located in Eastern province can be considered as relicts ecosystems which were formerly connected to Akagera complex. Some biodiversity exchange through species migration is possible between Akagera National Park and those patches scattered in the region particularly for species with good capacity of dispersal. In addition, those low land ecosystems constitute important refugia for many animal and plant species. Given that those ecosystems are located in the drier region of Rwanda, they contribute to climate regulation, refreshment and certainly to climate change mitigation. Many low land lakes located in the Eastern part of in Rwanda are still intact because the abovementioned low land ecosystems are contributing to the reduction of water loss by evaporation. In case those ecosystem are given less importance in conservation, the preserved lakes would disappear as it is the case in neighbouring country of Burundi (in Kirundo province), where many lakes have disappeared because of intense evaporation attributed to accelerated deforestation.

Concerning specifically military domains, they are the largest ecosystems and contribute a lot to biodiversity conservation, climate regulation and mitigation. It is important to find a way between institutions involved in environment and biodiversity conservation for a sustainable management of those ecosystems. This is because they also threatened like any other unprotected area in Rwanda.

Referring to IUCN PA categories, all the above mentioned ecosystems are fitting in Category VI fits better i.e. area managed mainly for the sustainable use of natural resources – area containing predominantly unmodified natural systems, managed to ensure long-term protection and maintenance of biological diversity, while also providing a sustainable flow of natural products and services to meet community needs.

In high lands, it has been inventoried Shagasha, Mukura, Nyabitukura, Buhanga and Busaga forests. All these forests have the common feature to be fragments of mountain forest such as Nyungwe or Gishwati forests. Except Buhanga forest, all the remaining ecosystems are known to protect water sources. They are moreover refugia for many plants and animal species after fragmentation of surrounding zones. Ntendezi forest is less concerned by this aspect because it is a very degraded and poor forest in terms of biodiversity. It is not recommended for conservation while all others should get special attention for their inclusion in the Protected Areas network in Rwanda.

Mukura has been recognized as a Nature Reserve since 1951 but on the field, that forest is as it was not under protection when considering its management status. The law establishing that ecosystem as a nature reserve exists but it is not implemented and therefore, according to IUCN PA definition cannot be considered as a PA. In fact, a protected area is "*an area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and* ***managed through legal or other effective means*** (IUCN, 1994)". The highlighted part of this definition does not match with the reality on the ground for Mukura forest. It deserves therefore more attention for its conservation

CHAPTER 5. CONCLUSION

The aim of this study was to carry out an investigation of location and status of remnant terrestrial ecosystem outside protected areas in Rwanda. A total number of fifteen ecosystems were identified, described and mapped throughout the country. Comparing to other provinces, the Eastern Province possesses the big number of these ecosystems, mainly due to the fact that they are close to Akagera National Park. The predominance of these ecosystems in the region is due to the reduction of 2/3 of its existing areas. Indeed, those ecosystems are found as isolated islands intercepted by agricultural and grazing zones.

In all Investigated zones, the ecosystems were found to have been depleted at a very fast rate. This significant destruction has adversely affected the biodiversity, and constitutes one of the major contributing threats mainly in natural forests. The destruction of the forests is occurring due to various reasons, and one of thethem being the pursuit of short term economic benefits. Some of the more common causes of deforestation consist in land clearance for agriculture, livestock and the cutting down of trees for firewood or charcoal production. Other illicit activities such as anarchic mining imperil the integrity of these ecosystems as well. Nonetheless, these natural ecosystems hold a significant richness in terms of biodiversity and the services they provide. Some of the flora and the fauna are endemic and rare, and therefore need a special attention for their protection and conservation. This is the case of particular plant species found in Mashyuza natural landscape (Bugarama, Rusizi) and leopard species found in some ecosystems of the Eastern Province.

In this regard, we proposed some measures of conservation, and we put an emphasis of establishing a defined management system for each area. Some of the conservation measures should consist in increasing the awareness creation by sensitizing local communities on the importance of biodiversity. The awareness creation will lead to the involvement of local community entities in protecting biological resources, and the promotion of participative conservation of biological resources found in those remnant terrestrial ecosystem. Due to a crucial challenge of encroachment occurring near natural ecosystems, a system should be designed to motivate communities to conserve and manage biological resources. There is also a need for strengthening legal framework and involvement of local authorities to ensure better management of the biodiversity of natural ecosystems outside of protected areas.

Drawing from the main findings for this study, conservation priority should be given to large ecosystems which are able to either sustain biodiversity conservation, or to play significant ecological or economical role. Moreover, ecosystems holding biological significance in terms of biodiversity richness and endemicity should be given high conservation priority.

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APPENDIX

Appendix I: Field data Collection Form

Date:

Time:

Name of the enumerator:

Cell:

Sector:

District:

Province:

Identification number of Ecosystem

GPS readings:

Number	Lat	Long.	Altitude	Map datum	EPE
# 1					
# 2					
# 3					

1. **Site ownerships**
   - 1.1. Public ☐
   - 1.2. RDB (Formal ORTN) ☐
   - 1.3. Private ☐
   - 1.4. Other ☐
2. **Site category**
   - 2.1. Forest ☐
   - 2.2. Wetland ☐
   - 2.3. Others ☐ . Precise ……..
3. **General Observations**:

Ecosystem specificities: Land use:……

……

Main threats:

- Soil erosion ☐
- Agriculture encroachment ☐
- Bush fire ☐
- Poaching ☐
- Others……..

……

Appendix II: List of Plants

Scientific name	Vernacular name	Conservation status
Acacia brevispica	Umugeyo	
Acacia gerradii	Umugunga	
Acacia hockii	Umugenge	
Acacia kirkii	Umunyaryera	
Acacia polyacantha	Umugunga	
Acacia senegal	Umukonji	
Acacia sieberiana	Umunyinya	
Acanthus pubescens	Igitovu	
Acokanthera schimperi	Umusagwe	
Aerangis kotschyana		CITES II
Aerangis ugandensis		
Afrocanthium lactescens	Umukondokondo	
Agave sisalana	Umugwegwe	
Albizia gummifera	Umusebeya	
Albizia petersiana	Umumeya	
Allophylus africanus	Umunywamazi, Umutete	
Alnus glutinosa	Arunusi	
Annona senegalensis	Ikiryohera	
Anthocleista grandiflora	Umuhanurantare	
Anthocleista schweinfurtii		
Asparagus africanus	Umushayishayi	
Bambusa vulgaris	Umugano	
Bersama abyssinica	Umukaka	
Blighia unijugata	Umuturamugina	
Boscia angustifolia var. *corymbosa*	Umuzizi	
Bridelia brideliifolia	Umugimbu	
Bridelia micrantha	Umugimbu	
Caesalpinia decapetala	Umufatangwe	
Capparis tomentosa	Umukorokombe	
Carissa edulis	Umunyonza	
Chassalia subochreata	Umusabanyama	
Chrysophyllum gorungosanum	Umutoyi	
Clausena anisata	Umuno	
Clerodendrum rotundifolium	Ikiziranyenzi	
Clutia abyssinica	Umutarishonga	
Combretum collinum	Umurama	
Combretum molle	Umukoyoyo	
Cordia Africana	Umuvugangoma	
Crossopteryx febrifuga		
Cyperus papyrus	Urukanganga	
Cytorkis aquata		
Dalbegia lactea	Umuhashya	
Dichaetanthera corymbosa	Umuhube	
Dichrostachys cinerea	Umuyebe	
Dodonea viscosa	Umusasa, Umunyuragisaka	
Dombeya torrida	Umukore	
Dovyalis macrocalyx	Umusongati	
Dracaena afromontana	Umuhati	
Dracaena steudneri	Igihondohondo	
Elatostema monticola		
Entada abyssinica	Umusange	
Eragrostis racemosa		
Erythrina abyssinica	Umuko	
Eucalyptus maidenii	Mayideni	
Euclea schimperi	Umushikiri	
Eulophia guinensis		
Euphorbia candelabrum	Umuduha	
Ficus acuta		
Ficus asperifolia		

Ficus cyathistipulata		
Ficus oreodryanum		
Ficus sycomorus	Umukuyu, Umuvumu	
Ficus thoningii	Umuvumura, Umuvumu	
Ficus vallis-choudae	Umudobori, Umurehe	
Flacourtia indica	Urutaka	
Galiniera saxifraga	Ikiryoheramuhoro, Umugaja	
Gardenia ternifolia	Umutarama	
Grevillea robusta	Gereveriya	
Grewia bicolor	Umukomagabo	
Grewia forbesii		
Grewia similis	Umukomagore	
Grewia trichocarpa	Umukoma	
Hagenia abyssinica	Umugeti	
Haplocoelum foliorosum	Umujwiri	
Harungana madagascariensis	Umushyayishayi	
Hymenocardia acida	Umusagamba	
Hyparrhenia filipendula		
Hyparrhenia lecomtei		
Impatiens burtonii var.burtonii	Indondori	
Juncus sp	Ubusuna	
Kigelia africana	Umuvungavungo, Umuremera	
Lagenaria abyssinica	Umutanga	
Lannea fulva	Umusinzigwa	
Lantana camara		
Leucas deflexa		
Macaranga kilimandscharica	Umusekera	
Macaranga neomildbraediana	Umurara	
Maesa lanceolata	Umuhanga	
Markhamia lutea	Umusave	
Markhamia obstusifolia	Umukundambazo	
Maytenus acuminata	Inembwe	
Maytenus senegalensis	Umweza	
Microcoelia globulosa	Ingurukizi	
Microglossa pyrifolia	Umunyuragisaka	
Mimulopsis violacea	Umunayu	
Mitragyna rubrostipulata	Umuzibaziba	
Myrianthus holstii	Umwufe	
Myrica kandtiana		
Neoboutonia macrocalyx	Umwanya	
Neorautanenia mitis	Igitembatembe	
Newtonia buchannani	Umukereko	
Nymphaea thermarum		
Olea europea var. *Africana*	Umunzenze	
Olinia rochitiana	Umusasa	
Osyris lanceolata	Umusheshe	
Ozoroa insignis	Umukerenge	
Panicum maximum		
Pappea capensis	Umuremampongp	
Parietaria debilis		
Parinari curatellifolia	Umunazi	
Paulinia pinnata	Umunyakagongo	
Pavetta ternifolia	Umumenamabuye	
Peddiea rapaneoides	Umusine	
Pelargonium graveolense	Geranium	
Pennissetum purpureum	Urubingo	
Pentas lanceolata		
Pentas zanzibarica var. rubra		
Pericopsis angolensis	Umubanga	
Persea americana	Avoka	
Phoenix reclinata	Umukindo	
Piliostigma thonningii	Ikidahotorwa, Igikongwa	

Pinus patula	Pinusi	
Pittosporum mildbraedii		
Pittosporum spathicalyx	Umukuyu, Umuhisyi	
Platylepis glandulosa		
Polyscias fulva	Umwungo	
Prunus Africana	Umwumba, Umujuga	CITES II
Psychotria mahonii	Ikiryoheramuhoro, Umugaja	
Psydrax parviflora	Umubaruka, Umugomera	
Psydrax schimperiana	Umukiragi, Umunyarutete	
Pterygota mildbraedii	Umuguruka	
Ranunculus bequaertii		
Rapanea melanophroides	Uruneke	
Rhoicissus revoilii	Umumara	
Rhoicissus tridentata		
Rhus natalensis	Umusagara	
Rhus vulgaris	Umusagara, Umuvumburankwavu	
Rumex bequartii	Nyiramuko	
Rytiginia kigeziensis		
Sapium ellipticum	Umushashi, Umusurirabakonzi	
Scadoxus multiflorus		
Scutia myrtina	Umugasa, Umunyarutete	
Securidaca longepedunculata	Umunyagasozi	
Sensevieria cylindrica		
Sericostachys scandens	Umukipfu	
Smithia elliotii var. elliotii		
Sterculia tragacantha	Igikungwe	
Strombosia scheffleri	Umushyika	
Strychmos (strychnos) lucens	Umuhonnyo	
Symphonia globulifera	Umushishi	
Syzygium cordatum	Umugote	
Syzygium guineense	Umugote	
Syzygium parvifolium	Umugote	
Tabernaemontana stapfiana	Umuronzi, Umubaribari	
Tacazzea apiculata	Inondwe	
Tacazzea floribunda		
Tapinanthus myrsinifolius	Ingurukizi	
Tridactyle anthomaniana		
Trimeria grandiflora	Umusabanyama, Umunyarubobi,	
Vangueria volkensii		
Vepris nobilis	Umuzo	
Vernonia kirungae		
Vernonia lasiopsis	Ivumo	
Ximenia caffra	Umusasa	
Xymalos monospora	Umuhotora	
Zanthoxylum chalybeum	Intareyirungu	

Appendix III. List of Birds

Scientific name	Vernacular name	Conservation status	
Acrocephalus scirpaceus	Eurasian Reed Warbler		
Anastomus lamelligerus	African Open-billed Stork		
Apalis personata	Mountain Masked Apalis		
Aquila wahlbergi	Wahlberg's Eagle		
Balearica regulorum	Grey Crowned Crane	CITES II	
Bradypterus graueri	Grauer's Rush Warbler		
Bubucus ibis	Cattle Egret		
Campephaga flava	Black Cuckoo-shrike		
Ceryle rudis	Pied Kingfisher		
Ceuthmochares aereus	Yellowbill		
Cinnyris bifasciatus	Purple-bed Sunbird		
Cinnyris regia	Regal Sunbird		
Colius leucocephalus	White-headed Mousebird		
Colius striatus	Speckled Mousebird		
Cossypha caffra	Cape Robin-Chat		
Cuculus solitarius	Red-chested Cuckoo		
Falco concolor	Sooty Falcon	CITES II	IUCN (Near Threatened)
Francolinus nobilis	Handsome Francolin		
Ispidina picta	African pygmy-kingfisher		
Lagonosticta rhodopareia	Jameson's Firefinch		
Lamprotornis purpuropterus	Ruppell's		
Lanius collurio	Rüppell's long-tailed Starling		
Lanius minor	Lesser Grey Shrike		
Leptoptilos crumeniferus	Marabou Stork		
Macronyx croceus	Yellow-throated Longclaw		
Merops apiaster	European Bee-eater		
Nettapus auriatus	African Pygmy-goose		
Oxylophus levaillantii	Levaillant's Cuckoo		
Parus fasciiventer	Stripe-breasted Tit		
Phalacrocorax carbo	Great Cormorant		
Pitta angolensis	African Pitta		
Pycnonotus barbatus	Common Bulbul		
Scopus umbretta	Hamerkop		
Tauraco johnstoni	Rwenzori Turaco		
Zoothera tanganjicae	Kivu Ground-Thrush		

Appendix IV: List of Mammals

Scientific name	Vernacular name	Conservation status	
Canis mesomelas	Black-backed jackal		
Cephalophus nigrifrons	Black-fronted Duiker		
Cephalophus silvicultor	Yellow-backed Duiker	CITES II	
Cercopithecus doggetti	Silver monkey	CITES II	
Cercopithecus l'hoesti	L'hoest's Monkey	CITES II	IUCN (Vulnerable)
Chlorocebus aethiops	Grivet Monkey		
Dendrohyrax arboreus	Southern Tree Hyrax		
Profelis aurata	African Golden Cat		
Funisciurus pyrrhopus	Tree Squirrel		
Heliosciurus ruwenzorii	Ruwenzori sun squirrel		
Herpestes ichneumon	Egyptian Mongoose		
Herpestes urva	Crab-eating Mongoose		
Hippopotamus amphibius	Hippopotamus		IUCN (Vulnerable)
Hylochoerus meinertzhageni	Forest Hog		
Hystrix africae australis	Porcupine		
Injongo			
Oryctolagus cuniculus	Common Rabbit		IUCN (Near Threatened)
Panthera pardus	Leopard	CITES I	IUCN (Near Threatened)
Papio anubis	Olive Baboon	CITES II	
Philantomba monticola	Blue Duiker		

Potamochoerus porcus	Red River Hog		
Procavia johnstoni	Rock Hyrax		
Thryonomys swinderianus	Ground hog		

Appendix V: List of Reptiles

Scientific name	Vernacular name	Conservation status
Bitis arietans	Puff adder	
Dendroaspis jamesoni kimosae	Jameson's mamba	
Naja melanoleuca	Forest Cobra	
Naja nigricollis	Spitting Cobra	
Opheodrys vernalis	Smooth green snake	
Python sebae	African Rock Python	CITES II
Thelotornis capensis	Twig snake	
Trachylepis varia	Savanna Variable Skink	
Trachylepis striata	Striped Skink	